#2/2026
ZKZ 4712 / € 9,50

sportärztezeitung

Sports Medicine for Physicians, Therapists & Trainers

Regenerative Medicine

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Univ.-Prof. Dr. med. Stefan Nehrer /
PD Dr. med. Markus Neubauer / Alexander Otahal

Prehabilitation

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Parkinson's Disease

Univ.-Prof. Dr. med. Brit Mollenhauer,
Christoph Klein, Sandra Attendorn

Targeted Nutrition

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HIGH-TONE THERAPY

Effects in Players on the German National Wheelchair Rugby Team

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A balanced relationship between load and recovery is essential for improving athletic performance. Efficient regeneration enables continuous progress and prevents persistent fatigue, performance decline, and increased susceptibility to infection. Targeted optimization of recovery can accelerate regenerative processes, allowing a higher training frequency and a greater overall training stimulus, thereby improving long-term performance development.

FIG. 4
Study participants from the German national wheelchair rugby team

High-tone therapy is a special form of electrotherapy in which amplitude (current intensity) and frequency (between 4,096 and 32,768 Hz) are modulated simultaneously. The higher the frequency, the more energy can be delivered according to the patient's individual current-perception threshold curve. It has been established in clinical practice for years and has demonstrated positive effects, particularly in degenerative diseases such as polyneuropathies [6, 7]. Further evidence of efficacy exists for tarsal tunnel syndrome [2], circulatory encephalopathies [8], post-traumatic stress disorders, and traumatic brain injuries [1]. Initial sports-science studies indicate that several weeks of high-tone therapy after intensive strength exercise leads to significant improvements in maximum strength and strength endurance [4, 5]. Whether these effects also transfer to endurance performance is the subject of the present study.

STUDY DESIGN AND PARTICIPANTS

A randomized pre-post design with an intra-individual comparison (within-subject design; arm side: treated vs. untreated) was used. Three women (age: 30.7 ± 16.0 years; BMI: 22.4 ± 0.8 kg/m²) and seven men (age: 31.3 ± 8.2 years; BMI: 22.0 ± 2.8 kg/m²) from the German national wheelchair rugby team participated in the eight-week intervention study. Endurance performance was assessed unilaterally on a hand-crank ergometer using a standardized incremental test (starting load: 10 W; increased by 10 W every 2 minutes until exhaustion). Before and after each exercise stage, lactate and glucose concentrations were determined from capillary earlobe blood by amperometric analysis, along with blood pressure; heart rate was continuously recorded using a chest strap and ECG (Fig. 1).

FIG. 1 Unilateral hand-crank test in one participant

The order of testing the right and left arms was randomized so that five participants were initially tested with the right arm and five with the left. A one-hour passive rest period was observed between the two pretests. After eight weeks, the examinations were repeated under identical conditions; testing took place at the same time of day and in the same order as during the pretest.

INTERVENTION

High-tone treatment was performed using the HiToP® 1touch therapy device with frequencies ranging from 4,096 to 32,768 Hz and was controlled via the SimulFAMi program. Immediately after the pretest, trained personnel instructed the participants in performing the treatment and applying the contact pads with elastic bandages (Fig. 2). The upper limb to be treated was randomly assigned: five participants treated the right arm and five the left. Treatment was self-administered and was to be performed for 60 minutes each day whenever possible. Each participant was provided with a therapy device for the entire intervention period. Individual treatment times were stored in the device.

DATA EVALUATION AND STATISTICAL ANALYSIS

Statistical analyses were performed with IBM SPSS Statistics (version 24). The maximum watt-minutes achieved were defined as the primary endpoint. Heart rate, lactate, glucose, and blood pressure were analyzed as secondary endpoints. Changes were examined using a two-factor repeated-measures analysis of variance (2 × 2), with the two within-subject factors time (pre vs. post) and arm side (treated vs. untreated).

