P 2-96

The Design of Cardiopulmonary Exercise Test Protocol using Aquatic Treadmill : A Pilot Study

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Introduction

Cardiac rehabilitation (CR) is an integral component 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 continued while increasing the metabolic equivalent (MET) constantly at regular intervals according to the protocol. Aquatic treadmill (AT) employs underwater treadmill that combines the benefits of water immersion with the advantages of body weight supporting effect due to buoyancy. AT can be used to evaluate exercise capacity in patients with difficulty in standing and walking as an alternative of land treadmill based CPX test. However, currently there is no CPX test protocol yet 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 lead a constant change in MET value using AT.

Method

Three male and two female were enrolled in this study. Their mean age was 29.6±5.94 years. The depth of the water pool was set up between xiphoid process and umbilicus. The room temperature was maintained at 25℃−26℃, while the water temperature was maintained at 28℃−29℃. The AT test comprised 12 stage at different velocities, at 3-minute duration per stage. The speed of the treadmill started at 0.1km/h in stage 1 and incrementally increased by 0.35km/h in each stage. After the end of the test, individuals walked for additional 5 minutes at a speed of 0.1km/h to cool down. A respiratory gas analyzer (Cosmed CPET, COSMED, Rome, Italy), pulse oximeter (Care vision HP-110, Medical supply, Wonju, Korea) and a treadmill (Aquatrac-2000, Naramed, Gwangju, Korea) were used. At every each stage, peak oxygen uptake (VO2peak), heart rate (HR) and rate of perceived exertion (RPE) were measured.

Result

For the analysis, all recorded values of each stage were averaged. At stage 4 (1.15km/h), VO2 value corresponded to approximately 2 METs (VO2, 6.94±1.05) in all subjects. 3METs (VO2, 10.57±1.09) was measured at stage 8 (2.55km/h). And 3.73METs (VO2, 13.06±1.46), 4.42METs (VO2, 15.51±1.54) were measured at stage 10 (3.25km/h) and 12 (3.95km/h), respectively. The parameters of AT CPX for each stage are shown in Table 2. As the exercise intensity increased at each stage, HR was incrementally increased.

Conclusion

It was demonstrated that AT walking can spend high METs at lower speed than land treadmill walking. This means that AT walking can be loaded higher exercise intensity at same speeds of treadmill. The development of a standardized aquatic treadmill CPX test protocol may be useful alternative option for evaluating cardiopulmonary function in patients who can not use land treadmill.

Table 1. General characteristics of subjects

Characteristics	Value
Gender	
Male	3
Female	2
Age(yr)	29.6±5.94
Height(cm)	167.4±5.59
Body weight(kg)	68.4±10.76
BMI(kg/m²)	22.52±3
Resting HR(beats/min)	82.2±10.03

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

Stage	1	4	8	10	12
HR (heats/min)	86.8 ± 6.8	90.4 ± 6.95	103.6 ± 9.1	113.0 ± 10.07	123.2 ± 11.14
VO2 (ml/min/kg)	5.9 ± 1.15	6.94 ± 1.05	10.57 ± 1.09	13.06 ± 1.46	15.51 ± 1.54
METs	1.69 ± 0.34	1.98 ± 0.30	3.02 ± 0.31	3.73 ± 0.42	4.42 ± 0.47
RER	0.89 ± 0.07	0.85 ± 0.07	0.87 ± 0.09	0.91 ± 0.08	0.96 ± 0.07

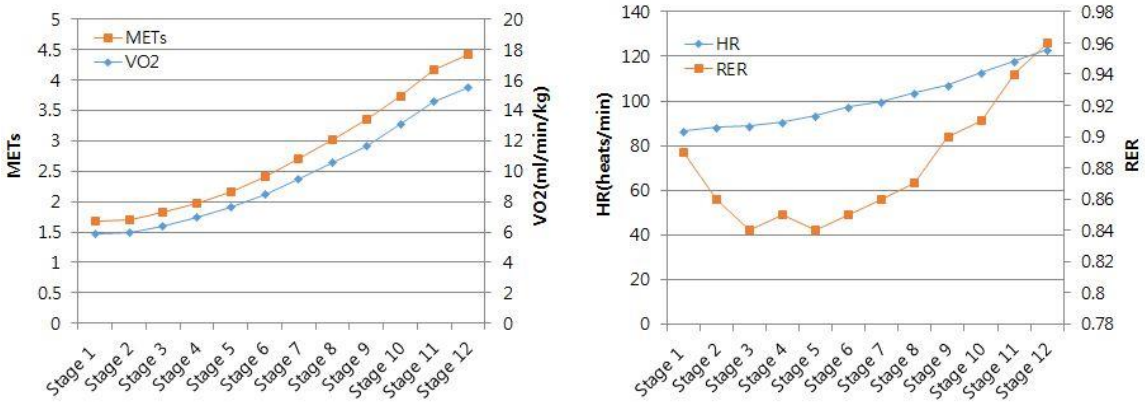

Figure 1. The parameters of aquatic treadmill cardiopulmonary exercise for each stage