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Research article

Comparison of the traditional, swing, and chicken wing volleyball blocking techniques in NCAA division I female athletes

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Abstract
In volleyball, blocking is highly correlated with team success. The identification of specific techniques that produce a more successful block would be helpful knowledge for coaches and players. This study compared the traditional, swing, and "chicken wing" blocking techniques in combination with the running step footwork pattern in order to determine which technique enabled athletes to perform a more effective block. High-speed videography (7 cameras, Vicon Motion Analysis System) was used to capture the blocking movements of thirteen female NCAA Division I athletes (age = 19.4 ± 1.19 years, height = 1.82 ± 0.08 m, mass = 70.63 ± 7.96 kg, and years of participation at the collegiate level = 2.23 ± 1.17 years). Each player was familiar with each blocking technique. Reflective markers were placed on the players and in randomized order the players performed 3 blocking trials of each technique. The following dependent variables were assessed: The time it took the athletes to get off the ground and get their hands above (vertically) the net was calculated. The distance the hand reached over the net or hand penetration (displacement between the net and finger in the anterior and vertical planes) was also measured. Lastly, jump height was calculated. Repeated measures ANOVA and post-hoc comparisons were done ($\alpha = 0.05$). There was no significant difference in the main effect for time to get off the ground ($p > 0.05$). There was a significant difference in the time to get the hands above the net ($p < 0.05$). The swing block was best for jump height ($p < .001$) and hand penetration ($p < 0.05$). These results can help coaches and players decide which blocking technique will benefit them most as a blocking team and as individual blockers.

Key words: Motion analysis, counter-movement, volleyball defense .

Introduction

Blocking is one of the most significant contributors to winning or losing volleyball games (Eom and Schutz, 1992; Lenberg, 2004). It is also one of the most difficult volleyball skills to master because it incorporates athletic ability with decision making (Scates, 1976). Decision making is difficult because every possession of the volleyball leads to a different scenario for blockers. The demand on blockers has increased because hitting has become more explosive and offensive combinations are being played at faster speeds (Coleman and Neville, 1990). Blockers adjust to these changes by anticipating where the ball will be set, making a quick decision, and executing a quick lateral move and jump with coordinated arm movements in order to defend the net effectively (Buekers, 1991; Cox et al., 1982).

Several characteristics define an effective block, including: lateral movement speed, quickness in getting off the ground and getting the hands above the net, jump height and hand penetration (displacement between the net and finger in the anterior and vertical planes) across the net. Lateral movement speed and quickness in getting off the ground are critical (Cox et al., 1982). Using pressure sensitive floor mats and timing lights researchers showed that the running step technique (Figure 1) was significantly faster than the slide step or the crossover step techniques. Consequently, the running step should be used in getting athletes from the middle of the court to the right side of the court and into the outside blocking position (Buekers, 1991). The time it takes a blocker to get both hands above the net height is an important characteristic because blockers are required to block quick offensive combinations. The ability to jump high and penetrate the plane of the net with the hands is another crucial characteristic in performing an effective block (Farokhmanesh and McGown, 1988). The further the hands penetrate over the net, the more court area is denied and the more the rebound of the ball can be controlled.

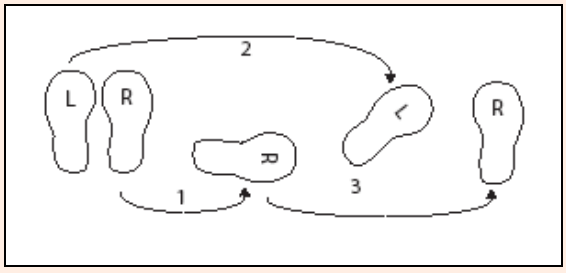

Figure 1. The running step footwork pattern. The athlete pivoted on the ball of the left foot and took a step with the right foot with the toes pointed parallel with the net. The shoulders turn from being square to the net to being perpendicular to the net. This step is followed by a long crossover step with the left foot in front of the body. The third step brings the right foot around to plant so the toes are perpendicular to the net and the shoulders are squared to the net.