The normal distribution of the difference scores was assessed using the Shapiro-Wilk test. With two levels per factor, the sphericity assumption was met. For significant interaction effects, post hoc analyses were performed using paired t-tests. In addition, a Wilcoxon signed-rank test was used as a robustness check for pre-post comparisons within each arm side. The significance level was set at $p < 0.05$. Effect sizes were calculated as partial eta squared (η^2_p) for the analysis of variance and as Cohen's d for dependent samples in pairwise comparisons.

RESULTS

One participant discontinued the intervention because of an injury; another female player could only be exercised submaximally during the posttest. Thus, eight individuals - six men and two women - were included in the analysis. Evaluation of usage data stored in the SimulFAMi program showed a mean daily unilateral application time of 36.5 ± 16.3 minutes. Work achieved in the incremental test increased after adjunctive high-tone therapy by a mean of 77.2 W·min on the treated arm and by 21.1 W·min on the untreated arm (see Fig. 3).

Analysis of variance and effect-size calculation showed a significant interaction between time and arm side, $F(1,7) = 7.78$, $p = 0.014$, $\eta^2_p = 0.36$. This indicates that change over time differed significantly between the intervention and control arms, with a large interaction effect. Post hoc analyses showed a significant performance increase on the treated arm ($p = 0.01$, 95% confidence interval 22.4 to 131.8 W·min). The result also remained significant under nonparametric assumptions (Wilcoxon signed-rank test: $p = 0.008$). In the control arm there was

FIG. 2 High-tone therapy device (HiToP) and fixation of the lower contact pad to the forearm with an elastic bandage. The second contact pad was attached to the upper arm/shoulder girdle.

	Intervention arm		Control arm	
Participant	pre	post	pre	post
1	170	200	170	200
2	175	200	196	140
3	720	810	720	720
4	120	140	105	120
5	140	275	250	360
6	300	360	300	330
7	1155	1360	262,5	300
8	173	225	200	200
Mean	369,1	446,3	275,4	296,3
SD	349,3	398,1	177,2	179,9

Watt-minutes achieved in the incremental test: pre-post comparison of the intervention and control arms

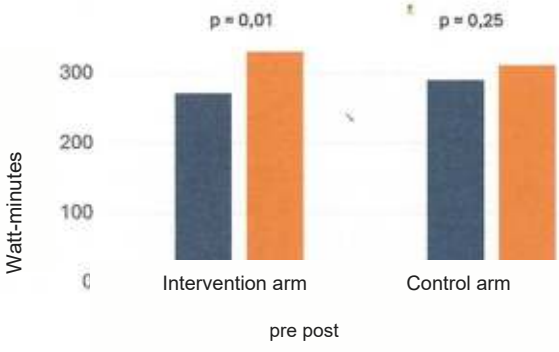

FIG. 3 Mean watt-minutes achieved in the hand-crank ergometer test for the intervention and control arms (N = 8)

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no statistically significant difference between pre- and post-measurement ($p = 0.25$). Heart rate, lactate, glucose, and blood pressure showed no statistically significant differences between the treated and untreated arms.

DISCUSSION

The present results show that adjunctive high-tone therapy during training led to a significantly greater improvement in endurance performance on the treated compared with the untreated arm. The observed interaction effect was large ($\eta^2_p = 0.36$), indicating substantial practical relevance. This supports the role of regenerative processes through high-tone therapy with faster adaptation. This may be attributable, among other factors, to improved microcirculation, accelerated metabolic clearance, or neuromuscular effects, as also described in strength-training studies. In contrast to the performance improvement, no significant changes were observed in the physiological parameters of heart rate, lactate, glucose, or blood pressure. This suggests that the observed performance gains are not primarily explained by cardiovascular or metabolic adaptations, but may instead be due to peripheral or neuromuscular adaptations. The results are consistent with studies in strength training [3-5], but extend these findings to endurance performance for the first time.

CONCLUSION

In summary, the present study indicates that high-tone therapy used alongside training can significantly improve endurance performance. The large interaction effect suggests a meaningful supportive influence on training-induced adaptation processes. Further studies with larger samples are needed to clarify its efficacy and the mechanisms underlying the performance effects.

The reference list is available with the article at www.sportaerztezeitung.com