BRG.LifeMOD™ modeling and simulation of swimmers impulse during a grab start

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I INTRODUCTION

The analysis of the temporal distribution has shown that the start phase accounts for 15 % and 7.7 % of total time, respectively for 50 m and 100 m freestyle events.

The aim of this study is to develop an approach for 3D modeling and simulation of swimmers impulse during a grab start in order to optimize the performance.

II METHODS

One national level swimmer was asked to perform a grab start. Subject's height and mass were respectively 179 cm (± 1) and 72,2 kg (± 0.2). The swimmer was fitted out with 16 passive markers fixed on anatomical point relating to each important articulation: foot, ankle, knee, hip, shoulder, elbow, wrist, finger (Fig.1).

For each start, 3 high speed video cameras (Photron Fastcam PCI at 125 Hz) were used. Simultaneously, the ground reaction force was measured using a 3D force-plate AMTI OR6-7-2000 mounted on the start block (Fig. 1) with sampling frequency of 1000 Hz.

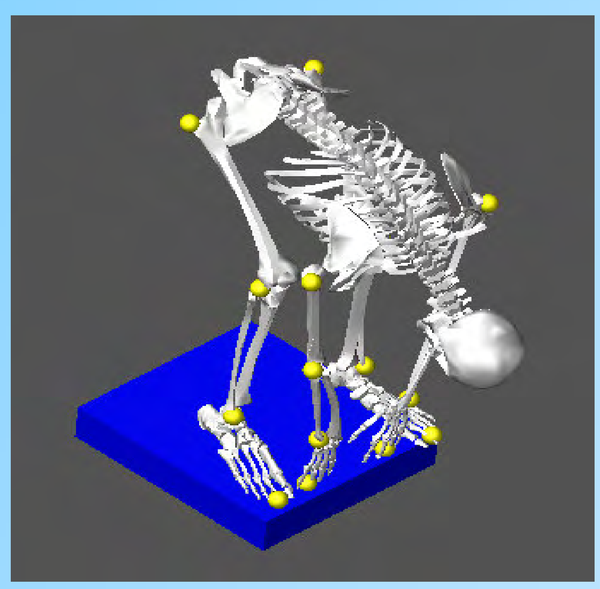

Figure 1 Passive markers positions (8 on the right and 8 on the left side). AMTI force-plate mounted on a block.

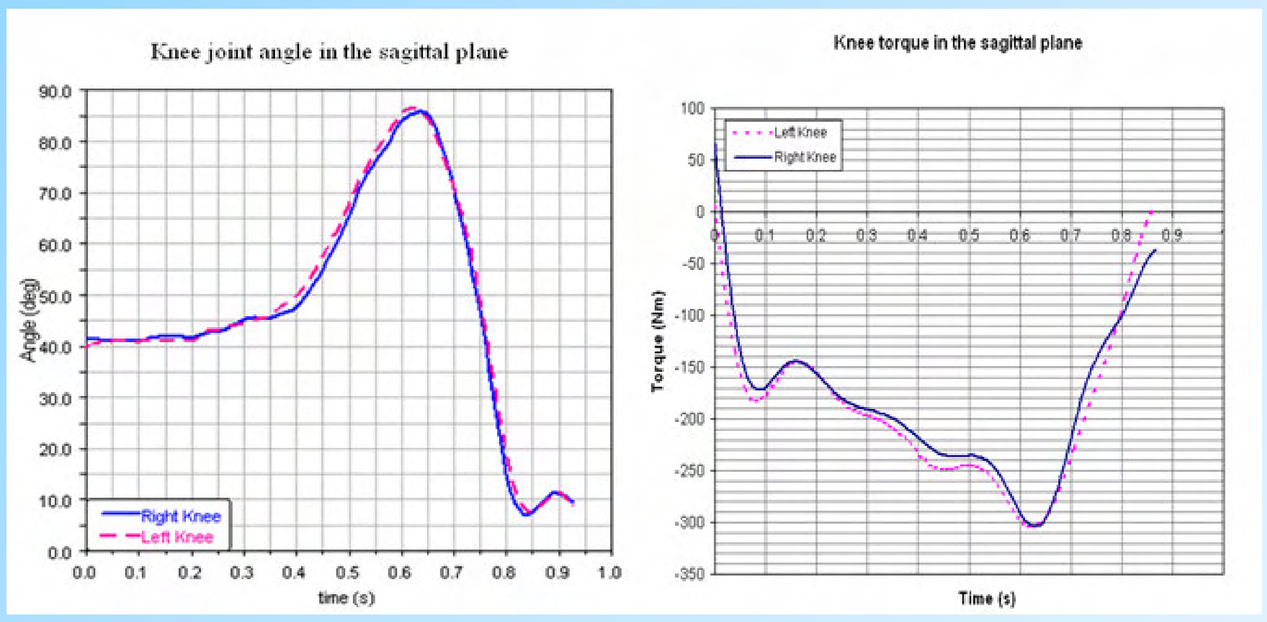

Figure 2 The swimmer's knee joint angles and torques (right and left) obtained using high sped video cameras and passive markers.

