Original Article

The influence of defender's positional gap on the aces in the sport of volleyball

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ABSTRACT

This study aimed to investigate the influence of the defending players' positioning on the service outcomes. Thirty-nine sequences of play involving serves were selected from nine games of a Professional Championship of volleyball held in Brazil. They characterized three main situations: (a) aces (serves that the ball hit the ground of the opponent's court without being touched by any defending player) (n = 13), (b) serves which a defending player touched the ball but there was no continuity in the rally (n = 13), and (c) serves received successfully, that is, a defender received the ball and made possible the continuity of the rally (n = 13). These situations were compared by considering the following variables: (1) defender's distance to the place of serve finalization, (2) velocity of defender's displacement to the place of serve finalization; (3) variability of defending player's displacement; and, (4) serve velocity. Results showed that the defender's distance to the place of serve finalization in the aces were greater than in the both other situations. The findings allowed us to conclude that in competitive performances in the sport of volleyball, the defender's distance to the place of serve finalization determined the service outcomes. **Key words:** SPACE OCCUPATION, MOTOR SKILLS, VOLLEYBALL, EXTRAPERSONAL COORDINATION, DECISION-MAKING.

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INTRODUCTION

The sport of volleyball is a FIVB's (Federation Internationale de Volleyball) official indoor game, played between two teams of six players each, on small court (18 meters of length and 9 meters of width) separated by a net whose height vary according to players' sex (2.43 m for men and 2.24 m for women), and with a small ball (circumference of 65–67 cm, a weight of 260–280 g). The main aim of this game is to score a point by making the ball touch on the ground of the opposing court. A team can also score if the opponent sends out the ball off the court. The game takes place through rallies (3 at a minimum and 5 maximum), which are initiated by service (act of hitting the ball with a hand so it flies over the net into the opponent's court, which is performed by a player placed in the service zone) and finished when a point is scored. During a rally, the teams might touch the ball up to three not consecutive times by individual players.

According to FIVB, the sport of volleyball refers to one of the team sports most practiced worldwide. One could say that this is due to three main aspects: (1) the sport's potential in fulfilling biological, psychological and social human needs[1]; (2) the advances in technology and scientific knowledge[2]; and (3) the changes in the rules of the game[3,4]. For instance, with regard to the latter, over past few years, numerous changes were made regarding to the service, which involved (a) increase in the service zone and the consequent removal of positional fault, (b) increase in the time limit for serving, and (c) the permission for the served ball to touch the upper edge of the net.

In fact, the service has called attention of sports coaches and researchers in recent years[3,4,7,8,9,10,11,12,13,14]. Notwithstanding the importance of others volleyball's motor skills used for solving tactical problems (e.g. blocking, digging, passing, and spiking), the special concern on service has emerged from its differential characteristics: (a) it occurs in a phase of discontinuity of the game, since it initiates a new rally after an interval following the end of the previous rally; (b) it is not directly influenced by the game dynamic; (c) server has a time period of 8 seconds to perform the service, which allows to him/her availability for analysing the opponents' disposal and decision-making on how and where to perform the service; and, (d) more than an action of starting the game, the service itself characterizes as an attack.

On this respect, one could say that regardless of the server's decision-making (e.g. how, from, and to where to serve), he/she aims to score a point[4,9]. This might occurs by an *ace*, that is, a service that hits the ground of the opponent's court without being touched by any defending player, or when a defending player touches the ball, but there is no continuity in the rally. Importantly here is that, in the same vein the server has availability to make decisions about the service, the defending players can also make decisions in order to receive the service, i.e. to prevent the score and to prepare the subsequent attack[3,5]. In fact, the service's outcome does not depend only on the server's abilities of performing motor skills or making decisions, but also on the defending players' actions and decisions[15]. This was the main concern of this study, that is, to analyze the defending players' decision-making on the service.

What decisions volleyball players use to make in order to receive the served ball? From the point of view of the present study, the main individual and team decision-makings are related to the positioning on the court, that is, space occupation. Although the positions of the six defending players at time of service are constrained by official rules, the specific ways in which they take up their spaces are not. Several factors may be considered in the defender's decision-makings (e.g. player's expertise, type of service, server's location, organization of subsequent attack, setter position, and opponent's pattern of play)[4,11]. However, it seems that the space occupation is an essential aspect for all of them.

