Isokinetics and Exercise Science 10 (2002) 69–72
IOS Press

Isokinetic evaluation of the knee extensors and flexors anaerobic capacity

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Abstract. This study focused on the design of an isokinetic test protocol for the evaluation of the anaerobic power-capacity of the knee extensors and flexors, and its validation using the Wingate 30" anaerobic test. Twenty male track and field, sprint and jumping events athletes aged 17–28 years took part in the study. In the first session evaluation of lower limb anaerobic power took place. Following 48 hours their knee extensors and flexors were tested isokinetically (30 Reps at 240°/sec for 30s). The results have indicated a very high correlation coefficient $r = 0.927$ between the values of the medium power for both tests, while the correlation coefficient between the fatigue indexes was relatively low $r = 0.485$. Thus isokinetic testing of knee musculature could provide a valid measure of the anaerobic capacity of the knee extensors and flexors, particularly with respect to athletes who perform through the anaerobic glycolitic way. On the other hand, isokinetically-based fatigue could not be compared with the more common and is therefore not advisable as an alternative indicator to the Wingate test.

Keywords: Anaerobic power-capacity, Wingate test, knee muscles

1. Introduction

Tests for anaerobic capacity or power of one muscle or group of muscles presuppose an exercise of high intensity and short duration: from a few seconds and up to a few minutes [6]. The Wingate anaerobic test is a reliable method for calculating the anaerobic peak power (APP) of lower limb muscles as well as the anaerobic medium power (AMP). The APP derives from the first 3–5 seconds of the test and characterizes the anaerobic power while the AMP characterizes the anaerobic capacity of the examined groups of muscles [4].

The most common versions of the Wingate test relate to test durations of 30 and 45 seconds. These two versions are known to be strongly correlated but the 45" is also known to be more exhausting albeit more reliable for anaerobic capacity [4]. However the 30" version is used more often due to its high index of accuracy and since it is less offensive especially if retesting is performed within a short span of time [4]. One disadvantage of the Wingate test is that it is nonspecific in terms of the involved muscles. In view of the widespread use of of isokinetics and its relative ease of operation, the aim of this study was to examine the utility of this technique in measuring the peak torque, the total work and power in relation to derivation of corresponding parameters from the Wingate test [2].

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2. Method

2.1. Subjects

Twenty male athletes of track and field sprinting and jumping events, aged 17–28 years, volunteered to be tested. The subjects' distribution according to event was: 100 m sprint ($n = 8$), 200 m sprint ($n = 2$), 400 m sprint ($n = 2$), long jump ($n = 6$), triple jump ($n = 2$). The athletes were tested at different periods, first with the Wingate test and after 48 hours later with the isokinetic test.

ISSN 0959-3020/01/$8.00

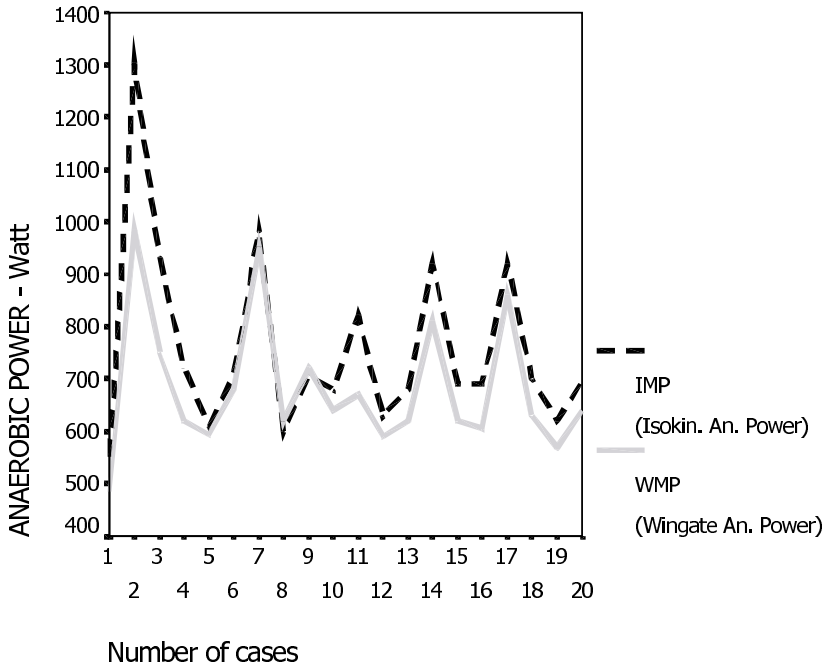

Fig. 1.

