Participation of upper extremities in generation of the ground reaction force impulse

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1. Introduction

Arm swing is natural movement allowing improve effectiveness of activities like run or jump. Bober [2] revealed swing induced increased velocity of body’s center of gravity during take off. Likewise Bosco and Komi [3] proved influence of arm swing on final body’s velocity or it’s parts. Studies concerning estimations of correlations between swing spaciousness and jump height or height and power took place as well [1, 4]. Gajewski et. all [4] stated take off power was determined by jump height, body mass and swing spaciousness. Authors mentioned above used force platforms or cinematographic method. Not many scientific issues are related to synchronization of force platform signals with results of measurements taken with cinematographic method. The aim of the study was evaluation of influence of upper extremities movements in the swing phase on the ground reaction force changes in vertical jump.

2. Methods

2.1 Material

Nine volleyball players (1.91 0.08 m of body height, 81.9 13.58 kg of body mass) participated in the study. All of them trained for I and II league volleyball teams in Warsaw and were characterized by correct jump technique in block and attack.

2.2 Methods

Measurement were taken in Main Laboratory of the Josef Pilsudski’s University of Physical Education in Warsaw. Subjects performed 2 kinds of vertical jumps on force platform synchronized in time with image recording by 2 digital cameras. First jump was performed with the initial standing position with hands resting on ilium crest which eliminated arms swing influence on the technique (jump I). Second jump was countermovement one with arms swing symmetrically (jump II).

2.2.1 Ground reaction force

Ground reaction force was measured with Kistler force platform. Sampling time was 120 Hz. Upon course of the ground reaction force in time the increment momentum of body was calculated and then velocity and height of the jump. Parameters describing jump as ground reaction force, force impulse, canter of gravity position and time of jump phases were taken to analysis.

2.2.2 Cinematographic method

Trials were recorded with two digital cameras JVC GR-DVL 9800 (probing 120 Hz, shutter-1/250s). 3D analysis was conducted with APAS 2000 software. Digitalization of the body was upon 17 points model was done manually by one and the same person. Three dimensional courses were smoothen by software build in digital filter (value 8). Upon model of location of the centers of gravity of individual parts of the body positions of the centers of gravity of upper extremities were calculated as well as their velocities (according to mechanics’ principles [5]).

3. Results

Vertical jump is action consisting of few phases (stable, swing, take off, flight, landing). Each differ from one another by position of the center of gravity as well as ground reaction force. Values obtained in two kind of jumps are presented in table 1. Subjects achieved the highest values of height of center of gravity (hj) during jumps with arm swing, which was influenced by higher force impulse values, take off velocities and ground reaction forces in take off phase (see table 2).
Results of the presented study showed, that in the jump with arms swing center of gravity of the body movement was followed by upper extremity center of gravity movement (delay was about 0.11s). After tis time ground reaction force was about 7% higher than in the beginning of the take off phase which may indicate significant affect of upper extremities and increase in force impulse. It could be assumed that synchronization of the movement of center gravity of upper extremities with the body center of gravity may lead to increase of the ground reaction force in take off phase and the same to the increase of the jump height.

4. Discussion

It is common knowledge that arm swing indicate height of the jump. However it is not completely known in what degree and in what time participation of upper extremities influence the result in the most extent. Many authors indicate type of swing, it’s spaciousness influence on he height of the jump (Gajewski 1996). Also Bosco and Komi (1980) revealed influence of swing on the jump height.

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References