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RELIABILTY AND VALIDITY OF A DISCONTINOUS GRADED EXERCISE TEST ON DANSPRINT® ERGOMETER

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Key words: kayaking, testing, ergometry.

Abstract

The aim of this study was to determine the validity and reliability of a graded exercise test on a specific kayak ergometer (Dansprint®) in which certain physiological and technical parameters that can to define kayaking performance were assessed. Fourteen male top-level kayak paddlers (all members of Spanish Kayaking National Team) participated in this investigation. All subjects carried out two ergometric tests (Ergo1 and Ergo2) and one flat water test (FWT) in random order. At anaerobic threshold (AnT) intensity, the results showed acceptable levels of reliability (comparison between data of Ergo1 and Ergo2 tests) in the assessment of velocity ($r=0.784$; $p=0.004$), stroke frequency ($r=0.976$; $p<0.001$), heart rate ($r=0.964$; $p<0.001$), and blood lactic acid concentration ($r=0.899$; $p<0.001$). Validity coefficients showed a strong relationships between Ergo2 and FWT tests in all physiological and technical parameters with the exception of velocity ($r=0.498$; $p=0.121$). It can be concluded that specific ergometry can be used to evaluate and to prescribe training AnT intensities of top-level kayakers attending to parameters such us heart rate, whole blood lactic acid concentration, and stroke frequency. Nevertheless, the training prescription through specific ergometry must be taken cautiously when velocity is the parameter of reference.

Introduction

Flat-water kayaking is an olympic sport that combines different types of boats (canoe and kayak) and distances (500 m for female and 500 m and 1000 m for male competition). The contribution of aerobic metabolism at individual races has been established between 60 and 80% for 500 m and 1000 m, respectively. In this sense, an accurate assessment of optimal kayaking training intensities to develop aerobic and anaerobic metabolisms is needed. This assessment can be achieved through field tests (flat water environment) or under simulated conditions in laboratory environment using specific kayak ergometers. Since 1973, when Pike et al.[1] designed and developed a specific kayak ergometer, a great number of engineers and researchers have tried to simulate the real conditions of paddling using both air-braked and mechanical resistance systems[2-10]. Analysis of technical actions on these ergometers has shown a high level of coincidence between ergometer and flat water paddling when wrist, elbow and shoulder motions were compared[2,3]. Moreover, a comparative analysis taken into account physiological variables were also performed[7], showing that air-braked kayak ergometers lead to reach the same ventilation, VO2 peak, and heart rate (HR) values that those observed on flat water kayaking. In this line, Bourgois et al.[11] reported similar blood lactate concentration and HR values after comparing kayak ergometry and flat water paddling. Also, muscular power expressed on mechanical braked ergometer and on flat water channel was very similar[8].

Despite of all above mentioned, it is very difficult that ergometry can reproduce exactly the metabolic demands of simulated sport activity. In this sense, several investigations have questioned the use of specific ergometers as an alternative to field test. Van Someren and Dunbar[12] reported a lack of correspondence between kayak ergometry and flat water paddling when muscular power and blood lactate concentration were compared, not advising the use of this kind of devices for monitoring kayakers' training adaptations. Kruger et al.[10] observed how HR response to an effort on air-braked kayak ergometer was lower than that registered on flat water paddling at the same exercise intensity.

So, the aim of this study was to determine the validity and reliability of a graded exercise test on a specific

kayak ergometer taken into account physiological and technical parameters that can to define kayaking performance.

Methods

*Subjects.*Fourteen male top-level kayak paddlers (all members of Spanish Kayaking National Team) participated voluntary in this investigation. Participant characteristics were as follows (mean ± SD): age 25.2 ± 2.3 yr; height 1.81 ± 0.05 m; body mass 84.7 ± 5.3 kg; training experience: 11.1 ± 2.1 yr, VO_{2max}: 67.7 ± 2.5 mL·kg·min^{-1}.

Procedures. All subjects carried out two graded exercise tests on a specific ergometer (Ergo1 and Ergo2) and one flat water test (FWT) in random order and separated by 48 h. Ergo1 and Ergo2 were performed on a Dansprint® ergometer (Dansprint ApS, Denmark) using a drag resistance coefficient of 35. After a 5 min warm-up at a speed of 9 km·h^{-1}, the first stage was set at 11.5 km·h^{-1} and the speed increments were 0.5 km·h^{-1} every 3 min including pauses of 30 s between work intervals. Each kayaker was allowed to freely adjust his stroke rate (SR) as needed, being continuously recorded by a stroke counter (Interval 2000, Nielsen-Kellerman, USA). Heart rate (HR) was monitored using standard HR telemetry (S610i; Polar Electro Oy, Finland) and recorded every 5 s. Also, capillary whole blood samples were taken from each kayaker's earlobe during test pauses, just at the end of the effort, and during recovery period (min 1, 3, 5 and 7). In any case, paddlers were encouraged to give maximal effort and to complete as many stages as possible. The test concluded when the subjects voluntarily stopped paddling or they were unable to maintain the imposed speed.