In fact, the space has been conceived as a key concept in team sports[16]. In this respect, spatial variables as, for example, distance between players or between they and objects and specific locations in the court, and their rates of change (e.g. velocity and variability) have been characterized as informational variables that constrain the players' decision-makings in team sports[17,18,19]. However, these assumptions have been mainly based on studies focusing team sports of invasion. In this type of team sport, defenders and attackers cooperate and make opposition by simultaneously occupying both attack and defense spaces. Nevertheless, in the sport of volleyball the players' interactions of cooperation and opposition occur with each team in their respective court. This is a type of team sport "*of net*" in which how to defend the space on own court has also been considered as an important tactical problem in preventing scoring[20]. However, not much attention has been focused on the occupation modes of the space of defense in relation to the reception of the service. Therefore, this study sought to understand the influence of the defending players' positioning on the service outcomes. We hypothesized that in the aces the defender's distance to the place of serve finalization would be greater than in the receptions. Additionally, we expected that the defender's rate of changing in positioning toward place of serve finalization would be different in the aforementioned situations, i.e. velocity would be smaller and variability would be greater in aces than in successful and unsuccessful receptions.

MATERIAL AND METHODS

Sample

Thirty-nine sequences of play involving serves were selected from nine games of 40th edition of the Paulista Championship 2013 (Division I) held in Brazil. This is one of the most important annual Brazilian championship, in which participated eight teams from different cities of the São Paulo state, and approximately 100 professional female players. Overall, this championship involved 91 games. Specifically, the sample consisted of aces (serves that the ball hit the ground of the opponent's court without being touched by any defending player; n = 13), serves in which a defending player touches the ball but there was no continuity in the rally (unsuccessful receptions; n = 13), and serves received successfully, that is, a defender received the ball and made possible the continuity of the rally (n = 13). This study was conducted within the guidelines of the American Psychological Association, and the research protocol was approved by the local ethics committee of the University of São Paulo.

Procedures

Concerning the data collection, the sequences of play were selected from digital video footage of the aforementioned games. They were recorded by a digital camera (Casio HS EX-FH100) located above and behind the volleyball court. The images were captured in a frequency of 30 Hz, and posteriorly adjusted to 25 Hz using the Video Converter Factory software. The sequences of play ranged from 0.88 to 3.84 seconds of duration.

Specifically, the displacement trajectories of the ball and the defending player closest to the end point of the ball trajectory were edited through TACTO software[21,22], from the moment the server touched the ball (initial moment "I") until the moment the ball touched the floor or a defender (final moment "F"). This procedure consisted of following the players' working point (projection of the centre of gravity of each individual player on the floor) in a slow motion video image (frequency = 2 Hz) using a computer mouse.

