KINEMATIC DIFFERENCES IN LEFT-RIGHT SIDE IN BLOCKING AMONG COLLEGE WOMEN'S VOLLEYBALL PLAYERS IN JAPAN

Koki Numata*, Yoshie Motoshima*, Koji Hamada*, Misato Sakanaka*, Shunsuke Murakami*, Hiroo Takahashi* and Ryogo Kashiwagi

National Institute of Fitness and Sports in Kanoya, Japan
Graduate School, National Institute of Fitness and Sports in Kanoya, Japan
1, Shiromizu, Kanoya, Kagoshima, JAPAN

*Email: k-numata@nifs-k.ac.jp
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Abstract

In recent years, the attacking tactics of top-level teams have been dominated by a combination of four attackers. The basic approach to defending against this move is to block in the direction of the toss (Read Block System). This study compares and examines the difference between the left and right sides of the crossover step of women's volleyball players using the read block system. Fifteen Japanese college women's volleyball players (age: 20.1±1.1 years, height: 169.3±5.5 cm) were eligible for the study. A time-synchronized 16 camera Mac3D optical motion capture systems (Motion Analysis Co.) and 10 force plates (Tec Gihan Co.) were used to determine three dimensional (3-D) coordinates of 38 retroreflective markers. The players were told that the toss from the setter would go up randomly in one of the left or right direction, and they were asked to block in response to the toss from the centre of the net. The results showed that the performance of the jump height ($p = 0.04$, $d = 0.50$), maximum block reach ($p = 0.01$, $d = 0.51$), and motion time ($p = 0.02$, $d = 0.75$) was better than the left, and the effect size was large. Since most of the subjects in this study were right-handed (two of the Opposites were left-handed), it is assumed that they tended to perform better on the left side, which is a block stepping similar to spike stepping. However, some players may not use the spiking hand, so individualized instruction is required.

Keywords: biomechanics, kinematics, motion analysis, Volleyball, blocking

Introduction

In Volleyball, blocking is a play that always appears in large numbers in response to an attack on a major play (Okano and Tanigawa, 2016). It is important as one of the factors in winning or losing a set (Ota et al., 2015). The aims of the block are: to stuff the ball, score a direct point, or deflect it to help the floor defence and continue with a counterattack. The Middle Blocker (MB) has the responsibility to protect the middle zone of the net against all quick attacks, yet the player has also to form a tight block against other opponent attacks moving laterally (Lobietti et al., 2006). In recent years, the attacking tactics of top-level teams have been dominated by a combination of four attacks. The basic idea of defence against this strategy is to block in the direction of the toss (lead blocking system). Therefore, the blocker needs to see the toss and then move quickly to block. In order to move quickly, the technique of stepping is very important. The steps include the slide step and the cross step. Among them, the crossover step showed the longest time of the jump and highest elevation (Lobietti et al., 2009). Lobietti et al. (2009) analyzed the left and right sides of the block using the crossover step, but with a single subject. The purpose of this study is to compare and examine the difference between the left and right sides of the crossover step of women’s volleyball players using the read block system.

Methods

The subjects were 15 Japanese colleges of a women's volleyball players (age: 20.1 ± 1.1 years, height: 169.3 ± 5.5 cm, weight: 64.8 ± 5.6 kg). The breakdown of positions included five outside hitters (OH), four middle blockers (MB), three opposites (OP), and three-setters (S). Two of those opposites are players who attack, left-handed. This team is at the level of winning the Japanese regional college league four years in a row.

The data were acquired by affixing reflective markers to each of the 38 body parts, 4 balls, and 4 nets for a total of 46 points, as well as an optical motion capture system Mac3D (16 Raptor-E cameras, Motion Analysis Co, 300Hz) and 10 force plates (TF-90100, 1,200 Hz, Tec Gihan, Co). The force plate data output was captured from a centralized transponder (Tec Gihan Co) and imported into the Mac3D software Cortex6.2 (Motion Analysis) via an AD converter (USB-6259, National Instruments Co).

The X-axis is the right direction, the Y-axis is the front direction, and the Z-axis is the vertical direction from the player's point of view. The obtained data were smoothed with a fourth-order Butterworth-type low-pass filter at a cut off frequencies of 20 Hz (3-D coordinate values) and 100 Hz (ground reaction force values).
The experiment was conducted in the layout shown in Figure 1 and Figure 2. The players were told that the toss from the setter would go up randomly in one of the left or right directions, and they were asked to block in response to the toss from the centre of the net. The left and right conditions were performed three times each, based on a total of six random tables. A block in a direction other than the direction of the toss is considered invalid and excluded. The data were selected from the one trial on each side with the highest jump height.