Three different blocking techniques are used when performing a volleyball block. The "traditional" technique requires the player to keep their hands about shoulder level throughout the whole blocking motion until the jump (Video 1; Avalaiable from URL: http://www.jssm.org/vol10/n3/video/video1). The "swing" block utilizes a full arm swing where the arms are initially

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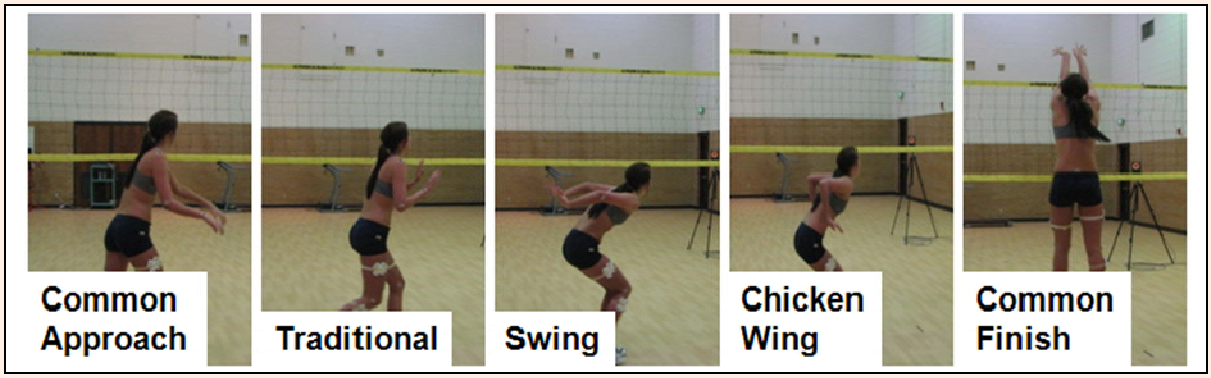

Figure 2. The traditional arm swing involves a relatively stationary arm position. The swing technique involves a typical counter-jump motion. The chicken wing technique is a compromise between the other two.

swung backward and then moved forward with the elbows fully extended throughout the entire blocking motion (Video 2; Avalaiable from URL: http://www.jssm.org/vol10/n3/video/video2/). The last, relatively new block, is referred to as the "chicken wing" (Video 3; Avalaiable from URL: http://www.jssm.org/vol10/n3/video/video3). In this blocking technique, the upper arm swing is the same as the swing block except that the elbows are flexed to a 90 degree angle throughout the back and forward swing movements. Each blocking technique is shown in Figure 2.

The effect of these three different techniques combined with the running step footwork pattern on blocking efficacy is unclear. Since blocking is highly correlated to team success, knowing which of these techniques lead to a more effective block is valuable for coaches and players. The purpose of this study was to investigate which blocking technique would allow the athlete to (1) move laterally the fastest in preparation for the block, and (2) raise both hands above the net fastest and (3) obtain the highest vertical jump and (4) reach the greatest magnitude of net penetration (quantified as the distance that the athlete was able to reach above (vertical) and over (anterior-posterior) the net). We hypothesized that: (1) the traditional block would allow the athletes to get off the ground fastest and get their hands above the net quickest, followed by the chicken wing and swing technique, and (2) the swing technique would maximize jump height and net penetration, followed by the chicken wing and then the traditional block.

Methods

Research design

This study was a 1x3x4 repeated measures within subjects design.

Participants

Thirteen female NCAA Division I volleyball athletes (age = 19.40 ± 1.19 years, height = 1.82 ± 0.08 m, mass = 70.63 ± 7.96 kg, and years of participation at the collegiate level = 2.23 ± 1.17 years) participated in the study. None of the participants suffered an injury within the three months of data collection that prevented them from playing in competitive matches and practices. Each athlete was highly practiced in the running step footwork pattern. Each athlete read and signed the University Institutional Review Board approved informed consent and completed a demographic questionnaire.

Data collection

Four 1.4-cm retroreflective markers were attached to each subject. A single marker was attached over the most distal, dorsal aspect of the right second metatarsal, the sacrum (S1 vertebrae), and bilaterally on the dorsum of the proximal phalanx of the third finger. Markers were attached using double-sided tape. .

A seven camera Vicon Motion Analysis System (VICON Motion Technologies, Centennial, Colorado, 250 Hz) was used to measure marker positions during the nine blocking movements. Camera location and orientation was determined using calibration procedures recommended by Vicon. All testing was performed in the same motion analysis laboratory and was completed on three consecutive days.

