THE SURFACE EMG ACTIVITY ANALYSIS BETWEEN BADMINTON SMASH AND JUMP SMASH

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Badminton smash is one of the most powerful techniques among all the racket sports. It may divide into smash and jump smash. The purpose of this study was to analyze the surface EMG activity of upper extremities between smash and jump smash by eight Taiwan elite badminton players. We used two digital video cameras to obtain the 3D kinematics data of shuttlecock, and measured the surface EMG signals of seven upper limb muscles. The results showed that there was no significant difference between the two smashes in initial shuttle velocity. Though the movements of the two smashes were similar, there were significant difference between the two smashes in the sequence of the surface EMG activity of the upper limb and the mean IEMG amplitude in a few muscles. We found that the jump smash exerted the higher EMG activity than smash in the phase before contact point.

KEY WORDS: biomechanics, EMG, badminton, smash, jump smash

INTRODUCTION: Badminton is a very popular sport in the world. Among all the badminton skills, the smash (Figure 1) is the most powerful stroke. Smash can be divided into two types, the standing smash (smash) and the jump smash (Figure 2). The most of previous studies of badminton studies were related to the photographic analysis. Such as, Poole (1970), Adrian (1971), and Gowetzke (1979), they used 2D model to describe the smash strokes. Tang, Abe, Katoh, and Ae (1995) they used 3D model to measure the rotation of the forearm and the wrist. Tsai, and Huang (1996), Tsai, Huang, Chang, and Lai (2003) compared the smash and the jump smash of elite players with 3D model. Only a few researchers they use surface EMG method to analyze the movement of badminton skill. Broer, and Houtz (1967) they observed the muscular surface EMG activities pattern of selected sport skills, including badminton clear stroke by a lady when she was hitting a shuttlecock that was suspended from the ceiling. The purpose of this study was to compare the difference between standing smash and jumping smash pattern. We analyzed the shuttlecock kinematics variables and the muscular surface EMG patterns on the upper extremities of the elite badminton players when they were performing the standing smashes and the jumping smashes. The variables were including shuttle velocity, contact duration time, muscular surface EMG activities sequences and the mean IEMG of the seven selected muscles.

Figure 1 The Smash.

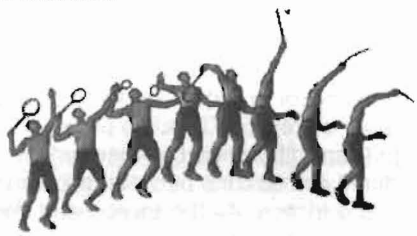

Figure 2 The Jump Smash.

METHOD: Eight badminton elite players (age of 20 ± 2 years, height of 175 ± 5 cm, weight of 66 ± 6 kg) served as the subjects to perform the standing smash and jumping smash to the ground of the opposite court. Figure 3 showed the schematic drawing of the experimental setup. Two Redlake 1000 high-speed digital cameras (250 Hz, Motion Scope, San Diego, USA) were used to record the shuttlecock 3D kinematics data. One Biovision wired EMG system (1000 Hz, National Instruments, Austin, TX) was synchronized to collect the EMG signals of seven upper limb muscle groups, which were wrist flexor, wrist extensor, biceps brachii, triceps brachii, middle deltoid, posterior deltoid and pectoralis major. The 3D kinematics data were calculated by Kwon3D system and the surface EMG data were computed by DasyLab system. Raw EMG signals were band-pass filtered (20-400 Hz), full wave was rectified by passed through a linear envelope at 10 Hz. We were interested in analyzing the integrated EMG signal (IEMG) was from the phase of -0.7 second before contact to 0.4 second after contact. The sequence of the surface EMG activities, the EMG amplitude at the shuttlecock contact point, the peak EMG amplitude, the mean IEMG of the movement phase of the upper limb muscle groups were the selected variables. A repeated measures t-test and a Product-Moment Correlation were to test the selected variables of smash and jump smash at .05 significant levels.