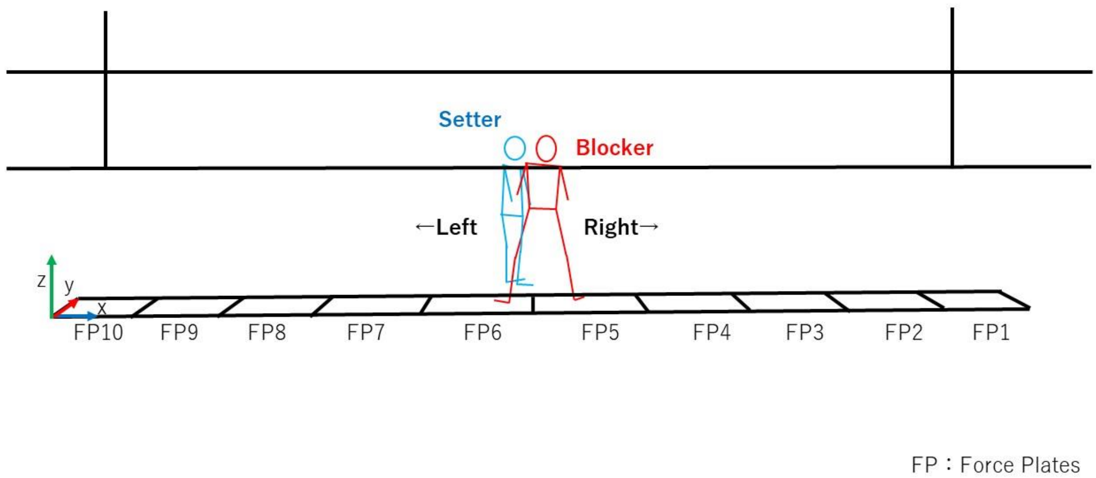

Figure 1. The layout of the experiment (from the back)

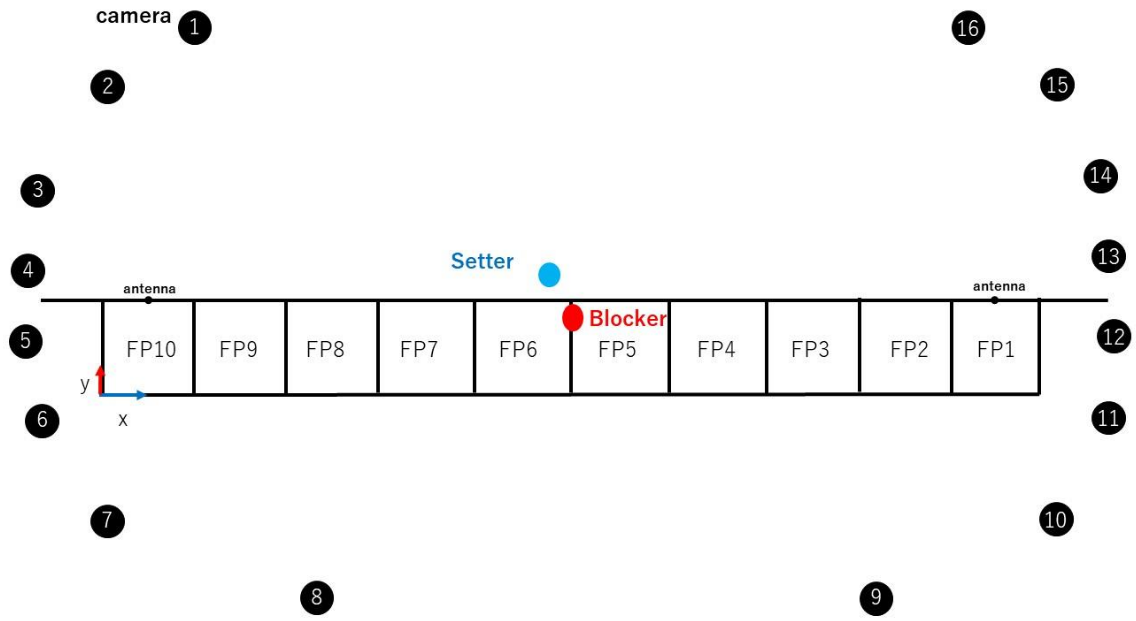

Figure 2. The layout of the experiment (from top)

The analysis items were: jump height, block reach, body centre of gravity velocity, reaction time, motion time, ground contact time, and ground reaction force at the start (Table 1).