A portable outdoor volleyball net was placed in the middle of the calibrated motion analysis volume. The height of the net, measured at the center and sides was regulation height (224 cm). Two retroreflective markers were placed on the top of the net; in order to fit within the calibrated motion capture volume, one marker was 90 cm from the right net pole and the other was 152 cm from the left net pole. The 7 cameras were set up in a circle around the volleyball net with two cameras facing the athlete, two cameras on the sides of the athlete, and three cameras behind the athlete. Starting location was near the center of the net and marked with tape on the floor.

Procedures

The study was described and explained to the athletes. The athletes then drew a paper from a hat listing the randomized order of the block to be performed. The orders on the paper were prepared beforehand using the Latin square design.

Next, we reviewed the three different blocking techniques with the athletes. The athletes performed each technique in combination with the running step footwork pattern until they were comfortable with each movement. They practiced these for two weeks. Each athlete met an acceptable performance level as evaluated by the primary

researcher.

The athletes were required to follow a normal pre-game routine the day before data collection, which meant they did not work out 24 hours before their scheduled time, they ate a good meal, and they were in bed before midnight. The athletes came to the motion analysis lab dressed in their team issued spandex shorts, sports bra, and court shoes. The primary researcher measured and recorded the athletes' height and weight (both with shoes).

The reflective markers were placed on the athletes when they arrived at the motion analysis lab. Next, the athlete was allowed five minutes of warm-up. The warm-up included performing three trials of each blocking movement. Once the warm-up was complete, the athlete was asked to line up in their starting position facing the net with their left foot near the tape. When the primary researcher said "Go", the athlete performed a maximum effort block jump to their right using the running step footwork pattern in combination with the appropriate block for each trial.

The athlete was allowed one minute to rest between trials. During this rest interval, the athlete was asked if they 1) used their maximum effort, 2) used the appropriate block, 3) used the running step, and 4) were comfortable with the performance of the trial. Additional trials were required if the primary researcher believed the performance of the trial did not accurately reflect the appropriate technique or if the athlete answered no to any of the aforementioned questions. After three acceptable trials had been performed for each blocking technique the reflective markers were removed and the athlete was free to leave.

Data processing

Three-dimensional coordinate data were derived from video data in VICON Nexus software (VICON Motion Technologies, Centennial, Colorado) using a modification of the non-linear transformation method that was developed by Dapena et al. (1982). Coordinate data were smoothed using a fourth order Butterworth zero phase-lag low pass digital filter (Winter, 2005), with a cutoff frequency of 10 Hz (Blackburn and Padua, 2009; Decker et al., 2003; Kernozek et al., 2008). Next, the coordinate data were imported into Matlab (The MathWorks, Inc., Natick, MA) for additional calculations.

In order to calculate the time it took for the athlete to get off the ground, start time and takeoff time were identified. The start time of each trial was considered to be the instant when the right toe marker resultant velocity (derived from the coordinate data using standard central difference equations) exceeded 1 m/s. Takeoff time was considered to be the instant when the height of the right toe marker exceeded the static standing height of the right toe marker by six times (after visual inspection of a number of different trials, this appeared to be a valid algorithm for takeoff identification). The time that elapsed between start and takeoff was considered to be the first dependent variable.

In order to calculate the time it took for the athlete to get their hands above the net, start time and the instant the athlete raised their fingers above the height of the net were identified. Each hand was considered separately and the slowest hand was used for statistical analysis. The finger was considered to be above the height of the net when the finger marker was greater than the net height. The time that elapsed between start and the instant the finger was above the net was considered to be the second dependent variable.

When determining how far the athlete reached over or penetrated the net, only the right hand was evaluated. The maximum displacement between the top of the net and finger was calculated. This displacement was considered to be the third dependent variable.

Jump height was determined by finding the maximal height of the sacral marker (Leard et al., 2007). This maximum height was considered the fourth dependent variable.