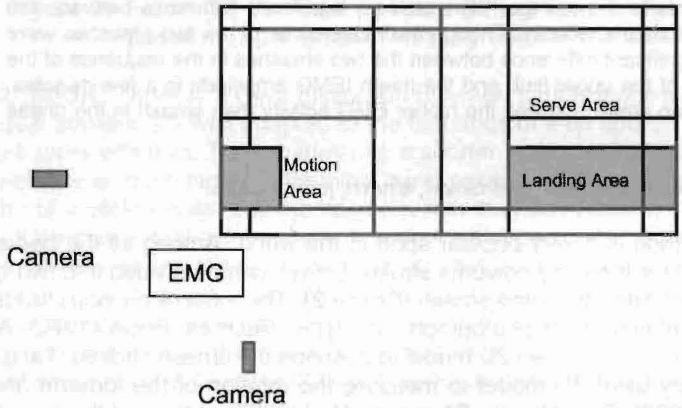

Figure 3 The Schematic of the Experimental Setup.

RESULTS AND DISCUSSION: Table 1 shows the kinematical data of the smash and jump smash strokes. There were no significant differences between the smash (68.93 m/s) and jump smash(70.98 m/s) in shuttle initial velocity. The contact duration time was 0.004 second in both smashes. The kinematics results of shuttle initial velocity and contact duration time were similar as the study of Tsai, et al, 1996 and 2003. The Figure 4 and Figure 5 show the rectified surface EMG signal patterns of smash and jump smash strokes from -0.7 second before contact to 0.4 second after contact point. The EMG patterns of smash and jump smash were looked very similar. Table 2 shows the onset time of surface EMG signal of every muscle group. There were significant difference in onset timing between the two smashes at wrist flexor, wrist extensor, triceps brachii, middle deltoid and posterior deltoid. There was a significant positive correlation in biceps EMG activity between two smashes. The wrist flexor and deltoids were acting in the very first period of the movement to stabilize the upper extremities in some players. For the EMG amplitude at the contact point, there was a significant difference between smash and jump smash on the wrist extensor. There were significant correlations between two smashes in the contact point EMG amplitude of the wrist flexor and triceps. As the triceps and the wrist flexor were the agonist muscles of the smash movements. We found, there were greater EMG activity of the antagonists, the biceps and the wrist extensor. There was no significant difference between smash and jump smash in the peak EMG amplitude of all the seven muscle groups. There were significant correlations between two smashes in the peak EMG amplitude of the wrist flexor, triceps and middle deltoid. For the mean IEMG amplitude integrated from 0.7 second before contact to 0.4 second after contact. There were significant difference between the two smashes at the wrist flexor, the wrist extensor, the triceps and the pectoralis major. There were significant positive correlation between two smashes in the wrist flexor, wrist extensor, middle deltoid and pectoralis major. The mean IEMG amplitude integrated from -700ms before contact between the two smashes were significant different on most of the muscles except the pectoralis major. The mean IEMG amplitude integrated of 400ms after contact was no different on most the muscles except the wrist extensor. As the results showed, the EMG activity of jump smash were significant greater than the activity of smash in most of the muscle groups of the upper limb. We found that the jump smash exerted the higher EMG activity than smash before the shuttlecock contact. The EMG activity after contact, the smash and jump smash were very similar.

Table 1 The Kinematics Variables of the Shuttlecock Between Two Smashes.

Variables	Smash	Jump Smash	t	r
Shuttle Velocity (m/s)	68.93	70.98	-.798	.093
Time of Contact (sec)	0.004	0.004	.000	.999*

* p < .05

Table 2 The EMG Activity Variables of the Smash and Jump Smash Strokes.