Table 1. The methodology of calculating the variables

Jump height	m	Block jump height
Block reach	m	Maximum hight of the marker affixed to the third metacarpal borne
Body center of gravity velocity	m/s	Maximum body center of gravity velocity from the onset of maximum ground reaction force until the first foot of the stepping motion contact ground.
Reaction time	sec	Time from the ball's lowest point in the setter's hand of maximum ground reaction force at the start
Motion time	sec	Time from the appearance of maximum ground reaction force at the start to the ground contact of the first foot for the crossing action
Ground contact time	sec	The time from ground contact to both feet separation of the first foot of the stepping motion
Ground reaction force at start	N	Maximum ground reaction force at the start of movement

A t-test was used for left-right differences, and two-way ANOVA was used for left-right differences that considered positions. The Bonferroni procedure was used for the post hoc test. The significance level was set at less than 5%. R (Version 3.6.6) and SPSS 26 (IBM) were used for statistical processing.

Results

The results showed that the left side performed better for jump height (p=0.04, d=0.50), block reach (p=0.01, d=0.51), and motion time (p=0.02, d=0.75), all of which were above the large effect size (Table 2).

Table 2. Comparison of left-right differences in block performance items

		Left			Right				
		Mean	±	SD	Mean	±	SD	*p*	ES
Jump height	m	0.448	±	0.056	0.420	±	0.056	0.044	0.50
Block reach	m	2.451	±	0.057	2.425	±	0.044	0.013	0.51
Body center of gravity velocity	m/s	3.559	±	0.167	3.525	±	0.200	0.484	0.18
Reaction time	sec	0.304	±	0.083	0.291	±	0.068	0.640	0.17
Motion time	sec	0.976	±	0.028	1.017	±	0.072	0.019	0.75
Ground contact time	sec	0.300	±	0.021	0.313	±	0.046	0.321	0.34
Ground reaction force at start	N	1402.46	±	239.91	1378.86	±	197.85	0.633	0.11

For the block reach by position, the main effect of position was significant (F(3, 22) = 3.73, p = 0.00, η^2=0.44), while the main effect of left and right (F(1, 22) = 2.38, p =0.14, η^2=0.05) and the interaction (F(3, 22) = 0.32, p =0.81, η^2=0. 03) were not significant (Figure 3). There were significant differences between MB vs S (p = 0.03), MB vs OP (p = 0.04), and OH vs S (p = 0.02) for the positions.

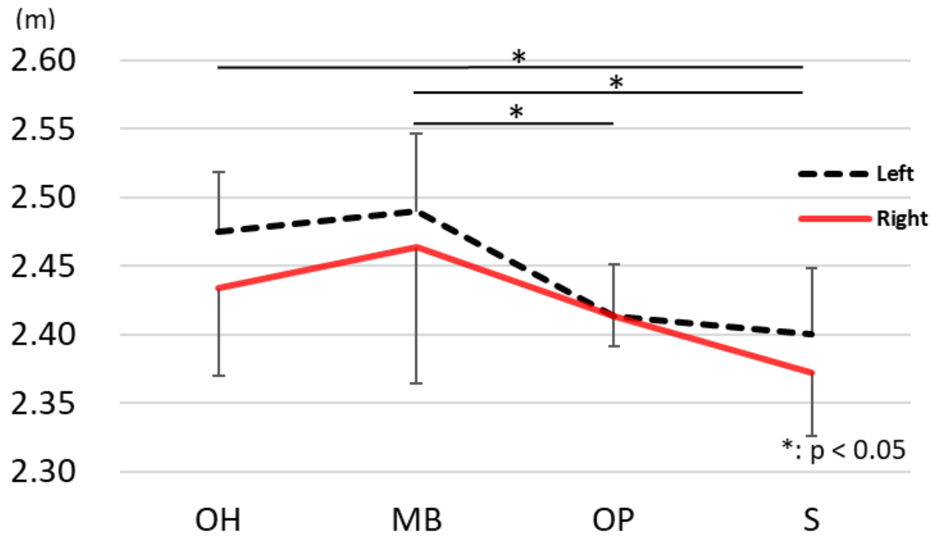

Figure 3. Comparison of left-right differences in block reach by position

For the motion time by position, the positional main effect (F (3, 22) = 1.83, p = 0.17, η^2=0.16), the left and right main effects (F (1, 22) = 3.23, p =0.09, η^2=0.10) and the interaction (F (3, 22) = 0.90, p =0.46, η^2=0.09) was not significant (Figure 4). However, it is possible that OH may differ between left and right in terms of effect size (d = 1.68).

