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Review Article

A REVIEW OF BLOCKING IN VOLLEYBALL: FROM THE NOTATIONAL ANALYSIS TO BIOMECHANICS

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ABSTRACT

This article reviews the state of art of the research concerning the biomechanics of blocking in volleyball. Since it is fundamental to link the "reality of the game" (what happens in the field) with laboratory simulations, the logic procedure to investigate this skill followed this progression: 1) the importance of block in the game was analyzed in terms of relationships with the match results. 2) Blocking footwork techniques were classified and data relative to the frequency of blocking to stop the opponents attack were collected and analysed. 3) Kinematical analyses of blocking techniques were performed in the laboratory of the Faculty of Exercise and Sport Science at the University of Bologna, Italy. These results allow coaches to adjust the tactic in the game, to differentiate the type of drills and to develop some special exercises to train players for the improvement of their blocking technique.

Key words: *stereophotogrammetry, block, lateral movement, kinematics*

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INTRODUCTION

Blocking successfully is a crucial feature of winning teams in today's volleyball. Key points for the effectiveness of block are anticipation, decision-making, movement speed and jumping ability. In this article I will review the state of art of the research concerning this important skill. A particular focus will be onto some studies recently performed at the University of Bologna, Italy, in which the block has been analysed following three main perspectives:

- The importance of this skill to win.
- The types of movement most frequently used by players for blocking, investigated with a technical analysis.
- The biomechanics of the block and of the vertical jump.

To block efficiently players should use a technique allowing the shortest time to arrive at the target (the ball-contact), the longest lateral movement along the net and a vertical jump. Also penetration and angulation of the hands relatively to the net plane are determinant to form an efficient surface over the net and to control the rebound of the ball. This is the reason for which coaches (Beal & Crabb, 1987; Kiraly, 1990; Paolini, 1998) consider the "frontality" of the body with respect to the net as an important factor: pelvis and shoulders should be parallel to the net as much as possible.

Previously few studies have compared different footwork techniques for the lateral movement sequence in volleyball blocking.

The two principal types of footwork techniques are the "slide or 2 step" and the "cross-over or three step". To better explain these movement in figure 1 and 2 are described the feet's actions of a blocker moving to the right.

In the slide step (figure 1) the right foot moves laterally and the left foot follows close to the leading foot, than the feet push up for the jump.

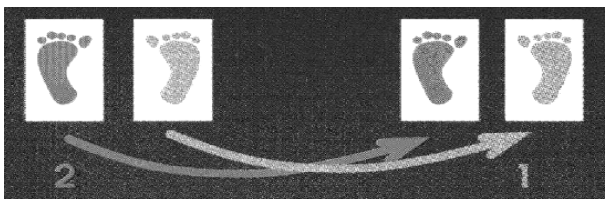

Figure 1. *Slide step*

In the cross over step (figure 2) the left foot first crosses over the right foot passing closer to the net and than the right foot closes the move crossing back, then both feet push up for the jump. Frequently the cross-over follows a previous short slide of the right foot: for that reason the name of a "three step technique".

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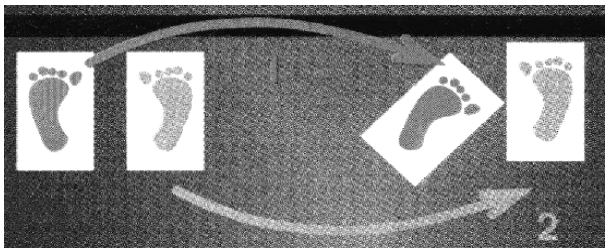

Figure 2. *Cross over step*

Cox et al. (1982) analysed the temporal variables of the lateral movement to the right using a pair of pressure sensitive floor mats. The authors (Cox, Noble, & Johnson, 1982) compared three different techniques: the cross-over and the jab cross-over (slide-cross and slide again) were better than the slide step in terms of getting the blocker off the ground and getting into the proper blocking position quickly.

Kwak et al. (1989) compared the cross-over and the slide steps used by female (14) and male (10) Korean players in terms of horizontal velocity, maximum vertical take-off velocity and maximum vertical ground reaction force. The systems used were cinematography and a force platform. Their findings showed no differences in females, while the cross-over step resulted more effective in males.

Buekers (1991) built a special apparatus with two pressure sensitive floor mats and a photocell system analysing temporal data from the feet start and the hands arrive over the net. In this way they analysed the performance of 10 female players moving from the middle of the court to the right side. The author stated that the optimal step technique should vary as a function of the lateral distance that must be covered by the blocker. Therefore, the slide step is the best in case of a short distance while the cross-over is better suitable when the opponent's attack is far away (Buekers, 1991).