FWT was performed on a flat water channel and its structure was similar to Ergo1 and Ergo2 test. Environmental conditions were also similar in all testing sessions and velocity was monitored thorough FWT using a GPS (Garmin mod.305).

Anaerobic threshold (AnT) was calculated from blood lactate concentrations (miniphotometer LP20; Dr. Lange, France) according to D-max method[13]. At this key point HR, SR, paddling velocity (PV), and blood lactate concentration were assessed.

Statistical analysis.

Standard statistical methods were used for the calculation of means and standard deviations (SD). Kolmogorov-Smirnov test was performed to evaluate conformity to a normal distribution and one-way ANOVA was applied to compare testing sessions for physiological and kayaking performance variables. After that, and Pearson's correlation coefficient was calculated to check both reliability (Ergo1 vs. Ergo2) and validity (Ergo2 vs. FWT). Significance was accepted at $p<0.05$ level.

Results

At AnT intensity level, no statistical differences were observed between testing sessions for any physiological or kayaking performance variables registered. Moreover, the results showed acceptable levels of reliability (comparison between data of Ergo1 and Ergo2 tests) in the assessment of PV ($r=0.784$; $p=0.004$), SR ($r=0.976$; $p<0.001$), HR ($r=0.964$; $p<0.001$), and blood lactic acid concentration ($r=0.899$; $p<0.001$). Validity coefficients showed a strong relationships between Ergo2 and OWT tests in all physiological and technical parameters with the exception of velocity ($r=0.498$; $p=0.121$) (table 1).

Table 1. Physiological and kayaking performance variables registered in both ergometric and flat water tests.

	Ergo1	Ergo2	r1; p1	FWT	r2; p2
PV (km·h^{-1})	12.99±0.22	13.05±0.32	0.784; 0.004	13.30±0.31	0.496; 0.121
SR (st·min^{-1})	79.5±5.7	79.5±5.6	0.976; 0.000	73.9±5.0	0.985; 0.000
HR (bp· min^{-1})	173.0±6.6	174.5±6.3	0.964; 0.000	172.0±4.7	0.924; 0.000
Lactate (mMol·L^{-1})	2.98±0.56	3.21±0.50	0.899; 0.000	3.13±0.37	0.920; 0.000

r1 and p1 show Pearson correlation coefficient between Ergo1 and Ergo2, and its level of significance, respectively. r2 and p2 show Pearson correlation coefficient between Ergo2 and FWT, and its level of significance, respectively.

Discussion

Several investigations have attempted to test the validity of kayak ergometers, comparing flat water kayaking and kayak ergometry. The results of some of these studies showed a lack of correspondence of physiological responses to open water and ergometric tests. However, there have been advancements in the development of air-braked kayak ergometers that can to offer new possibilities in the application of laboratory test for prescription and evaluation of kayak paddlers. This is the case of Dansprint® kayak ergometer, a new air-braked device that gives new possibilities to improve kayak testing.

In the present investigation we proposed a discontinuous graded exercise test on Dansprint® ergometer (Ego1

and Ergo2) that was applied on flat water channel too (FWT). The main aim of this test was to calculate the AnT point, a valid criteria to determine kayaking performance. After comparing physiological and kayaking performance variables from Ergo1 and Ergo2 testing sessions, we observed high levels of reliability in the assessment of PV, SR, HR, and blood lactic acid concentration at AnT paddling intensity. On the other hand and when validity indexes were calculated (Ergo 2 vs. FWT) we observed high values of Pearson correlation coefficients for SR, HR, and blood lactic acid concentration at AnT intensity. Although validity level for PV was acceptable, and a significant relationship was established, this data suggest certain differences in paddling velocity calculation. Probably, different devices used for PV calculation (on-board computer and GPS terminal in ergometric and FWT, respectively) induced a lower value for this kayaking performance variable.

Anyway, our results are opposed to those described by Van Someren and Dunbar[12] and Kruger et al.[10], who reported a lack of correspondence between kayak ergometry and flat water paddling when blood lactate concentration and HR were compared. Also, our data are in agreement with the previous report by Bourgois et al.[11] and Oliver[14] who registered similar blood lactate concentration and HR values after comparing kayak ergometry and flat water paddling.

It can be concluded that Dansprint® ergometry can be used to evaluate and to prescribe training AnT intensities of top-level kayakers attending to parameters such us HR, whole blood lactic acid concentration, and SR. Nevertheless, the training prescription through specific ergometry must be taken cautiously when velocity is the parameter of reference.

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