New technologies for crew boat analysis in sprint kayaking – a case study

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Summary

This case study investigated performance determinants in a four-person kayak crew utilizing instrumented paddles and devices to synchronize timestamps and measure the crew stroke rate (SR) and the kayak speed. Force kinetic metrics were calculated from force recordings during on-water kayaking at four pre-determined increasing SR in one race (R1) with ordinary synch strategy (seat 2-4 slightly earlier than seat 1 in stroke catch) and one emphasizing a complete synch (R2). With higher SR, the kayak speed increased while peak force and stroke impulse changes were inconsistent. Kayak velocity, peak force, and stroke impulse were similar in R1 and R2. The new hardware constitutes promising tools for crew boat analysis, but further software development is essential for future studies and practical settings.

Introduction

Sprint kayaking involves competing in single (K1) and crew boats (K2, K4), but the key performance factors in crew boats are less investigated. With instrumented paddles and K2 crews, it was shown that proficient kayakers generated higher kinetic outputs than the less proficient ones, whereas the coordination between the crew boat members at key time events was similar [1]. This study aimed to investigate performance determinants in a K4 (four-person kayak) crew utilizing new technologies.

Methods

Instrumented paddles (OGL, gen.3.1, Nelson, NZ) were customized for each athlete, and calibration of force metrics was verified using a newly developed innovative jig [2]. A GPS sync box synchronized the UTC timestamp, while a Bluetooth-based device remotely triggered the data recording. Stroke rate and kayak speed were obtained from a device with GPS and IMU (Catapult Optimeye B5). On-water recordings were done on a racecourse with negligible wind influence. Four male elite kayakers performed one race (R1) using their ordinary synch strategy (seat 2-4 slightly earlier than seat 1 in stroke catch) and one race (R2) with emphasizing synchronization. In both races, 30s@SR75, 30s@SR90, 20s@SR120, and 15s@SR137. Peak force and impulse were calculated (in Matlab) for 20 strokes for each crew member (10 on the L-side and 10 on the R-side) and averaged for each bout and all crew members. Each stroke was defined as the interval from the initial rise in force until the force returned to zero.

Results and Discussion

Table 1 presents force validation results, demonstrating minimal deviation across both low and high loads.

Table 2 summarizes the kayak speed and stroke rates, demonstrating that paddlers successfully adhered to the prescribed stroke rates and increased the kayak speed.

Table 3 shows the corresponding peak force and stroke force impulse. Peak force and stroke force impulse changes were inconsistent but higher at SR ~137 vs ~76.

Table 1. Verification of force metrics, J= applied force in Jig

J	**201 N**	**299 N**	**398 N**	**496 N**	**594 N**
R	194±0.7	291±0.4	386±1.1	486±2,2	581±3,5
L	198±2.2	295±3.2	393±3.8	491±5.6	593±6.5

Table 2. Kayak speed and crew paddle stroke rates

	Kayak velocity (m/s)				**Stroke rate (strokes/min)**			
R1	4.6	5.0	6.0	6.3	76	89	121	137
R2	4.6	5.2	6.1	6.3	77	89	121	137

Table 3. Peak force and force impulse

	Total peak force (N)				**Total stroke force impulse (N*s)**			
R1	1483	1701	1698	1669	777	820	936	894
R2	1397	1475	1294	1582	721	710	739	833

One possible explanation for these observations is that once the K4 reaches a certain speed, its substantial momentum makes further acceleration increasingly difficult. At the same time, even if the applied force remains constant, increasing the stroke rate can still be beneficial for performance. Future measurements of paddle power would provide additional clarity on these relationships.

Conclusions

Instrumented paddles with embedded technology, devices for timestamp synch, trigger data collection and metrics of kayak velocity, and SR establish appreciated hardware for analyzing K4 crew boats with elite kayakers. However, further software development for analysis is essential for future studies and practical settings.

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References

[1] Kong et al. (2020) Sensors, 20, 6317

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