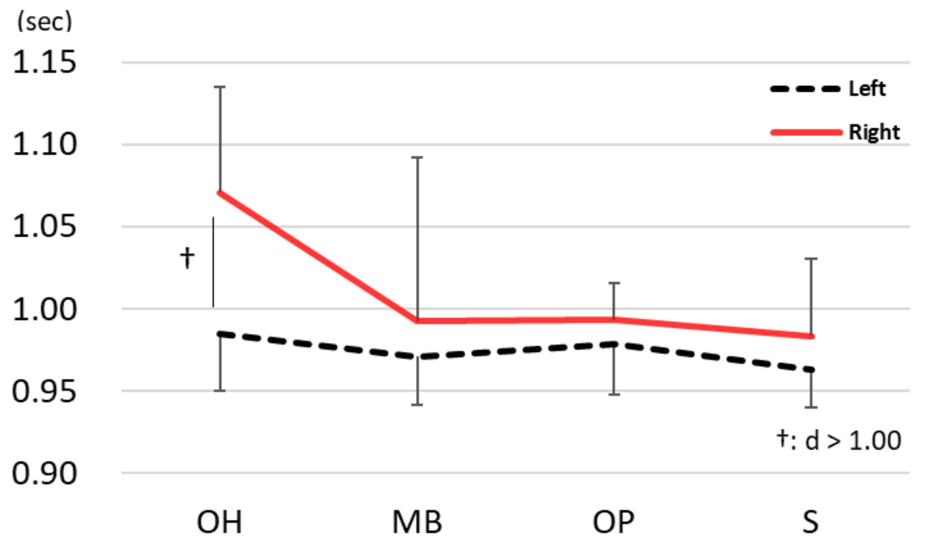

Figure 4. Comparison of left-right differences in motion time by position

Discussion

The purpose of this study was to compare and examine the difference between the left and right sides of the crossover step of women's volleyball players using the read block system. The results showed that the left side performed better in terms of jump height, block reach and motion time. Lobietti et al. (2009) conducted a kinematic analysis of spike jump and block movements, suggesting a similarity between spikes and blocks when moving to the left. Since most of the subjects in this study were right-handed (two of the OP were left-handed), it is assumed that they tended to perform better on the left side, which is a block stepping similar to spike stepping. However, some players may not want to use the spiking hand, so individualized instruction is required (Figure 5).

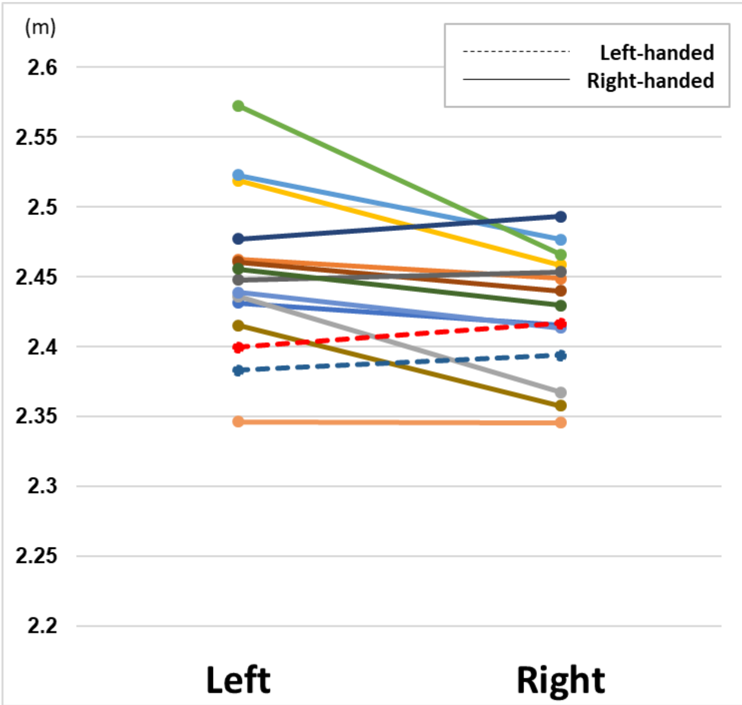

Figure 5. Maximum block reach

In this study, the effect size was large and may have differed in motion time of the OH. Lobietti (2009) stated that outside blockers use a cross-step when moving to the outside and a sidestep for the middle. This suggests that the blocking of OH against the right usually uses a sidestep, which may have made a difference in the present study. It is recommended that future longitudinal studies should be conducted to study the improvement of the players blocking ability. Further transversal studies with a larger number of players will be conducted as well to find the difference between roles, levels and genders. A limitation of the current study was the inclusion of left-handed subjects.

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