A KINEMATIC MODEL TO PERSONALIZE BOAT SETTINGS IN ORDER TO TARGET A GIVEN RANGE OF MOTION IN SCULLING

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INTRODUCTION: The boat settings is a complex topic in rowing as many parts of both boat and oars can be set. The amplitude of the rowing stroke, one main parameter of performance in rowing (Smith & Loschner, 2002), is directly affected by these choices. Surprisingly, the scientific literature is very poor on this subject and boat and oars settings are mainly based on rowers' and coaches' experiences (Nolte, 2011). Most of the time, all crew members have the same settings, while they can display various segment anthropometries and joint flexibilities. Therefore, this study aimed to implement and validate a numeric kinematic model to individualize boat settings in order that scullers can reach given catch and finish angles. For that purpose, it is possible to adjust both inboard of the rigging (boat) and spread (oar) lengths. The inputs of the model should be measured using simple testing that can be performed by coaches and athletes.

METHOD:
Firstly, our kinematic model needs some input data. The anteroposterior linear range of motion of the hand was measured on a rowing ergometer (Concept 2, Model E, Morrisville, VT, USA) using a rubber band. The upper limb length (i.e., from the acromion to the head of third metacarpal) was also measured.
Secondly, some assumptions were performed. The acromion was supposed to move in the horizontal plane, in the longitudinal direction of the boat. Hand trajectory was considered circular and only in the horizontal plane. At the catch, the upper limb was supposed to be fully extended. The model was 2D in the horizontal plane, and adjustments were performed to take into account the upper limb angle with respect to the horizontal plane (i.e., flexion/extension of the shoulder). A cost function was calculated as the summed squared differences between the hand and the handle locations at the catch and finish. The cost function was minimized by adjusting the inboard and spread lengths.
In order to assess the accuracy of our model, sculling kinematic measurements were performed with an optoelectronic 3D motion analysis system (Optitrack, NaturalPoint Inc, Corvallis, Oregon, USA) on a specifically designed ergometer (Fohanno, Sinclair, Smith & Colloud, 2014). Markers were placed on the ergometer (for the reference frame), the acromion, head of the third metacarpal and the oar (to measure oar angle). Subjects performed 10 strokes at a comfortable pace with various settings (inboard lengths: 83, 88 and 91 cm; spread lengths: 155, 159 and 163, that being 9 configurations) tested in a randomized order. Oar angles at catch and finish estimated with the model were compared with those measured during the experiments.

RESULTS: Preliminary results were obtained for two subjects, but experiments are currently ongoing in order to confirm these results. First, it was possible to find a minimum to the cost function, and thus to estimate the appropriate settings to reach the desired catch and finish oar angles. Second, a good agreement between modeled and experimental range of motion was found.

DISCUSSION: Using simple measurements, the proposed approach takes into account both rower flexibility and anthropometry, to individualize the inboard and spread lengths in order to set targeted catch and finish oar angles. This method can be very useful, particularly for team crews with various anthropometries which is often the case especially for young rowers. Depending on the rowers and coaches feed-backs, a smartphone application would be proposed in order to share the model with the rowing community. Note that the present study was only focused on oar range of motion, and the resistance (i.e., ratio between outboard and inboard length) will be analyzed in separate further studies.

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