Laterality in Upper Limb Composition and Maximal Isometric Strength of Elbow Joint of Baseball Players

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Abstract

The purpose of this study was to investigate the laterality in upper limb composition and maximal isometric strength of elbow joint of baseball players. The professional baseball players (n = 8) and the healthy male volunteers (n=10) served as the subjects. The cross-sectional areas of each tissue in upper limb were measured on both dominant and nondominant sides by the ultrasonic method. Also, the maximal isometric strengths of both elbow extension and flexion were measured for each subject. Comparison of the two groups indicated that the baseball group was distinguished from the controls by significantly large corss-sectional area of the extensor muscle in the dominant forearm. The cross-sectional area of the flexor muscle was larger in the dominant forearm both of baseball players and of controls. No significant lateralities were observed in the cross-sectional areas in the other tissues (muscle, bone and fat) for the baseball group. Furthermore, for both groups, there were no significant differences in the maximal isometric strengths of the elbow extension and flexion between the dominant and the nondominant limbs. It was concluded that the baseball players seemed to indicate the influence of training on the muscle hypertrophy in the dominant forearm.

Key Words: baseball, laterality, limb composition, isometric strength

Introduction

It has been indicated that the cross-sectional area of muscle normally reflects its maximal isometric strength.[7,11,12] The increases of cross-sectional area and maximal isometric strength of the muscle submitted to strength training have already been confirmed.[3,4,13] Therefore, it is considered that when an athlete is engaged in one kind of sports for a long time, which is adequate as a stimulus to develop muscle hypertrophy, he selectively reveals the increases of cross-sectional area and maximal isometric strength of the muscle recruited in his activity. In case of tennis, tennis players were distinguished from the controls by significantly increased isometric strength of metacarpophalangeal joint extension of the fingers on the dominant side.[17] But, there has been few investigations on the laterality in limb composition of the athletes who use striking instrument in their sports activities.

In this study, baseball players were chosen as the subjects because they swing a bat and use their

Table 1. Comparison of body height, body weight and %fat between baseballers and controls

group	height (cm)	weight (kg)	%fat (%)
baseballers (N = 8)	179.7 ± 1.7**	78.0 ± 6.3***	11.16 ± 3.87
controls (N = 10)	171.7 ± 7.3	59.4 ± 5.7	11.87 ± 2.63

Values are mean ± SD.
**p<0.01, ***p<0.001
The Brožek[1] equations were used to predict %fat and LBM from body density determined hydrostatically.

dominant upper limb to throw a ball. It seems a worthwhile problem in baseball players to investigate the laterality in upper limb composition and maximal isometric strength of elbow joint.

Procedures

Eight professional baseball players, aged 19-24yr, served as the baseball group. They had no symptom of exercise-induced pain. The control group was comprised of 10 healthy male volunteers, aged 18–20yr. All were informed of the procedures and purpose of this study. The characteristics of the subjects studied are given in Table 1.

The cross-sectional area of upper limb tissue of the subject was measured by the ultrasonic apparatus (ALOKA, ECHO-VISION SSD-120) connected with the circular compound scanner.[7] The 60% distal point from the acromion for upper arm and the 30% distal one from the olecranon for forearm were adopted as the point for the measurement of cross-sectional area. Dominant and nondominant limbs of each subject were alternately immersed in a water tank to get the cross-sectional image. The 5MHz frequency of ultrasonic wave was selected to get a clear image on the screen. The cross-sectional areas of each tissue such as fat, muscle and bone were calculated from photographed image by using a planimeter. The cross-sectional area of each muscle was anatomically classified into two groups of the extensor and the flexor muscles.

The maximal isometric strengths of both elbow extension and flexion were measured on both dominant and nondominant sides by means of a strain gauge transducer. Each subject seated on a chair and put his upper arm on a specially designed horizontal rest set above each side edge of the seat, and the forearm was half-pronated at 70° flexion in the elbow joint (full extension=0°).

A paired t-test was used to compare the values obtained from the dominant and the nondominant upper limbs in all cases. Difference in laterality between the baseball and the control groups was tested for significance by ANCOVA. The 0.05 level of confidence was accepted as statistically significant for all statistical tests. Data in the text and tables are presented as mean ± SD.

Results

The cross-sectional areas of each tissue in the upper limb are presented in Table 2. The baseball group indicated significantly greater values in the cross-sectional areas of the extensor ($p<0.01$) and

Table 2. Cross-sectional areas of each tisse in upper limb

		baseball group		control group		
		dominant	nondominant	dominant	nondominant	
forearm	bone	4.81 ± 0.68	4.78 ± 0.58	3.48 ± 0.36	3.49 ± 0.51	(cm^2)
	extensor m.	18.75 ± 1.91**	17.11 ± 2.94 $	14.74 ± 2.46	13.99 ± 2.05	
	flexor m.	25.16 ± 2.17*	22.91 ± 3.08	19.40 ± 1.22**	17.90 ± 1.72	
	fat	8.65 ± 3.24	9.03 ± 1.59	7.15 ± 1.46	7.14 ± 1.43	
upper arm	bone	4.71 ± 0.41	4.29 ± 0.51	3.65 ± 0.50	3.64 ± 0.76	
	extensor m.	23.95 ± 3.12	24.60 ± 4.16	15.82 ± 3.18	16.48 ± 2.87	
	flexor m.	18.41 ± 2.87	18.17 ± 2.44	14.73 ± 1.96*	13.46 ± 2.46	
	fat	16.74 ± 5.97	16.44 ± 5.03	12.18 ± 4.00	11.53 ± 3.59	

* $p<0.05$, **$p<0.01$; difference between the dominant and the nondominant limbs
$ $p<0.05$; difference in laterality between the baseball and the control groups.

