KINETIC COMPARISON OF ERGOMETER AND ON-WATER ROWING

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INTRODUCTION

Ergometer rowing is widely used within the rowing community even though the specificity of ergometer rowing to on-water rowing has been repeatedly questioned within the research and rowing literature[1][2]. To our knowledge, however, no studies have examined how closely the timing and magnitude of forces developed during ergometer rowing replicate those produced in the boat, and specifically how differing designs of foot stretcher mechanism affect the replication of the on-water stroke.

The aim of this study was to examine the handle, pin and stretcher forces developed during ergometer and on-water rowing. By comparing the force delivery by the rowers at the handle and the stretcher, the study aims to highlight how well the components of on-water rowing are replicated by the ergometer conditions. The results of such comparisons may have a major bearing upon the choice of ergometer used for analysis and testing of rowers in both the laboratory and training setting.

METHODS

The timing and magnitude of the forces generated throughout the rowing stroke during ergometer and on-water rowing at 32 strokes·minute^{-1} was investigated for 24 male rowers. Testing was conducted on the RowPerfect (RP) and Concept2 (C2) ergometers and a single scull rowing boat, all of which were instrumented to measure the three dimensional forces produced at the handle (ergometer) or on the pin by the oar (single scull) and at the foot stretcher. Ergometers were instrumented identically although they differed in the design of their foot stretcher mechanism. The RP ergometer has a foot stretcher - flywheel complex that is mounted on the slide and is free to move in the anterior – posterior direction. The C2 ergometer has a fixed foot stretcher complex so that the rower accelerates their body mass away from the fixed stretcher around the catch.

RESULTS AND DISCUSSION

Both ergometer conditions were shown to significantly reduce the length of the drive phase (44% stroke) when compared to on-water rowing (51% stroke). While rowing the ergometers, subjects demonstrated a delay in the rise of the force produced at the handle when compared to that at the pin on the water, regardless of stretcher design. This resulted from the handle velocity having to 'catch up' with the velocity of the continually rotating flywheel before forces could be applied at the handle. The shape of the ergometer handle velocity curves were also different to those reported on the boat, with larger values leading to an elevated average velocity throughout the drive phase, which in turn reduced the ratio of drive to recovery phases when compared to the boat (Figure 1).

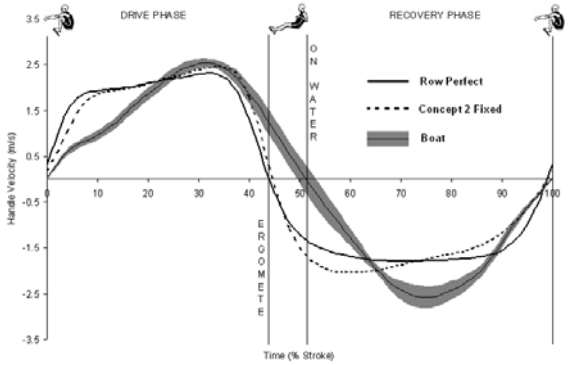

Figure 1: Oar and Ergometer handle velocity throughout the entire stroke

Results did, however, suggest that ergometers with a sliding stretcher mechanism, such as the RP, follow much more closely the time series curves of the on-water data than do ergometers with a fixed foot stretcher such as the C2. The magnitude of stretcher forces at the catch position on the C2, as a result of the increased inertial loads from the fixation of the feet, are less realistic when compared to the on-water condition than those on the RP. The magnitude of horizontal forces generated at the catch on the RP ergometer and the on-water condition were very similar.

CONCLUSION

The study suggests that ergometers with a sliding stretcher mechanism, such as the RP, follow much more closely the time series curves of the on-water data, than do ergometers with a fixed foot stretcher such as the C2. However, the relationship between the rower and the boat on-water cannot be replicated fully during ergometer rowing, regardless of stretcher design. Delayed handle forces developed at the catch and increased handle velocity throughout the drive phase during ergometer rowing results from the presence and continual rotation of the flywheel on the ergometers. It may however be possible, with the manipulation of flywheel inertia and the implementation of a braking system and / or other mechanisms that act throughout the recovery phase, to reduce the handle velocity throughout the drive phase and increase the force around the catch. This may then enable ergometers to provide a more accurate representation of on-water handle forces throughout the stroke.

REFERENCES

1.Torres Moreno et al., Int. J Spo Biomech, 21, 41-44. 2000

2. Christov et al., FISA Coaches Conference, Limerick, Ireland, 48-74. 1988