Vint (1997) analysed these studies and built a complete deterministic model of the block. He also proposed a qualitative analysis with a film blockers performed with two synchronized cameras. In his work, some key points determinant for the technical effectiveness of the block were identified: time from start to the contact with the ball, angulation and penetration of the hands, body position relative to the net in the flight phase of the block, and elevation of the jump.

Lehnert et al. (2001) performing a 3D videography (APAS) of only two male middle blockers (going to the right) stated that dropping hands during lateral displacement positively affects the kinematic characteristics of the movement (velocity of the movement and block jump height).

All these studies fixed the distance that the players had to cover laterally (2,70 m for Cox and Kwak, 3,00 m for Buekers), collected temporal data to arrive to the target from the starting positions (Cox et al., 1982; Kwak et al., 1989), and computed mean horizontal velocity (Kwak et al., 1989). Since the distance that players have to cover laterally is not a constant but depends on starting position and players' specialisation, a different approach in the kinematical analysis was followed in our pilot studies:

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- The first study was limited to the analysis of the lower limb of 6 players moving to both the directions (left and right) and using 4 types of footwork techniques (Lobietti et al., 2005).

- The second study focused on the vertical jump to block the Quick Attack (Lobietti et al., 2006).

The Notational Analyses

- The importance of the block to win the game has been investigated with a cluster analysis comparing the male (M) and female (W) Italian Volleyball Professional League (Lobietti et al., 2006). The investigation analysed the performance using the software Data Volley collecting points scored per set serving, attacking and blocking or by means of opponent's error. This study showed that, for male players, the block resulted the second skill in importance after the attack: block's points per set were highly correlate with the final ranking (R=0.74).

- Blocking footwork techniques were classified and data relative to the frequency of blocking to stop the opponents attack were collected by means of an observational analysis. The blocking movements were classified watching a film realised from a central position back the court with a video-camera (25 Hz). The types of movement most frequently used by players resulted the vertical jump (20% W and 16% M), the jump to block after one or more slide step (43% W and 45% M) and a combination of cross-over step (22% W and 36% M) (Lobietti & Merni, 2006).

Instrumentation used for the kinematical analyses

A system for three-dimensional analysis of motion (Vicon Motion System) has been used. Passive markers fixed to different anatomical landmarks of joints during blocking exercises were filmed with 6 infra-red video cameras with a max resolution of 300.000 pixels and a frequency of 100 Hz. The system uses stereophotogrammetric procedures to create a 3-D image.

First Study (Lobietti et al. 2005)

Subjects: six (4 hitters, 1 middle blocker, 1 setter) male volleyball players (age 26.8±5.5 years, height 189.6±5.5 cm, weight 83.4±4.1 Kg, all right handed).

Each player executed 4 trials of each type of movement: one (SS) and two consecutive slide (DSS), a single cross step (CS) and a slide-cross (SCS) in both directions. The players were asked to reach the best speed, the longest distance, the maximal elevation and verticality of the jump, maintaining the best frontality at the net.

The great differences with the real game was the absence of the ball, of the opponents and the possibility for players to start by themselves rather than reacting at situations, so we have to consider the following results as a description of a typical blocking drill session. A single trial of each player on each footwork technique for both directions has been selected.

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Table 1. *Elevation and the mean value of duration of the different phases of the move: the data regarding support and pivot foot contact time are very interesting for coaches to select special exercises reproducing or reducing this time.*

Blocking footwork technique	Time of the last step	pivot foot contact time	Time of the closing step	Support foot contact time	Time of the jump	Total time	Vertical speed at jump foot off	Elevation
	sec	sec	sec	sec	Sec	sec	m/sec	Mm
SCS	0,526	0,369	0,340	0,175	0,677	1,977	3,767	557
CS	0,436	0,408	0,318	0,203	0,663	1,519	3,471	532
SS	0,464	0,450	0,331	0,249	0,632	1,558	3,059	474
DSS	0,447	0,419	0,352	0,210	0,613	2,076	3,069	458
Mean	0,468	0,412	0,335	0,209	0,646	1,783	3,279	505
St. Dev.	0,061	0,056	0,049	0,046	0,040	0,263	0,307	72
Min	0,360	0,310	0,250	0,120	0,580	1,320	2,463	367
Max	0,570	0,540	0,470	0,310	0,750	2,260	4,061	662

Mean values of frontality at jump foot off confirmed that the orientation of the body was not so far to be parallel to the net by these players: SCS 18±11 deg; CS 21±19 deg; SS 7±5 deg; DS 5±3 deg.

