AN APPLICATION OF ACCELERATION ANALYSIS TO EVALUATION OF A ROWING TECHNIQUE

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INTRODUCTION

A rowing shell is accelerated by the force from the oar, while the shell is decelerated by such factors as resistance of water, air and the movement of the oarsmen's body. Oarsmen will perform repetitively, forward (oarsmen move sternward) and backward (oarsmen pull the oars put into the water) action of 20-40 strokes per minute during rowing competition. Movement of the oarsmen's body on the shell is due to the rowing technique and affects the shell's propulsion. The corresponding movement of oarsmen's body to accelerate and/or decelerate the shell may be effected by rowing technique. In this study, we observed the characteristics of the rowing motion by measuring the acceleration of the shell.

METHODOLOGY

The subjects were 10 candidates from the Japanese National Crew (singlescull: 3 males, 1 female/pair without coxswain (pair): *6* males) and three members (singlescull) of the varsity rowing club.

The equipment was composed of an acceleration transducer and a data logger weighing about 300g and manufactured to measure the acceleration of the rowing shell on the water. The acceleration data during rowing was obtained from a transducer mounted on the bottom of the shell and stored in a portable data logger.

RESULTS

In figures 1-4 the acceleration change of the rowing shell with respect to the zero line is determined by calculating the mean value of acceleration at the steady state of the shell on the water. The force forward is presented as the acceleration of the positive side, while the force backward is presented as the acceleration of the negative side. In acceleration curve of the rowing shell, it was observed that there were three different phases per stroke (Fig. 1). At the first phase, the values of acceleration descend gradually, and increase suddenly after reaching the lowest pint during stroke cycle. At the second phase, the curve increases slowly and decreases after reaching the second peak. At the third phase, the acceleration changes up-anddown within a narrow range. The shell's velocity per stroke was calculated by integrating the acceleration data.

The velocity change almost corresponds with the study by Marin, T.P. et. al. (1980) using filming technique. In this previous study, each phase of the oarsmen's body actions during rowing were assumed from the acceleration curves.

When acceleration was measured at several different velocities, the magnitude of the acceleration and/or deceleration increased with increasing; velocities of the shell. When mean velocity of the shell was almost constant in a given distance, the variations of the acceleration and deceleration in a stroke were lower in the National crew than the varsity rowers (Fig. 2).

It was observed that the acceleration changes corresponded to each phase in rowing motion and showed marked characteristics compared with emphasized motions in several rowing phases such as the catch (the instant when the blades of the oars had made contact with the water), final (the instant when the blades of the oars had made lift out of the water) and forward phases (the period when oarsmen moved sternward) (Fig. 3).

In order to study the acceleration changes in different types of shells, the pair and the singlescull acceleration was measured in the same manner. The acceleration curves of the pairs showed larger and sharper changes than those of the singlescull (Fig. 4).

DISCUSSION

In competition, oarsmen must efficiently exert their physical power to maintain the velocity of the rowing shell. It is assumed that the large variations of the acceleration/deceleration cause loss of balance of the shell and waste the oarsmen's physical energy. The movement of the oarsmen's body is the main element of the rowing technique, and has strong effects on the shell's propulsion. In the measurement of the rowing shell, the variations of acceleration and deceleration in a stroke were lower in the skilful crew than in the varsity rowers. The acceleration curves therefore, reflect the level of movement skill performed by oarsmen during rowing (Fig. 2).

The movement of the oarsmen's body in the phase of catch, final and forward affect to the shell's motion and must be performed carefully to prevent a reduction of the shell's propulsion. When the oarsmen's body movement was emphasized at the catch, the acceleration change is very large and the shell is joggled widely (A). It may cause a loss of the shell's balance and decelerate the shell by increasing the water resistance, because the state of the shell before the catch is very unstable within the rowing cycle. In the final phase, if excessive force is given to the shell, the acceleration changes the attenuation of the forward motion (B). It is also assumed

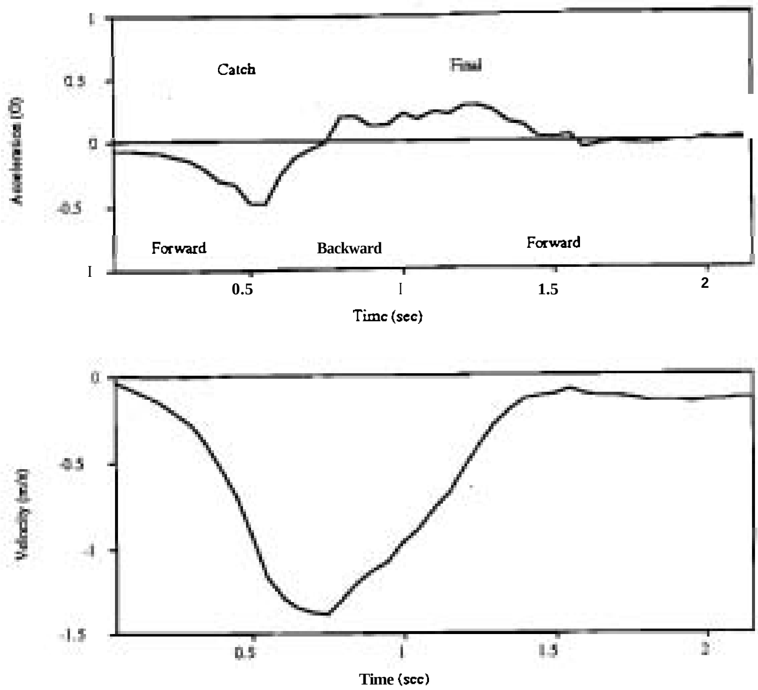

Fig 1 Acceleration curve flop) and Velocity curve (Bottom) per stroke during constant velocity (Single scull)
Mean value of 5strokes

