EVALUATION OF ELBOW AND FOREARM MOTION BETWEEN SIDEARM AND OVERHAND PITCHING

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This study is to analyze the differences in kinematics, electromyography (EMG) and ultrasonography between two types of pitchers. We intend to observe and simulate the muscles around glenohumeral and elbow joints in different pitching motions and hope to discover the connections and differences in between. 12 pitchers from the top level were recruited. Larger elbow flexion was found in sidearm pitchers during the acceleration phase. Decrease of the distance of nerve to medial epicondyle was also found as the elbow moved to a more flexed position. More anterior translation of the ulnar nerve might occur during acceleration phase. Slightly lower flexor carpi radialis (FCR) activity was displayed in sidearm pitchers, showing that FCR might play a less crucial role in protecting medial elbow by providing less varus torque.

KEY WORDS: baseball, fastball, electromyography, ultrasonography

INTRODUCTION: Sidearm pitching is one of them, characterized by delivering the ball with relatively less shoulder abduction and more elbow extension. The statistics in baseball has shown that it is more difficult for a batter to hit the ball well when facing a sidearm pitcher of same handedness. However, it has been long questioned that whether this type of delivery would have any negative impact on pitchers' bodies or more likely to cause injuries.
Our study intends to analyze the differences between these two kinds of pitchers and whether the sidearm throwing does have more negative impacts on them.

METHODS: 12 right-handed baseball pitchers without any history of injuries in upper extremity were recruited in this study and divided into two groups (sidearm and overhand throwing). Baseline ultrasonographic examinations were carried out in 4 positions of the elbow respectively before and after the formal experiment. Then the participants were instructed to pitch 6 successful fastballs into the strike zone with maximum effort. In the meantime, the activation of selected muscles, which were flexor carpi radialis (FCR), flexor carpi ulnaris and extensor carpi radialis, was recorded by the surface electromyography (EMG) system and a radar gun was used to measure the ball speed of each pitch. The results analysis was focused on the acceleration phase. Significant level was defined as $p<.05$. The independent t-test was used to analyze the kinematic and muscle activity between the two groups.

RESULTS: Analysis of this study focused mainly on acceleration phase. Significantly larger peak elbow flexion angle was found in sidearm than overhand pitchers ($p = .042$). Significant difference was found in FCR activity ($p = .001$). Measurements of baseline ultrasonographic examinations are shown in Table 1. There were significant differences in the distance of nerve to epicondyle of four elbow positions of overhand pitchers. It turned out that the result of 120^{o} flexion was significantly smaller than the other three positions.

Table 1 Comparison of the ultrasonographic examination results at the elbow.

Parameter	Pitching	0°	45°	90°	120°	*p*-value
NA (mm^2)	Sidearm	5.50±0.71	5.50±0.71	4.00±1.41	6.00±1.41	.417
	Overhand	5.71±1.38	5.43±1.13	5.57±1.90	5.43±1.90	.985
p-value		.284	.392	.271	.271	
ND (mm)	Sidearm	3.50±0.85	3.30±0.14	3.00±0.28	3.80±1.56	.838
	Overhand	3.67±0.75	3.57±0.51	3.30±0.73	3.61±0.87	.783
p-value		.754	.162	.148	.175	
DNE (mm)	Sidearm	8.95±3.75	5.45±0.50	3.65±0.07	1.10±1.56	.072
	Overhand	7.19±1.45	6.63±1.87	4.80±1.60	1.69±2.65	.000*
p-value		.056	.210	.075	.229	

Data = Mean±Standard deviation; * $p < .05$; NA: Nerve area, ND: Nerve diameter, DNE: Distance of nerve to epicondyle

DISCUSSION: Study focusing on overhand pitchers by Fleisig et al. (1995) found out that the peak elbow joint angle during acceleration phase was 85° to 105°. In this study a similar result in this parameter was 93.19±10.11°. In sidearm pitchers, a significantly larger peak elbow angle was found to be 107.50±3.54°. Ultrasonographic measurements showed that as the elbow joint moved to a more flexed position, the distance of ulnar nerve to medial epicondyle would decrease, indicating more anterior translation of the ulnar nerve. This is in accordance with the study by Tai et al. (2014). Larger peak elbow flexion angle was displayed in sidearm pitchers, indicating that more anterior translation might have occurred when a sidearm pitching motion was used. This anterior movement would result in the compression of the nerve against the tip of medial epicondyle and the fascia of the flexor-pronator muscles (Okamoto, et al., 2000). Maximum FCR activity was identified during the late cocking and acceleration phase of the pitching cycle (Sisto, et al., 1987). Moreover, lower FCR activity was found in elbows with medial collateral ligament insufficiency. Lower FCR activity was found in sidearm pitchers than overhand ones, which showed that FCR also played an essential role in the pitching motion in sidearm and overhand pitchers.

CONCLUSION: Larger peak elbow angle in sidearm pitchers might result in the more anterior translation of the ulnar nerve at the medial elbow. In addition, slightly lower FCR activity displayed in sidearm pitchers might contribute to lower production of varus torque. Training of the forearm muscles, especially FCR, is recommended for the pitchers to enhance the production of varus torque to protect the medial elbow.

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