

Three-dimensional analysis of balance control strategies in elite karateka

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In karate, balance control represents a key performance determinant (1). Balance stability was reported to be related to a refined control of the center of mass (CoM) displacement (2). The aim of the current study was to quantitatively investigate the motor strategies adopted by elite and non-elite karateka to maintain balance control. We analyzed the execution of traditional karate techniques (kata) in two groups: elite Masters (n=6, 31±19 years) and non-elite Practitioners (n=4, 25±9 years). On each participant, the three-dimensional coordinates of 14 reflective markers (landmarks: right and left tracion, acromion, olecranon, radius styloid process, great trochanter, femur lateral epicondyle, lateral malleolus) were recorded by nine infrared cameras of an optoelectronic motion analyzer with a 120 Hz sampling rate. Kinematic parameters assessed were: CoM, step width, joints range of motions. CoM kinematics was computed according to the segmental centroid method (3). In the 11 steps of kata, CoM height was 8% lower ($p<0.05$, Mann-Whitney non parametric U-test), CoM average velocity and rms acceleration were approximately 35% higher ($p<0.05$) and step width was higher ($p<0.05$) in Masters. There was a significant difference between groups in CoM height and step width in seven and six out of the 11 steps, respectively. CoM vertical displacements resulted almost equal along the vertical direction, while in the horizontal direction it was significantly ($p<0.05$) higher in Masters than in Practitioners. Results suggest that elite karateka developed a refined body balance control, obtained through the increase of the base of support and different maneuvers of lower limbs. The proposed method could be used to objectively detect talented karateka, to measure proficiency level and to assess training effectiveness.

References

- [1] Cesari, P. & Bertucco (2008) Coupling between punch efficacy and body stability for elite karate. *M. J Sci Med Sport* 11(3), 353-356 ; doi:10.1016/j.jsams.2007.05.007.
- [2] Hrysomallis (2011) Relationship between static and dynamic balance tests among elite Australian Footballers. *C. Sports Med* 41(3), 221-232; doi:10.2165/11538560-000000000-00000.
- [3] Mapelli et al. (2014) Validation of a protocol for the estimation of three-dimensional body center of mass kinematics in sport. *Gait Posture* 39(1), 460-465; doi:10.1016/j.gaitpost.2013.08.025.

Keywords

Martial arts; center of mass; karate biomechanics; body stability control.