A THREE-DIMENSIONAL ANALYSIS OF INTRA-CYCLE KINEMATIC PARAMETERS OF THE CENTRE OF MASS OF FEMALE BUTTERFLY SWIMMERS

Laura Priest, Ross Sanders and Stelios G. Psycharakis

Centre for Aquatics Research and Education, The University of Edinburgh, UK

KEY WORDS: swimming, elliptical zone

INTRODUCTION: The analysis of intra-cycle velocity fluctuations in butterfly swimmers has been the subject of several swimming studies. Despite the fact that swimming is not a planar activity, most studies have examined these fluctuations with the use of two-dimensional (2D) analysis techniques, for example Maglischo et al. (1989), thereby introducing important limitations in both the data collection and analysis. In addition, the assumption of bilateral symmetry is untenable due to asymmetric patterns in the technique and asymmetries in the anthropometric characteristics (Arellano et al., 2003). Furthermore, Barbosa et al. (2003) showed that the hip does not represent properly the intracyclic variation in the kinematics of the centre of mass. Therefore, the purpose of this study was to investigate the intra-cycle fluctuation of the displacement, velocity and acceleration of the centre of mass in competitive female butterfly swimmers using three-dimensional (3D) analysis methods.

METHOD: Ten competitive female swimmers swam 25m butterfly with maximum effort. The performance was recorded simultaneously by four underwater and two above water synchronised JVC KY32 CCD video cameras, with a frequency of 50Hz and a shutter speed of 1/125s. A total of 19 anatomical points were marked on each swimmer. A 6.75m^3 frame was used to calibrate the above and below water space (Psycharakis et al., 2005). The 'elliptical zone method' (Jensen, 1978) was used to determine the body segment parameter data using a recently developed MATLAB program running on a PC (Deffeyes and Sanders, 2005). An Arial Performance Analysis System was used to digitise the marked segment endpoints and to determine their 3D coordinates. A MATLAB program was written to calculate the 3D kinematics.

REFERENCES:

Arellano, R., Lopez-Contreras, G., & Sanchez-Molina, J. A. (2003). Qualitative evaluation of technique in international Spanish junior and pre-junior swimmers: An analysis of error frequencies. In J. C. Chatard (Ed.), *Biomechanics and Medicine in Swimming IX.* St Etienne: University of St Etienne Publications, pp. 87-92.

Barbosa, T., Santos, V., Sousa, F & Vilas-boas, J.P. (2003). Comparative Study of the Response of Kinematic Variables from the Hip and the Centre of Mass of Butterfliers. In J. C. Chatard (Ed.), *Biomechanics and Medicine in Swimming IX,* St Etienne: University of St Etienne Publications, pp. 93-98.

Deffeyes, J., & Sanders, R. (2005). Elliptical zone body segment modeling software: digitising, modeling, and body segment parameter calculation. In Q. Wang (Ed.) *Proceedings of the XVII International Symposium on Biomechanics in Sports*, Beijing, China: The China Institute of Sports Science, pp. 749-752.

Jensen, R.K. (1978). Estimation of the biomechanical properties of three body types using a photogrammetric method. *Journal of Biomechanics*, 11, 349-358.

Maglischo, E. W., Maglischo, C. W. & Santos, T. R. (1989). Patterns of forward velocity in the four competitive swimming strokes. In W. E. Morrison (Ed.) *Proceedings of the VIIth International Symposium of the Society of Biomechanics in Sports*. Footscray, Australia: Footscray Institute of Technology, pp. 139-149.

Psycharakis, S. G., Sanders, R. & Mill, F. (2005). A calibration frame for 3D swimming analysis. In Q. Wang (Ed.) *Proceedings of the XVII International Symposium on Biomechanics in Sports*, Beijing, China: The China Institute of Sports Science, pp. 901-905.