

ANALYSIS OF SINGLE AND TEAM KAYAK ACCELERATION

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The purpose of this study was to gain more insights about 3D acceleration patterns in kayaks with different numbers of paddlers. Four female international level paddlers participated in this study. A tri-axial accelerometer was positioned on the deck of the kayaks. The paddlers were tested in kayaks of one, two and four athletes. The acceleration data were observable in real time as well as stared for subsequent analysis. Results suggested a similar vertical and lateral acceleration-time pattern curve for the three kayaks in the study. The shape of the curve of acceleration in the direction of travel was different for the kayaks with single paddlers from those of the kayaks with two and four paddlers.

KEY WORDS: kayaking, accelerometer, velocity, team boat.

INTRODUCTION: The oscillations in boat movement and velocity that occur in sports such as sprint kayaking challenge the investigators to find a way to provide accurate measurements as the boat does not travel at a consistent velocity. The fact that kayakers use a boat as a vehicle makes it important not only to study the linear and angular kinematic data of the paddling technique, but also to analyse the kayak's motion. However, boat speed measuring transducers are troublesome due to the problem of using and calibrating electrical equipment in water and the relatively low levels of sensitivity (Staniak et al., 1999). Taking these facts into consideration and the limitations of GPS (commonly available GPS's are capable of a data rate of 10Hz – Smith, 2010) it was considered that a suitable option is to collected the acceleration data on the kayaks' deck. According to Staniak et al. (1999) it is more useful to study acceleration than measuring speed because it has a high operational reliability, straight-line calibration procedure and works without contact with water.
The purpose of this study was to gain more insights about 3D acceleration patterns in kayak with different numbers of paddlers and to validate the calculation of the velocity-time curve integrated from acceleration data obtained from accelerometer.

METHODS: Four female (n=4) international level paddlers, world K4 sprint medallists in 2009, were tested during kayak performance using a 3D accelerometer attached to the deck of the kayak immediately in front of the cockpit (for the kayak of two (K2) and four (K4) the accelerometer was in front of the cockpit of 2nd and 3rd paddlers, respectively). The athletes performed different trials in kayaks of one, two and four places. Data collection was performed in flatwater conditions (without waves and wind) over a distance of 150 m. It was suggested to the athletes to paddle at 95 strokes.min^{-1}, to allow all the boats (K1, K2 and K4) to perform the distance at the same stroke rate. Anedoctal evidence collected from coaches suggests that as increases the number of paddlers on the kayak increases the competition paddling frequency. By requesting a rate slightly below the performance in K1 ($\approx$110strokes.min^{-1}) all the boats could meet the rate requested. A MicroStrain Inertia-Link® tri-axial accelerometer with wireless communication interface was used with a sampling rate of 100 Hz. During wireless communication, data were transferred in real time to the 3DM-GX2® Software Development Kit.

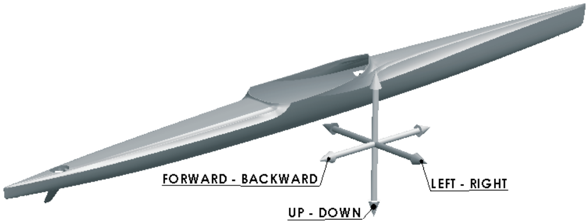

Figure 1: Kayak acceleration variables in study

Five complete paddling strokes (a total of five left and five right strokes) were selected from each trial for analysis. The onset of each stroke was considered to be the moment of transition from negative to positive values in the channel representing forward-backward motion of the kayak. The change in velocity during a stroke cycle was obtained by integration of the acceleration-time function curve within a range of a paddling stroke (n=10). As suggested by Staniak et al. (1999) to facilitate analysis it was accepted that the value of speed at the beginning of the paddling stroke was equal to zero (boundary condition velocity(0)=0).

RESULTS AND DISCUSSION: Acceleration data from the K1, K2 and K4 were recorded and transmitted in real time to the on-land data storing system. Figure 2 shows the mean 3D acceleration profile of the analysed padding strokes (time corresponding to the duration of a paddling stroke – left and right strokes) for the three types of kayak assessed.

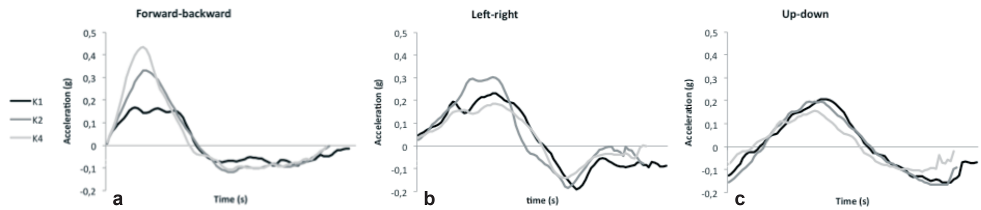

Figure 2: Forward-backward (a), left-right (b) and up-down (c) mean acceleration profile for paddling stroke (n=10) on K1, K2 and K4.

It is observable (Figure 2a) that the pattern of acceleration in the direction of the kayak motion is very similar for K2 and K4, being different only in the range of positive acceleration (maximum acceleration value for K2 is 3.26m.s^{-2} and for K4 is 4.27m.s^{-2}). The acceleration profile for K1, after achieving the maximum value, had a plateau rather than a peak as observed for K2 and K4. The lateral and vertical acceleration profiles are very similar for K1, K2 and K4. In relation to lateral acceleration a higher amplitude between the maximum and minimum values (4.79m.s^{-2}) for K2 compared with K1 (4.15m.s^{-2}) and K4 (3.20m.s^{-2}). With increase in the number of paddlers in the kayak, the velocity-time curve rises more steeply, reaches a higher maximum value, and finishes at a higher velocity.

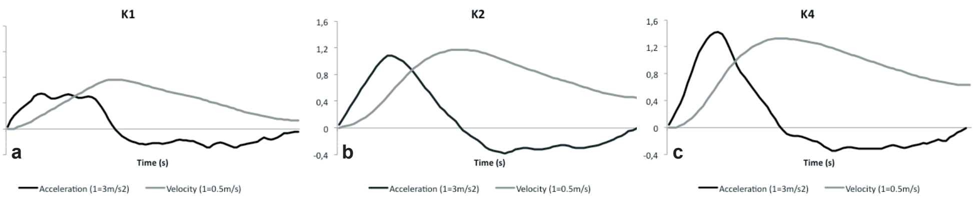

Figure 3: Acceleration and velocity curves for paddling stroke (n=10) on K1(a), K2(b) and K4(c).

CONCLUSION: The use of a 3D accelerometer is a useful way to study the acceleration and change in velocity of the kayak, allowing the study of the intra-cyclic velocity variation during the paddling stroke. Further research is required to fully characterize the acceleration and velocity-time curve profile in kayaks with different number of paddlers, and should include more subjects.

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