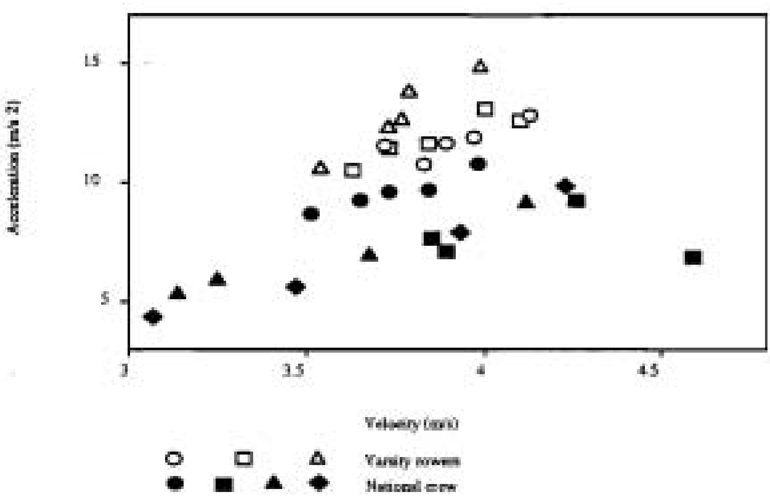

Fig 2 Variations of Acceleration during constant velocity
Variation= Maximum value-Minimum value

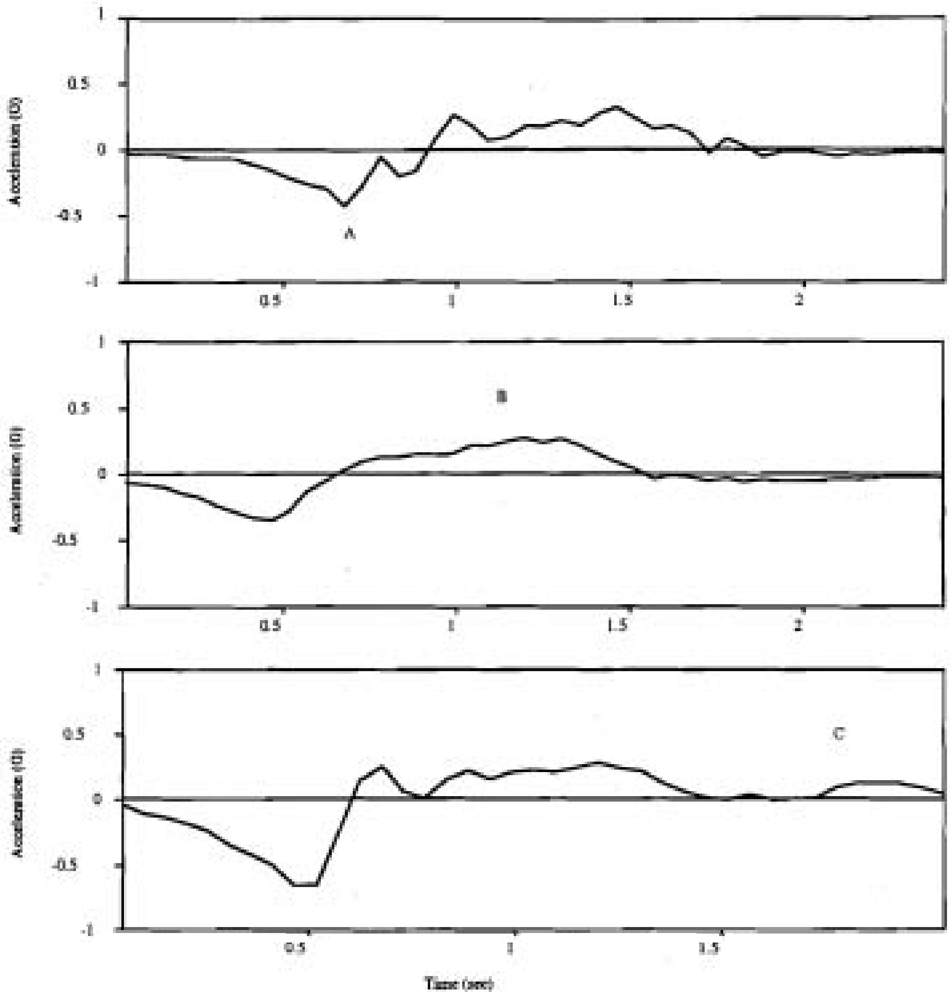

Fig.3 Emphasized motion in catch phase (Top), in final phase (Middle) Quick movement of seat in forward phase (Bottom) (Single scull) Mean value of 5strokes