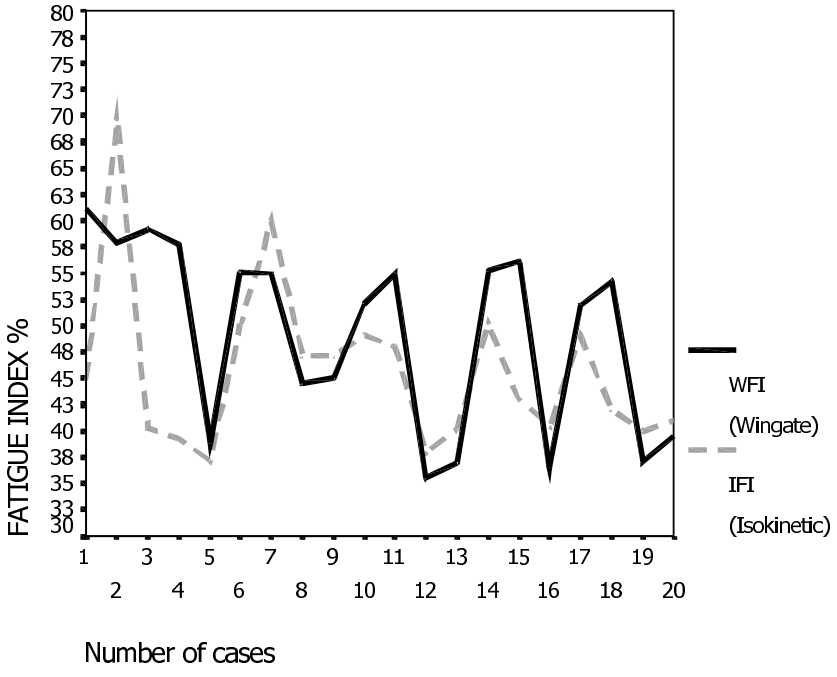

Fig. 2.

2.2. *Wingate 30" anaerobic test*

The Monark ergometer was used with a resistance setting of 10Kp/Kgr [3] which is approximately equivalent to 5.6 joule per pedal revolution per Kg of body weight. A 7 min warm-up on the cycle ergometer preceded the test. A 2 min pause was followed by the test in which the subject was asked to pedal as fast forcefully

Table 1
Correlation Wingate vs isokinetic median power

	Mean	Std. deviation	N
WMP	683.035	128.296	20
IMP	758.00	176.70	20

Table 2
Correlation Wingate vs isokinetic fatigue index

	Mean	Std. deviation	N
WFI	49.230	8.901	20
IFI	45.8150	7.8735	20

as possible for 30". From the data the anaerobic peak power (APP), the anaerobic medium power (AMP) and the fatigue index (WFI) decline of the power during the test were caculated.

Isokinetic test: a CYBEX 1200 (Lumex NY) isokinetic dynamometer was used. A 7 min warm up using a cycle ergometer preceded familiarization with the dynamometer which consisted of submaximal repetitions performed at low, medium and high angle velocities (90-120-240°/sec). Subject was stabilized on the dynamometer using standard methods. Range of motion was set at 120° (0° = full extension). The angular velocities of both flexion and extension were 240°/sec.

The subject was asked to perform reciprocally (extension-flexion-extension-flexion etc.) at the maximal level of effort and to reach 30 repetitions. From the data the medium power in Watt (IMP) and the fatigue index (IFI) that represented the % decline in power between the initial and the final repetition were calculated. To calculate the isokinetic IMP the four values of the power were added (2 of the Quadriceps and 2 of Hamstring) and the sum in watt was considered as representing the medium power of the extensors and flexors during the test. This value was compared to the relevant Wingate values. For the fatigue index, the average of the sums of the indices of the four muscle groups was defined.

3. Results

Table 1 and Fig. 1 outline the medians, SDs and the correlation coefficient between the anaerobic medium power during the Wingate test (AMP) and during the isokinetic test (IMP). Table 2 and Fig. 2 show the same parameters for the comparison between the Wingate fatigue index (WFI) and the isokinetic-based fatigue index (IFI). The two methods were highly correlated with respect to medium power ($r = 0.927$) but weakly correlated in terms of fatigue indices ($r = 0.485$).

4. Discussion

Previous comparison of maximal power output between a maximal isokinetic effort and an all-out sprint on an ergo-cycle revealed that the previous measure was significantly higher than the latter [1] a finding that is in agreement with the present results. In addition a significant and high correlation coefficient was noted between the two tests in that study.

In the present work a very high and significant correlation, $r = 0.927$, was found between the two methods in terms of the anaerobic capacity of the lower limbs. It should be emphasized that although a high correlation does not ensure a high measure of agreement, it does mean that given the difference in power output recorded between the two methods, it is possible to convert results from the isokinetic test into 'Wingate'-based units. This high correlation which is also reflected in the graphical illustrations provides adtional validation for the use of isokinetic dynamometry as an alternative tool substantiate particularly when applied to athletes who perform through the anaerobic pathway.

In terms of endurance measurement, a previous study [5] which compared the Wingate 30" anaerobic test and a 60" isokinetic endurance test yielded only a moderate correlation, $r = 0.52$, in terms of peak and mean power. This level of association is in very good agreement with the present finding, $r = 0.485$. The reason for this discrepancy could be the different time spans of the two tests and therefore the isokinetic fatigue index is not interchangeable with the Wingate 30's.

5. Conclusions

The results of this study research indicate that the isokinetic protocol used for evaluation of the anaerobic capacity of the knee extensors and flexors (ROM 120° – 30 REPS – 240°/sec) provides a relatively accurate index for this purpose and in combination with the testing in low and median speeds could complete the dynamic evaluation of the examined muscles in all the ergo-physiological parameters (max strength, speed-force and force-endurance).

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