Time period: 0.00s to 0.92s

During the impulse phase, subjects were represented using an open tree structure composed of eight straight segments connected via frictionless joints (Fig. 1). The model input data consisted on the fitting angles computed at each joint (Fig.2) as well as the subject's inertial parameters.

III RESULTS

For this swimmer, a 3D model was generated using BRG.LifeMOD™ Biomechanics Modeler on the base of individual inertial parameters and kinematics data.

For each joint, the dynamic torques and forces were computed based on the inverse dynamics method, i.e. using the Newton Euler equations (Winter, 1990; Houel, 2004). The time history of the pelvis center of mass in the sagittal plane from t = 0.00 s to 0.92 s are shown on Fig. 3 (along the x-axis (horizontal) and the y-axis (vertical)). The model was validated comparing the predicted ground reaction force with the AMTI force-plate one during the grab start period. The time delay between the simulation results and the measured ones can be explained by the fact that the swimmer takes support on the edge of the force plate in experimental conditions. (Fig. 4).

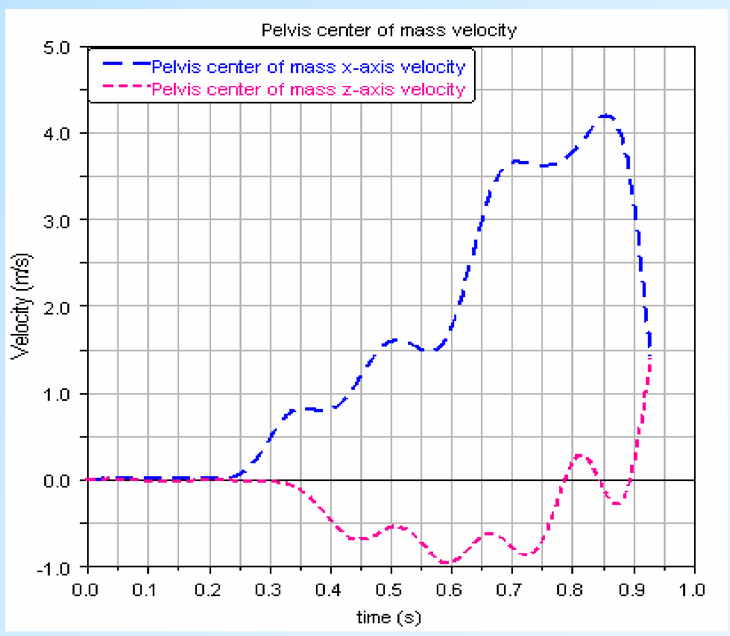

Figure 3 The velocity/time functions of the pelvis centre of mass in the sagittal plane for the time period 0.00 s to 0.92 s

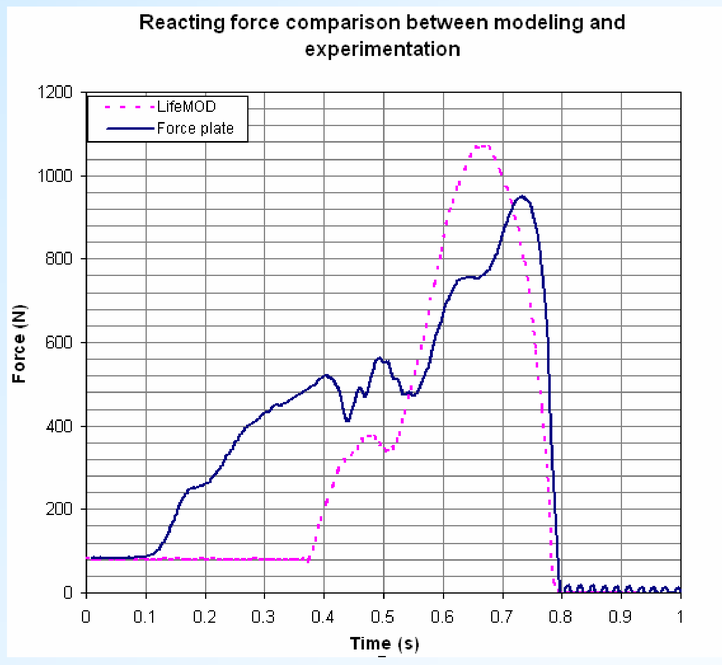

Figure 4 Comparison between the mesured ground reaction forces and the predicted by the model during the start period of maximal efforts (along x-axis)

IV CONCLUSION

The proposed approach allows predicting swimmer's joint torques during the impulse phase of the grab start. The model was validated comparing the predicted ground force with the measured one during the grab start period. In further works, the interest of such studies should be the segmental coordination analysis by means of relative phases (Delpierre et al., 2005, Li et al., 1999) associated with muscular activation investigation for each swimmer in order to optimize their performances.

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