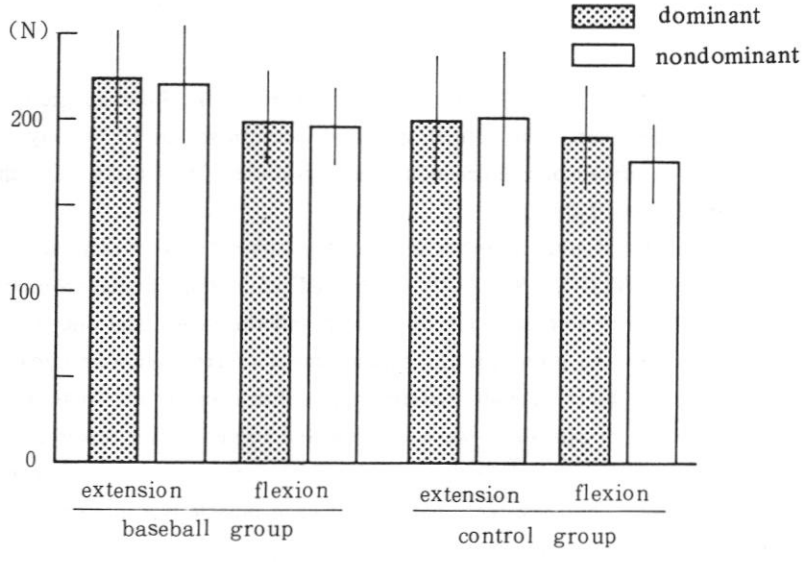

Fig. 1 Maximal isometric strength of elbow joint

the flexor ($p<0.05$) muscles in the dominant forearm than those in the nondominant. Significant lateralities were not consistently observed between the dominant and the nondominant upper limbs in the other tissues for the baseball group. The control group showed significantly greater values in the cross-sectional areas of the flexor muscle in the dominant forearm ($p<0.01$) and upper arem ($p<0.05$). Additionally, the difference in the cross-sectional area of the extensor muscle between the dominant and the nondominant forearm was greater ($p<0.05$) for the baseball group than for the controls.

The maximal isometric strengths of the elbow extension and flexion for the baseball group averaged in 224.1 ±29.2 N (mean ± SD) and 198.2 ± 25.7 N on the dominant side, and 220.5 ± 34.8 N and 196.1 ± 22.8 N on the nondominant side, respectively. The corresponding values for the control group were 201.2 ± 37.8 N and 190.8 ± 30.2 N on the dominant side, and 202.1 ± 38.7 N and 176.5 ± 20.8 N on the nondominant side, respectively (Figure 1.) For both groups, there were no significant

differences in the maximal isometric strengths of the elbow extension and flexion between the dominant and the nondominant limbs.

Discussion

There was no significant difference in %fat between the baseball and the control groups, although body height and body weight for the baseball group were significantly greater than those for the controls (Table 1). The value of %fat for the baseball group (11.16 ± 3.7%) were approximately similar to that of previous studies.[2,6] The baseball group in the present study seems to be representative of the characteristics of general baseball players.

It has been pointed out that when the dominant limb with a ball is accelerated forward in space during the pitching motion, the extensor muscle in the dominant upper arm is notably active.[8,10,14] It indicates the possibility of the hypertrophy in the extensor muscle. No significant difference, however, was observed in the cross-sectional area of the extensor muscle between the dominant and the nondominant upper arms for the baseball group (Table 2). And as a consequence of the same amount of the extensor muscle, there was also no significant difference in the maximal isometric strength of the elbow extension between both upper arms (Figure 1). According to the comparative study between the little leaguers and the professional baseball players, there was no significant difference between them in the percentage of the cross-sectional area of the triceps muscle to that of the whole upper arm muscle.[9] It might be considered that the strength exerted by the extensor muscle in the dominant upper arm during the pitching motion was small as compared with the maximal isometric strength of it, for the elbow joint of the dominant limb was rapidly extended. It was also reported that soccer players did not indicated the increase in muscle strength of the knee extension by soccer training alone.[15] The present results on the elbow extension seems to support the opinion that the activity of ball game is inadequate for increase in maximal isometric strength measured by regular strength test.[18]

The baseball players were distinguished from the controls by significantly larger cross-sectional area of the extensor muscle in the dominant forearm. This result is also supported by the previous investigation that there was a strong correlationship between the wrist extension and throwing speed.[16] Furtheremore, the baseball players indicated larger cross-sectional area of the flexor muscle in the dominant forearm than that in the nondominant, although there was no significantly different laterality in this area between both groups. As the angular velocities of the wrist extension and flexion during the pitching motion are smaller than that of the elbow extension,[5] it may be possible to consider that the wrist joint owed the role for fixation of the hand against the forearm during the pitching motion, especially during follow through movement. Another factor for this result that should be considered is that the baseball players swing a bat many times. Metacarpophalangeal joint extension strength is reported to be significantly greater in the dominant arm of tennis players.[17] Similar to the tennis racquet, the mass of the baseball bat might be adequate to increase the cross-sectional area and the maximal isometric strength of the peripheral muscle in the upper limb.

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