

ORAL PRESENTATION 3-1

심폐재활

발표일시 및 장소: 10 월 18 일(금) 13:15-13:25 Room C(5F)

OP3-1-1

The Design of Cardiopulmonary Exercise Test Protocol using Aquatic Treadmill

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Introduction

Cardiac rehabilitation (CR) is an integral part of the continuum of care for patients with cardiovascular disease. The core components of CR include patient evaluation. A cardiopulmonary exercise (CPX) test is a key component of the initial assessment made before a patient begins an exercise program. The test is performed as the metabolic equivalent (MET) is constantly increased at regular intervals according to the protocol. Aquatic treadmill (AT) employs underwater treadmill that combines the benefits of fluid resistance and the body weight supporting effect of buoyancy. AT can be used to evaluate exercise capacity in patients with difficulty in standing and walking as an alternative to land treadmill based CPX test. However, there is currently no CPX test protocol using AT, and it is necessary to develop a standardized aquatic treadmill CPX test protocol. Therefore, this pilot study was conducted to design a CPX test protocol that can bring about a constant change in MET value using AT.

Method

Nineteen male and one female subjects were enrolled in this study. Their mean age was 31.6 ± 6.9 years. The depth of the water pool was set up between xiphoid process and umbilicus. The room temperature was maintained at 25°C–26°C, while the water temperature was maintained at 28°C–29°C. The AT test comprised 12 stage at different velocities, with 2-minute duration per stage. The speed of the treadmill started at 0.7km/h in stage 1 and increased by 0.7 or 0.6 km/h in each stage. After the end of the test, individuals rested while standing for additional 2 minutes at cool down phase. A respiratory gas analyzer (Quark-CPET, COSMED, Rome, Italy), automatic blood pressure (BP) analyzer (Tango M2, SunTech Medical, USA), pulse oximeter (Care vision HP-110) and an AT (Aquatrak-2000, Naramed, Gwangju, Korea) were used. Moreover, electrocardiograms (ECGs) were monitored using by 10 carbon electrodes made of graphite and cables made of copper applicable in water with 12 channel ECGs for real-time CPX test (CASE, GE healthcare, USA). At each stage, oxygen consumption (VO₂), METs, heart rate (HR), BP,

respiratory exchange ratio (RER), minute ventilation (VE), VE/VCO₂ and rate of perceived exertion (RPE) were measured.

Result

For analysis, all recorded values of each stage were averaged. At stage 2 (1.4km/h), VO₂ value corresponded to approximately 2 METs (VO₂, 6.94 ± 1.05) in all subjects. 3.35 METs (VO₂, 10.57 ± 1.09) were measured at stage 5 (3.3km/h). And 4.16 METs (VO₂, 13.06 ± 1.46), 4.99 METs (VO₂, 15.51 ± 1.54) were measured at stage 6 (4km/h) and 7 (4.6km/h), respectively. The parameters of AT CPX test for each stage are shown in Table 2. As the exercise intensity increased at each stage, HR and RPE was incrementally increased.

Conclusion

It was demonstrated that AT walking can lead to high METs at lower speed than land treadmill walking. This means that AT walking can load higher exercise intensity than land treadmill at same speed

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Table 1. General characteristics of subjects

Male : Female (number)	19 : 1
Age (year)	31.6±6.9
Height (cm)	175.2±5.3
Body weight (kg)	76.0±9.2
BMI (kg/m ²)	24.7±2.3
Resting HR (beats/min)	80.0±9.7
Resting SBP (mmHg)	125.2±16.2
Resting DBP (mmHg)	77.7±13.7
Immersion HR (beats/min)	73.9±9.0
Immersion SBP (mmHg)	127.4±16.9
Immersion DBP (mmHg)	78.1±9.6

BMI: body mass index, HR: heart rate, SBP: systolic blood pressure, DBP: diastolic blood pressure

Table 2. The parameters of aquatic treadmill cardiopulmonary exercise test for each stage

Stage	SPEED (Km/hr)	HR (Beats/min)	VO ₂ (ml/min/kg)	METs	RER	RPE	VE (L/min)
1	0.7	75.3±9.2	6.3±1.1	1.8±0.3	0.89±0.09	7.0±1.6	15.1±3.5
2	1.4	78.9±11.1	6.7±0.9	1.9±0.3	0.83±0.08	8.0±1.8	15.0±2.8
3	2	82.8±9.9	8.0±1.4	2.3±0.4	0.80±0.06	9.2±1.8	16.3±3.0
4	2.7	87.2±9.5	9.5±1.5	2.8±0.4	0.79±0.07	10.6±1.6	18.4±3.5
5	3.3	91.6±10.5	11.6±1.9	3.4±0.6	0.80±0.06	11.7±1.6	21.5±3.3
6	4	100.1±10.4	14.3±2.5	4.2±0.8	0.83±0.06	12.9±1.8	26.5±3.9
7	4.6	110.9±12.7	17.4±2.6	5.0±0.8	0.89±0.05	14.1±1.7	33.1±4.9
8	5.3	126.5±14.6	21.4±3.1	6.1±0.8	0.95±0.06	15.5±1.1	42.4±6.2
9	5.9	143.5±18.3	25.1±4.1	7.2±1.1	1.02±0.07	16.8±1.1	54.6±10.3
10	6.6	153.4±20.2	27.6±6.1	7.9±1.5	1.04±0.07	17.8±1.1	63.1±12.8
11	7.2	165.8±14.1	29.0±4.4	8.4±1.1	1.06±0.07	18.1±1.1	71.1±11.0
12	7.9	167.4±9.4			1.05±0.08	18.5±1.1	

HR: heart rate, VO₂: oxygen consumption, METs: metabolic equivalents, RER: respiratory exchange ratio, RPE: rate of perceived exertion, VE: minute ventilation