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Construction of a multiple-regression model for estimating the force in tethered swimming, and power in semi-tethered swimming for males

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Abstract

The purposes of this study were to clarify the relationship between the force in tethered swimming (TS) and the power in semi-tethered swimming (STS), and to develop multiple regression models to estimate the force in the TS and the power in the STS using plural physical elements. To perform these purposes, the force in the TS and the power in the STS of 53 elite male high school and junior high school swimmers as subjects were measured. The force in the TS was measured by an electrical digital force gauge. The power in the STS was measured by the ergometer attachment improved a bicycle ergometer. Furthermore, height(163.2cm in average), weight (51.6kg), finger reach span (168.4cm), foot length (26.1cm), vertical jump (43.0cm) and its power of each subject was measured. The results of this study were summarized as follows; 1) The relationships between the force in the TS (X) and the power in the STS (Y) was Y=0.182X+16.35 (r=0.814). This relationship was highly significant statistically ($p<0.001$). 2) 49 of the multiple regression models to estimate the force in the TS were derived. The highest correlation coefficient model in theses was as follows; TS=0.16×weight+0.75×age+0.03×finger reach span+1.10×foot length+0.22×vertical jump-41.68 (r=0.787). 3) 59 of the multiple regression models to estimate the power in the STS were derived. The highest correlation coefficient model in these was as follows; STS=0.03×height+0.45×weight+2.26×age+0.41×finger reach span+0.27×vertical jump+0.01×vertical jump power-88.56 (r=0.866).

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Keywards: Force; tethered swimming; power; semi-tethered swimming; multiple regression model

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1. Introduction

The resisted swimming carried out in the competitive swimming training has 2 types. One type is fully-tethered swimming (TS) without swimming forward. Another type is semi-tethered swimming (STS) with swimming forward [1, 2]. Moritani et al. evaluated the swimming performance of Japanese elite swimmers using the STS [4]. Furthermore, they clarified the relationship between the STS and the rating of perceived exertion in swimming [5]. Shionoya et al. developed the ergometer attachment for measuring the power in the STS and reported the relationship between the swimming performance in sprint events and the power in the STS [3, 7]. On the other hand, concerning the TS, Shionoya et al. developed the system for measuring the force in the TS and reported the relationship between the swimming performance in sprint events and the force in the TS as in the STS case [8]. The relationship, however, between the power in the STS, the force in the TS and the physical capacity or the physique has not been clarified yet.

The purposes of this study were to clarify the relationship between the force in the TS and the power in the STS, and to develop the multiple regression models to estimate the force in the TS and the power in the STS using the plural physical elements.

2. Methods

Subjects were 53 elite male high school and junior high school swimmers designated to train by Niigata swimming association between 2004 from 2010. Figure 1(a) shows an overview for measuring the force in the TS. Each subject swum with pulling the wire connected to the digital force gauge (IMADA:DPX-50T). The force was measured by this digital force gauge. The output signal from the force gauge was transformed by an A/D converter to be analyzed by a kinetic analysis system (ELMEC: DAC-Win Ver4.7) installed into a personal computer. Figure 1(b) shows an overview for measuring the power in the STS. The Power was measured by the ergometer attachment installed the attachment drum coiling a wire, of which each swimmer pulled, onto one side of pedal of a bicycle ergometer. A bicycle ergometer equipping with an electrical magnetic breaking system (COMBI Corp. Power Max V) was used as a core of the ergometer attachment in this study. The power was calculated by the product of a velocity and a force. Figure 2(a) shows a calibration way of a velocity and a force in the ergometer attachment. In order to calibrate a velocity of the attachment drum, a digital tachometer was installed onto the side of drum. The velocity of the drum was equal to the swimming velocity. In order to calibrate the force loaded to a wire, the force calibration board used a digital force gauge was installed onto the

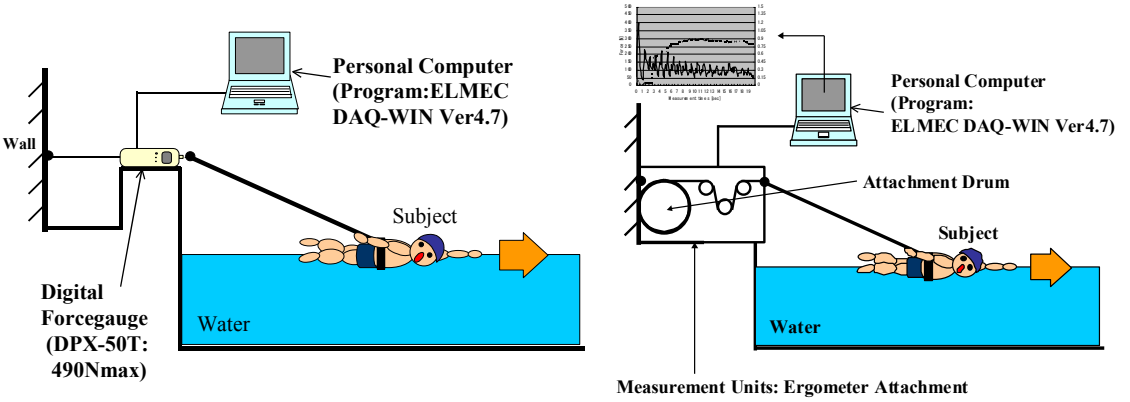

Fig.1. (a) Overview of the force in the TS measurement; (b) Overview of the power in the STS measurement