The Journal of Physical Therapy Science

S P T S

Original Article

Underwater treadmill training and gait ability in the normal adult

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Abstract. [Purpose] Our working hypothesis is that underwater treadmill training improves normal people's gait ability. [Subjects and Methods] Twenty-five healthy subjects with no orthopedic history of lower extremity were recruited. Gait training is performed using an underwater treadmill (HydroTrack® Underwater Treadmill System, Conray, Inc., Phoenix, AZ, USA), for twenty minutes per session, five sessions a week for four weeks. The water temperature was set at about 33 °C and the depth was fixed to reach between the subjects' xiphoid process and the navel. [Results] After the intervention, step length, velocity, and cadence increased significantly. [Conclusion] This study conducted underwater treadmill training with normal people, with positive effects on gait ability.
Key words: Step length, Underwater treadmill, Velocity

INTRODUCTION

Underwater treadmill training is a method of gait training that uses the characteristics of water. Water provides buoyancy, hydrostatic pressure, and viscosity, affecting the human body[1]. Buoyancy makes the body float on the water. Water depth supports body weight: water as high as symphysis pubis relieves the weight by 40%, as high as the navel relieves by 50%, and as high as the xiphoid process relieves more than 60% of the weight[1]. The water pressure rises as immersion depth increases, and the increase in water pressure induces movement of bodily fluids. Due to the viscosity of water, friction occurs against the skin, and fluid resistance of the water enables it to be used in resistance training[1].

Underwater treadmill gait training utilizes water buoyancy to run a gait training session with alleviated weight. The training method is similar to the on-ground weight support treadmill gait training[2, 3]. Underwater treadmill training itself is a complete work-out, by which subjects can practice walking; therefore, it is one of the gait training methods that can be normally used[2, 3]. Most studies of gait training were of on-ground techniques and few studies have focused on underwater treadmill training. Considering this background, our working hypothesis is that underwater treadmill training improves the normal people's gait ability.

SUBJECTS AND METHODS

The subjects in this study were 20 healthy males. The selection criteria were as follows: no history of orthopedic surgery on a lower limb, never taken any drug due to a neurologic problem, and no musculoskeletal system disease. Their average age was 21.20 ± 2.30 years old, height was 174.51 ± 9.62 cm, and weight was 73.85 ± 7.27 kg. Sufficient explanation of this study's intent and the overall purpose was given, and voluntary consent to participation in this study was obtained from all of the subjects. Information on the study and written informed consent according to the ethical standards of the Declaration of Helsinki were provided to all subjects prior to their participation.

Gait training is performed using the underwater treadmill (HydroTrack® Underwater Treadmill System, Conray, Inc.,

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Table 1. Comparison of changes in characteristics of the experimental group (n=20)

	Pre-test	Post-test
Step length (cm) [b]	54.17 (5.25) [a]	57.81 (6.54)*
Velocity (m/s) [b]	86.24 (3.54)	92.74 (4.51)*
Double support (%)	17.24 (12.67)	21.58 (6.81)
Cadence (steps/min) [b]	102.74 (15.42)	109.62 (13.91)

[a]Mean ± SD, [b]Significant difference from the pre-intervention value, *$p < 0.05$

Phoenix, AZ, USA), for twenty minutes per session, five sessions a week for four weeks. The water temperature was set at about 33 °C and the depth was fixed to reach between the subjects' xiphoid process and the navel. Round 1 is composed of five minutes walking on the underwater treadmill at a comfortable speed. On Round 2, the speed was slowly increased by 0.5 km/h every two minutes, then when the rating of perceived exertion (RPE) reaches the score of 13 (somewhat hard) after the start, that level of RPE was maintained for ten minutes. If a subject's RPE is not maintained at the high speed, the previous speed was used instead. Finally, during Round 3, the exercise was completed with five minutes at the comfortable speed[4].

Gait was measured using the GAITRite walkway system (GAITRite, CIR System Inc., NJ, USA). The GAITRite is a portable gait anlaysis tool for automated measurement of spatio-temporal gait parameters. To precisely analyze gait, the subjects were asked to walk along a two meter long walkway for three sessions, and the average values were used. The subjects, with heads lifted and looking straight ahead, walked barefoot while lightly shaking their upper arms[5]. The GAITRite system has excellent reliability for most spatio-temporal gait parameters in both young (ICC=0.88–0.92) and older subjects (ICC=0.88–0.91)[6]

The mean and SD were calculated for each variable. Before the intervention, differences in the general characteristics of the experimental group were analyzed by descriptive statistics. Variables were compared before and after training within experimental group using paired sample t-tests.

The statistical analysis was conducted using SPSS 20.0 (SPSS, Chicago, IL, USA), and statistical significance was accepted for p values <0.05.

RESULTS

After the intervention, step length, velocity, and cadence increased significantly ($p < 0.05$) (Table 1).

DISCUSSION

This study conducted underwater treadmill training with normal people, yielding a positive effect on gait ability. Light aerobic exercise, walking, running, side steps to music in chest-deep water for three thirty-minute sessions a week for eight weeks, enhances maximum oxygen consumption by 22%, and improves walking speed, walking distance and muscular strength[7]. Masumoto et al.[8] observed an increase in walking speed due to strengthened hip flexor muscles, and an increase in cadence from increased step length in the elderly after underwater treadmill training. Underwater treadmill training's use of buoyancy eases partial support of weight and its stable applicability provides psychological stability; these two factors seem to induce increased step length, velocity, and cadence[8]. The underwater treadmill training session is a method in which patients repeatedly walk a certain length within a fixed time at a constant rate under a limited depth of water. This provides double support and improve gait and balancing abilities as it provides stability during the stance period of walking[9].

The limitations of this study were a small sample size, lack of a follow-up test to determine the carry-over effects, and no constraint of the effects of other joints. Further investigation of the effects of an underwater treadmill training in subjects with modifications to address the above-mentioned limitations is needed.

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