The lateral shift of the body during the flight (verticality) in the jump showed a mean value of about 28 cm using the two types of cross techniques and about 10 cm using the slide.

This study suggested to coaches some adjustment for the players: outside blockers should use the CS when they are moving to outside and to use SS to the middle; middle blockers should use mostly the SCS or CS.

These players were faster to the left: thanks to the results of the study they changed their strategy in game. When starting to block in position 4 they can start closer to the middle of the court helping the middle blocker, whereas in position 2 they had to start a little bit wider to be ready against the opposite outside hitter.

Second Study (Lobietti et al. 2006)

Subjects: Four male volleyball players (age 16.5±1 y, height 182.7±2.8 cm, weight 72±5 Kg) of an under 18 team were filmed during the execution of vertical jump simulating the two types of tactic used to block the quick attack. In the Read Block System (RBS) the blocker starts close to the net looking at the opponent's setter, with hands up and bent legs. He is ready to react jumping vertically from this position, in case of a quick set, or to move his feet and follows the ball, in case of an outside set. Outside blocker (OB) starts also ready to help the MB against the quick set or to move laterally against an outside set in front of him. In the Commit Block System (CBS), the MB has to jump at the take off of the quick hitter's spike without worrying about the set. In the simulation of this two situations in the laboratory of biomechanics, the blocker starting close to the net had to execute the block trying to reach the maximum elevation of the jump and the maximum hands' penetration. In the CBS, the player decided by himself when to jump. In the RBS, the player was ready to react, reading the

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coach miming the opponent setter in all the three possible directions (left, right, or up) and then moved or jumped consequently. Three trials for each type of block were acquired and the best trial was identified as the execution with the maximum elevation for the CBS and with the shortest reaction time for the RBS.

In table 2 are reported data relative to the different phases of the block, elevation and penetration angle for both the types of tactic.

Table 2. *Durations, distances and velocity (Mean±SD)*

	Preparatory phase (sec)	Push-off phase (sec)	Flight phase (sec)	Hands time to arrive over the net (sec)	Elevation of the COM (cm)	Penetration Angle (deg)
CBS	0,38±0,14	0,32±0,05	0,60±0,01	0,75±0,15	442±29	135±7
RBS	0,18±0,20	0,22±0,07	0,56±0,02	0,43±0,30	364±34	141±2

A non-parametric Friedman test was performed to analyse the differences between the two types of techniques. In the RBS, the elevation was lower, the arms extension allowed the hands to arrive over the net in a shorter time. The quantitative analysis of upper limbs showed a similar penetration, although reached with different movement strategies, In the CBS, a countermovement allowed to jump higher. This can be explained by the eccentric preload of hip extensors). On the other hand, the starting position of the RBS requires directly to jump without any countermovement. As observed by Komi (1983), the countermovement jump allows the athletes to perform a higher jump compared to the squat jump. However, the lower elevation of the RBS was compensated by a shorter time necessary for the hands to arrive over the net.

A limit of this study, as well as all previous studies, was the absence of the ball and of the attackers but these results could help coaches to teach and train the blockers better.

CONCLUSION

One of the most interesting results of these studies was relative to the countermovement before the jump:

- In the Vertical jump of the Commit Block at the moment of the maximal flexion the knee angle was around 90 degree.

- In the lateral movement (slide and cross) the value of the knee angle of the pivot foot was around 90 degree.

These evidences suggest coaches to use this angle in all the exercises of weight -or jump- training proposed to improve blocking abilities.

Volleyball is an open skill sport and for this reason the variability of the movement is very high. Therefore, the biomechanical studies have to follow notational analyses and qualitative descriptions of the skills. Blocking was ranked as the second skill in importance to win the game; the most popular techniques used by players in matches to block resulted the simple vertical jump, the slide and the cross over step. The stereophotogrammetry permitted to

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investigate the kinematics of the block and after the classification of the frequency of different type of technique and tactic used by players was possible to standardize the researches. Due to the importance of the lateral speed in the footwork techniques and jump's height to determine blocking efficiency, the investigations conducted and published focused mostly on the kinematics of the lower limb. The results presented in this article are the first step of a major project: further studies will be conducted to suggest to coaches drills and exercises to improve blocking abilities.

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