Statistical analysis

A repeated measures ANCOVA test was performed to determine if there was a difference between groups. The independent variables of the study were the three different arm movements: the traditional, swing, and chicken wing. The dependent variables were the 1) time to take off or the amount of time it took the athlete to get off the ground from the start of the blocking motion, 2) amount of time it took the athlete from the start of the blocking motion to get their hands above the net, 3) athlete's jump height, and 4) amount of hand penetration the athlete had over the plane of the net. The values for each dependent variable were the averages across trials for each subject for each arm movement.

Co-variates were height, weight, age, and years of participation of the athletes. A pairwise comparison was used to determine where the differences existed between the groups. The alpha level was set at $\alpha \leq 0.05$. Statistical analysis was performed using the Statistical Package for Social Sciences V18 (SPSS Corporation, USA).

Results

Table 1 lists the results, standard deviations, and statistical significances for the study variables. We answered four research questions. First, there was no significant difference in the three blocking techniques in the amount of time it took the athlete to get off the ground from the

Table 1. A comparison (means ± SD) of the time to takeoff, time to hands above the net, jump height, and hand penetration between the traditional (T), swing (S), and chicken wing (CW) arm movements and post hoc comparisons.

	T	S	CW	T vs S*	T vs CW*	S vs CW*
Time to takeoff (s)	1.37 (.12)	1.34 (.13)	1.31 (.13)	.167	.054	.497
Time to hands above net (s)	1.39 (.11)	1.33 (.11)	1.32 (.10)	.013*	.022*	.894
Jump height (cm)	152.2 (5.55)	157.3 (6.33)	155.2 (5.87)	<.001*	<.001*	<.001*
Hand penetration (cm)	29.4 (5.89)	34.5 (6.83)	31.6 (6.83)	.001*	.025*	.045*

* p values. Data are means (±SD).

start of the blocking motion. Second, both the chicken wing and swing techniques allowed the athlete to get hands above the net significantly faster than the traditional blocking technique. Third, the swing block technique allowed the athlete to jump significantly higher than the other two blocking techniques. The chicken wing block also allowed the athlete to jump significantly higher than the traditional technique. Fourth, the swing block resulted in significantly greater hand penetration than the other two blocking techniques. Also, the chicken wing technique provided significantly greater hand penetration than the traditional technique.

Discussion

Since blocking is highly correlated with team success, the purpose of this study was to determine which blocking technique enabled female NCAA Division I athletes to perform a more effective block. The time it took the athletes to get off the ground, get their hands above the net, jump height, and the amount of hand penetration were calculated.

The data revealed there was no significant difference between the three techniques in the time it took the athlete to get off the ground. The results did not support our hypothesis that the traditional block would allow athletes to get off the ground the fastest. The time difference to get off the ground between the chicken wing block and the swing block was 0.03 seconds; the time difference between the swing block and the traditional block was 0.03 seconds (Table 1). Although, the difference between the blocking techniques were not statistically significant they may be practically significant with 0.06 seconds between the chicken wing and traditional techniques. It takes only 0.05 seconds for an offensive player to swing the arm forward and strike the ball, thus a difference of 0.06 seconds may be practically significant (Chung, 1988). Therefore, the differences in time to get off the ground could influence the decision to change from one arm swing to another.

Our data indicated the chicken wing and swing block techniques allowed the athletes to get their hands above the net significantly faster than the traditional technique. The hypothetical advantage of the traditional block was that the hands are closer to the top of the net at the initiation of the blocking motion (the hands never drop). Therefore, it was hypothesized that the traditional block would enable athletes to get their hands above the net the quickest as the other two techniques drop their hands. However, our findings do not support this hypothesis. The traditional block was the slowest of the three techniques. The counter-movement which lowers the center of mass, initiated by the arm swing, has been shown to increase jump height and perhaps take less time to perform than the traditional block. The traditional block does not incorporate an arm swing to lower the center of mass; hence it might take longer for athletes performing a traditional block to get their hands above the net because it takes them longer to perform the jump compared to the chicken wing and the swing block (Walsh et al., 2007) .