Variables Muscles	Stroke	Onset A. Time *(ms)*	t r	ContactAmp. *(mv)*	t r	Peak Amp. *(mv)*	t r	Mean IEMGA. *(mv)*	t r	-0.7s Mean IEMG A. *(mv)*	t r	0.4s Mean IEMG A. *(mv)*	t r
Wrist Flexor	Smash	-132.50	*	0.567	*	2.108	*	0.104	**	0.097	**	0.116	*
	J.Smh.	-771.75		0.538		2.240		0.136		0.146		0.119	
Wrist Extensor	Smash	-392.25	**	0.310	*	2.603		0.185	**	0.196	**	0.167	**
	J.Smh.	-583.38		0.799		2.650		0.238		0.243		0.229	
Biceps	Smash	-334.38		1.270		3.308		0.194		0.151	*	0.269	*
	J.Smh.	-483.88		0.760		3.682		0.272		0.280		0.260	
Triceps	Smash	-147.25	*	0.297	*	2.639	*	0.140	**	0.130	**	0.157	*
	J.Smh.	-177.88		0.233		3.091		0.176		0.170		0.186	
Middle Deltoid	Smash	-422.63	*	0.470		2.830	*	0.176	**	0.176	**	0.177	*
	J.Smh.	-680.75		0.572		3.124		0.260		0.293		0.202	
PosteriorDeltoid	Smash	-419.00	*	0.421		3.528		0.183	**	0.174	*	0.211	
	J.Smh.	-676.13		1.024		3.221		0.274		0.294		0.237	
Pectoralis Major	Smash	-285.75		0.288		3.391		0.236		0.287		0.147	
	J.Smh.	-295.38		0.188		3.568		0.258		0.301		0.183	

*p < .05

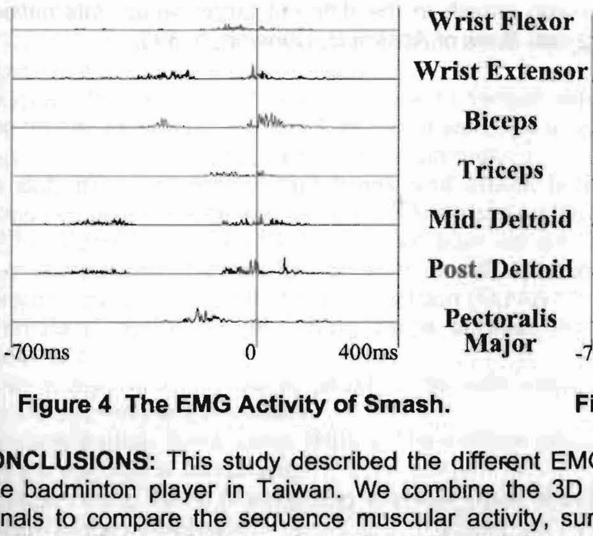

Figure 4 The EMG Activity of Smash.

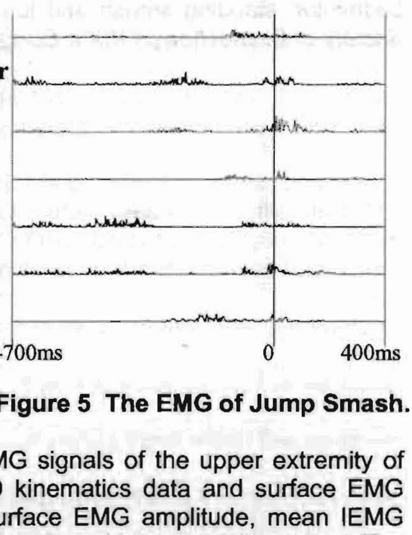

Figure 5 The EMG of Jump Smash.

CONCLUSIONS: This study described the different EMG signals of the upper extremity of elite badminton player in Taiwan. We combine the 3D kinematics data and surface EMG signals to compare the sequence muscular activity, surface EMG amplitude, mean IEMG amplitude of upper limb muscles between badminton smash and jump smash strokes. The results showed that there was no significant difference between the two smashes in initial shuttle velocity. The sequence of the surface EMG activity of the upper limb and the mean IEMG amplitude in a few muscles were different between smash and jump smash. Though the movement of the two smashes looked very similar, the muscular strategy of the smash and jump smash was not the same. As the triceps and the wrist flexor were the active muscles of the smash movements. There were greater EMG activity of the antagonists, the biceps and the wrist extensor during contact point. We found that the jump smash exerted the higher EMG activity than smash during the action, especially in the phase before contact.

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