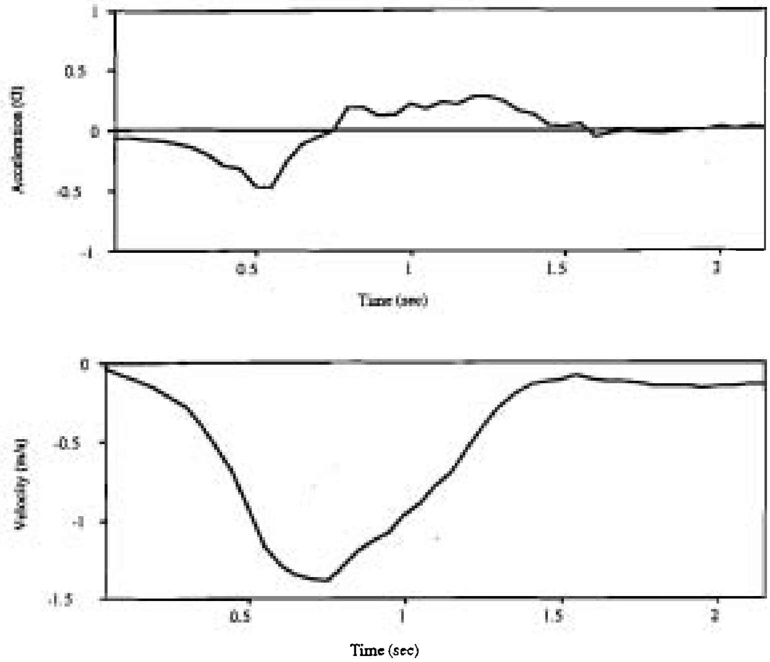

Fig.4-a Acceleration curve (Top) ad velocity curve (Bottom) per stroke during constant velocity (Single scull)
Mean value cl 5strokes

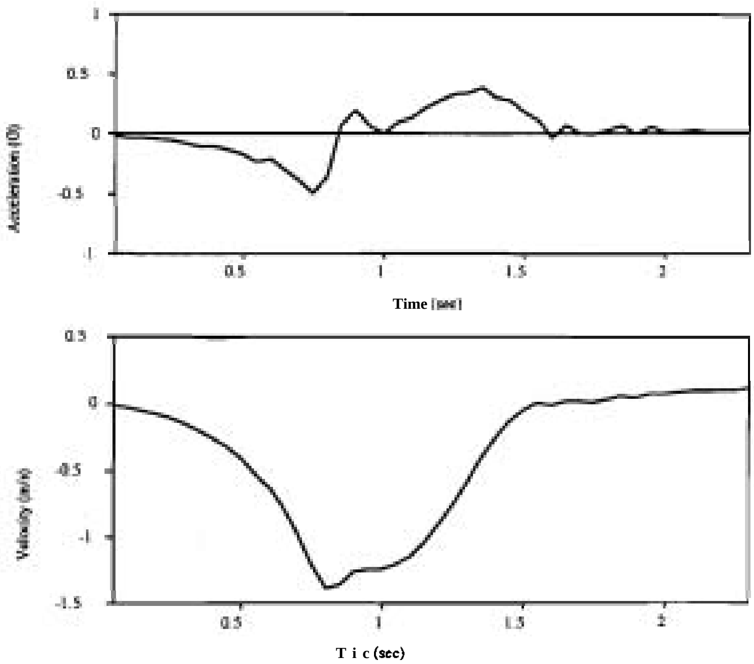

Fig.4-b Acceleration curve (Top) ad velocity curve (Bottom) per stroke during constant velocity (Pair)
Mean value of 5strokes

that when the shell is joggled widely it may cause a loss of the shell's balance. In the forward phase, if the sliding seat is move quickly sternward, the acceleration increases and drops suddenly during the following deceleration phase (before catch) (C). This may cause the shell to decelerate (Fig. 3).

In the research for the sweep rowing shell, the acceleration curve showed larger changes in the pair than the singlescull (Fig. 4). In the sweep rowing shell, the force given to the shell by pulling the oars and the shifting of the oarsmen's body are bigger than in the scull, since every oarsmen uses one oar respectively. This suggests that the movement of the oarsmen's body and the handling of the oars strongly affects the shell's movement when there is an increase in the number of rowers. The rowing actions of the oarsmen is more critical with a small number of rowers.

As the acceleration change corresponded to each of the rowing motion phases, the force exerted to the rowing shell, which is invisible by external observation, was clearly observed by examining the acceleration changes. The acceleration curves also indicate the movement characteristics of the shell and the oarsmen's body.

It is concluded that the acceleration data is useful as an indicator for evaluating rowing technique, and provides useful information to check the rowing action of the oarsmen and the crew.

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