A strong block is formed by having both hands above and reaching over the net. Offensive combinations are being played at quicker speeds. It is common for the sets to the outside hitters to be low and fast (Coleman and Neville, 1990). In order to block these sets, blockers must reach the outside of the court and have their hands above and penetrating the net before the ball is hit by the opposing hitter. Experienced hitters take advantage of blockers when they only get one hand above the net by hitting it off that hand. The time difference between the hands of the chicken wing block and the swing block was 0.01 seconds and between the hands of the swing block and the traditional block was 0.07 seconds. To better understand the practical relevance of this difference for time, we need to consider the time it takes an offensive player to strike the ball. During a volleyball attack, approximately 0.34 seconds elapse from the instant of takeoff until the instant of ball contact. It takes an athlete 0.29 seconds to jump and cock their arm which means only 0.05 seconds are needed to swing the arm forward and strike the ball (Chung, 1988). If a blocker is not above the net by the time the attacker has started their arm swing, they will not have time to penetrate the net before the ball has passed them.

The results showed that the swing block produce statistically significant highest jump height followed by the chicken wing block and then the traditional block. These findings also support the large amount of research that indicates that an arm swing together with counter-movement increases jump height (Harman et al., 1990; Lees et al., 2004; 2006; Shetty and Etnyre, 1989; Viitasalo, 1982; Viitasalo and Bosco, 1982; Walsh et al., 2007). The differences in jump height between the three blocking techniques were statistically and practically significant. There was a 2.10 cm difference between the swing block and the chicken wing block, and a 3.00 cm difference between the chicken wing block and the traditional block. Research has shown that jump height is crucial because it allows the player to get their hands and arms over the net further (Farokhmanesh and McGown, 1988; Gladden and Colacino, 1978; Richards et al., 1996; Viitasalo, 1982).

Our data indicated the swing block produced statistically significant greater hand penetration of the net compared to the other two techniques. These results supported our hypothesis. The swing block incorporates a counter-movement and a full arm swing which have been shown to increase jump height (Walsh et al., 2007). The higher an athlete jumps, the further they will be able to reach over the net. The chicken wing block produced second furthest hand penetration followed by the traditional block. It appears even a small arm swing is better than no arm swing (like the traditional block) in the amount of hand penetration that is possible.

As well, the differences in hand penetration between the three blocking techniques are practically significant. The difference between the hands of the swing block and the chicken wing block is 2.90 cm. The difference between the hands of the swing block and the traditional block is 5.10 cm. A penetration of 2.54 cm by the middle blocker takes away about 19.05 cm of court at the cross court sidelines (Lenberg, 2004). Thus, an additional

2.90 cm and 5.10 cm in net penetration is a very important variable to consider when choosing which blocking technique to perform.

There were some limitations related to this study. The athletes in this study were familiar with the running step footwork pattern and were all competent in the swing block arm swing because this method was preferred by their respective coaches. This may have influenced the results. Additionally, these results probably do not completely represent results that might have been found during competition. This study was performed in a laboratory without a real visual start cue or hitter to block against, also there was not the psychological or physiological stress involved during competition.

Another limitation of this study was the limited number of participants and the inclusion of defensive specialists, who never block in a real competition. Future studies should select a greater number of participants from multiple NCAA Division I volleyball programs. This study focused on the running step footwork pattern going to the right. It would be important to look at the footwork pattern going in both directions because usually only the middle blocker is familiar with going both directions. The setter is usually more comfortable going to the right and the outside hitters are usually more comfortable going to the left.

Conclusion

In conclusion, the chicken wing technique was the quickest in getting the athlete off the ground and getting their hands above the net. The swing block proved superior in jump height and net penetration. This knowledge can help coaches and players decide which blocking technique will benefit them most as a blocking team and as individual blockers. The traditional technique does not seem to have any advantages. Thus, it may benefit athletes, especially middle blockers to learn both the swing and chicken wing techniques. The blockers would then have the option to use either arm swing in a competitive setting. If they have ample time, the swing block would be recommended. However, if the blocker had to make a quick move, they could utilize the chicken wing block.

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Key points

- The swing blocking technique resulted in greater jump heights and increased hand penetration, relative to the traditional and chicken wing blocking techniques.
- The chicken wing blocking technique resulted in greater jump heights and increased hand penetration, relative to the traditional blocking technique.
- The traditional blocking technique does not appear to provide any competitive advantage related to the variables observed during this study: (1) duration spent getting off of the ground and placing hands over the net, (2) jump height, and (3) hand penetration magnitude.

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