THE 3-D KINEMATIC ANALYSIS OF DIFFERENT TENNIS SERVE

Hui-Ting Lin[1], Jia-Hao Chang[2], Jia-rea Chang Chien[3], Ching-Sung Tseng[2]

**Department of Physical Therapy, I-Shou University, Kaohsiung County,Taiwan[1],
Department of Physical Education, National Taiwan Normal University, Taipei, Taiwan[2]
Department of Electronic Engineering, National Kaohsiung First University of Science
and Technology, Kaohsiung, Taiwan[3]**

INTRODUCTION: The key to success for a good tennis player is to be able to take the advantages of serving and keep the serve. The world's professional tennis players in front of the world rankings, most have very excellent serve skills. Two different footwork techniques in tennis serve used by most professional tennis players are the foot-up and foot-back serve technique. Most researchers investigated the differences between these footwork techniques using 2-D kinematics data (Elliott et al, 1983). However, little evidence has demonstrated that which serve technique is better (Bylak et al, 1998) or if a difference exists between foot-up and foot-back technique using 3-D analysis (Elliott et al, 1996). The purposes of this study were to investgate the differences in 3-D kinematics between the foot-up and foot-back tennis serve techniques.

METHOD: Eight tennis players (height: 181.5±6 cm, weights:74.9±6 kg, age: 21.5 ±2 years and experience for tennis: 11.1±2.8 years) participated in this study. Vicon Motion System with 10 cameras (frequency 400 Hz) was used to capture the upper extremity (U/E) and lower extremity (L/E) movements of the tennis player during serving with the dominant hand. Fifty-three reflective markers were attached on the anatomic landmarks. In addition, five markers were also adhered on the tennis racket (Figure 1). Visual 3D was used to analyze the collecting data of dominated hand. Ball velocities were also recorded. Three phases (preparation phase, loading phase, and swing phase) were defined. The 'preparation phase' begins when the subject initiates his motion and ends when the racket reaches the highest level. The 'loading phase' begins when the racket reaches the highest level and ends when the racket achieves the most posterior position. 'Swing phase' begins when the racket achieves the most posterior position and ends when the subject completes the serve. Two-sample t-test test was used to identify statistically significant differences in ball velocity and joint angles and angular velocities between two serving techniques. All data analyses were performed using SPSS for window 12.0 (SPSS, Inc., Chicago, IL).
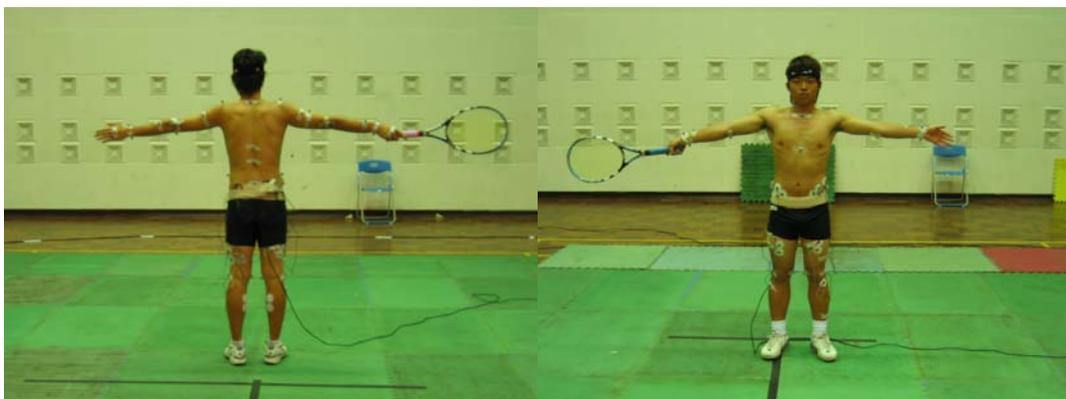

Figure 1. Markers were attached on right and left forehead and posterior head, sternal notch, processus xiphoideus, processus spinosus of the 7th cervical and 8th thoracic vertebra, most dorsal point on the acromioclavicular joint, upper arms, medical and lateral epicondyles, ulnar styloid, radial styloid, 2nd and 5th metacarpal joints, sacrum, anterior superior iliac spine, mid-thigh-cuff with marker on wand, lateral femoral epicondyle, mid-shank-cuff with marker on wand, lateral malleolus, second metatarsophalangeal joint, heel.

RESULTS: The preparation phase was about 65% of serving phase, while the loading phase and the swing phase were 25% and 10%, respectively. Ball velocities during foot-up serve and foot-back serve were listed in Table 1. Ball velocity during foot-up serve was faster than that during foot-back serve. The differences of ball velocities were less than 5 km/hr during different serving. The four types of tennis serving skills were similar in U/E joint angles and angular velocities.

Table1. Ball velocities (km/hr) of each subject including mean and standard deviation (SD) values during four types of tennis serving (RFU: Foot-up serving to the right court; RFB: Foot-back serving to the right court; LFU: Foot-up serving to the left court; LFB: Foot-back serving to the left court)

No. subject	RFU	RFB	LFU	LFB
1	179	183	184	183
2	172	166	174	167
3	184	178	176	162
4	187	191	189	190
5	166	172	174	170
6	178	165	172	173
7	185	178	186	176
8	170	171	168	170
Mean	177.62	175.5	177.87	173.87
SD	7.65	8.79	7.49	8.99

DISCUSSION: Ball velocity during foot-up serve was faster than that during foot-back serve, however, the differences of ball velocities were less than 5 km/hr during different serving. Similar movement patterns (especially U/E) were observed during foot-up and foot-back serve techniques. It appears that the same ball velocities, U/E joint angles and joint velocities were obtained using two different tennis serve techniques.

CONCLUSION: No differences of ball speed, serving phase timing, and kinematics data were found during different tennis serving.

REFERENCES:

Elliott, B. C., & Wood G.A. (1983) The biomechanics of the foot-up and the Foot-back tennis service techniques. *The Australian Journal Sport Science*,3(2), 3-6.

Elliott, B.C. Marshall, and Noffal. G.J. (1995). Contribution of upper limb segment rotations during the power serve in tennis. *Journal of Applied Biomechanics*, 11, 433-442.

Bylak J, Hutchinson MR Common sports injuries in young tennis players. *Sports Med.* 1998 Aug; 26(2):119-32. Review.