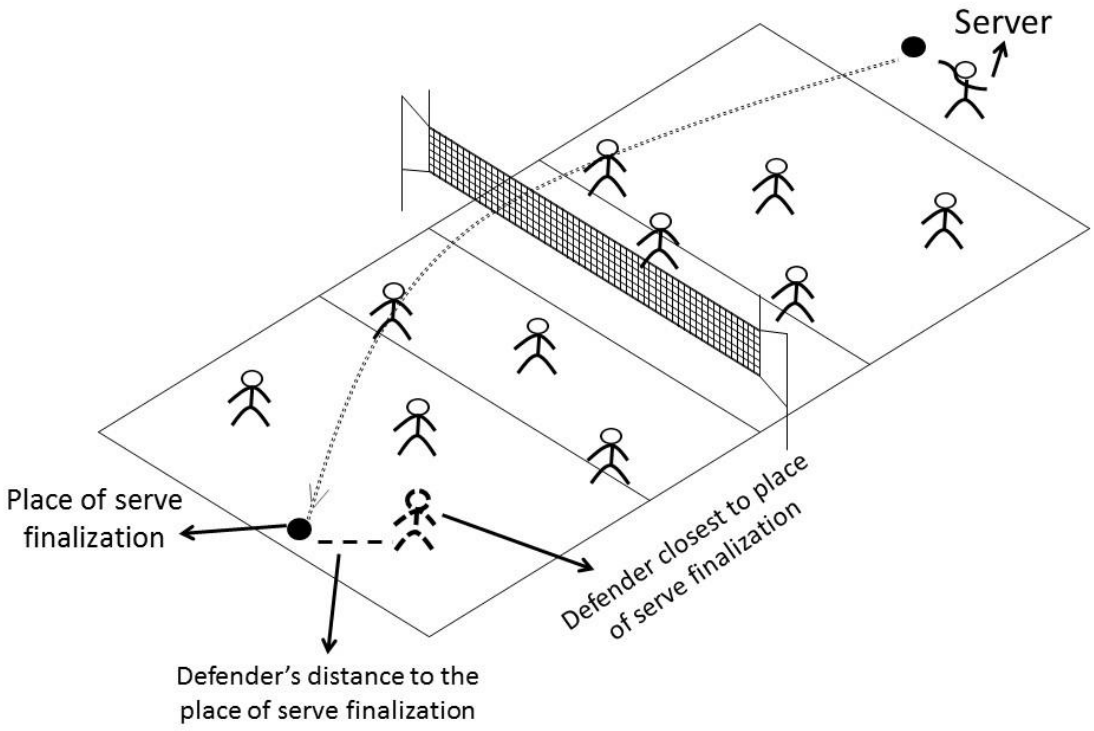

Figure 1. Illustration of environment experimental.

This procedure allows the acquisition of the virtual *x* and *y* coordinates of each displacement trajectories (i.e. in pixels). After that, these coordinates were transformed into real coordinates by direct linear transformation (DLT2D) software, filtered with a low-pass filter (6 Hz)[21]. This method considers the *z*-coordinates to be equal to zero and directly correlates an object point located in the object space/plane with a corresponding image point on the image plane[22,23].

From the ball and player's *x* and *y* coordinates of displacement trajectories, we calculated the following variables:

(1) Defender's distance to the place of serve finalization, i.e. place in which the ball touched the floor or a defender. It was calculated by the following equation: $d = \sqrt[2]{(P2x - P1x)^2 + (P2y - P1y)^2}$, where *d* refers to the distance of defending player (P1) to the place of serve finalization (P2);

(2) Velocity of defender's displacement to the place of serve finalization. It was calculated through $v = [(dF - dI) / t]$, where *v* was the velocity, *dF* was the final distance, i.e. the place defender was at the moment that the ball touched the floor or was received by him, *dI* was the initial defender distance to the place of serve finalization, and t referred to the time between both initial and final distances.

(3) Variability of defending player's displacement. This measure considered the values of each distance in each frame from the initial to final moments. This was calculated by $CV = \sigma / \mu$, where CV was the rate of variability (coefficient of variation), σ the standard deviation and μ the arithmetic mean.

(4) Serve velocity. It referred to temporal rate of the ball flight, which was calculated through $vb = [(pF - pI) / t]$, where *vb* was the ball flight velocity, *pF* was the place of serve finalization, *pI* was the ball location at the moment of the serve, and *t* referred to the time between both initial and final positions.

Statistical procedures

A multivariate analysis of variance (MANOVA) was run by considering those above described four dependent variables (1 - defender's distance to the place of serve finalization; 2 - velocity of defender's displacement to the place of serve finalization; 3 - variability of defender's displacement; and 4 - serve velocity). These variables were compared in relation to three aforementioned situations: S1 – aces; S2 – unsuccessful receptions; S3 - successfully receptions. Observed significant effects were followed up using univariate analysis and $Tukey_{HSD}$ test. All analyses were preceded by Shapiro-Wilk's W and Bartlett's tests of normality and homogeneity of variance. For all analyses, the level of significance was set at $p < .05$, using STATISTICA® 13.0 software - Stat Soft Inc., Tulsa, USA.

RESULTS

The Figure 2 shows that defender's distance to the place of serve finalization seemed to be significantly higher in the S1 than in S2 and S3 situations, with no overlapping of group range values. Conversely, the velocity of defender's displacement to the place of serve finalization in S1 situations had mean slightly lower than in both other situations (S2 and S3), and that the range of values were also overlapped. Regarding the variability of defender's displacement to the place of serve finalization, the S1 situations obtained an intermediate value, i.e. the mean was slightly superior to S2 and inferior to S3. However, similarly the range of values in the three situations were also overlapped. Finally, in S1 situations the mean of the ball flight velocity was slightly higher than in both other situations (S2 and S3), but that the range of values were overlapped.

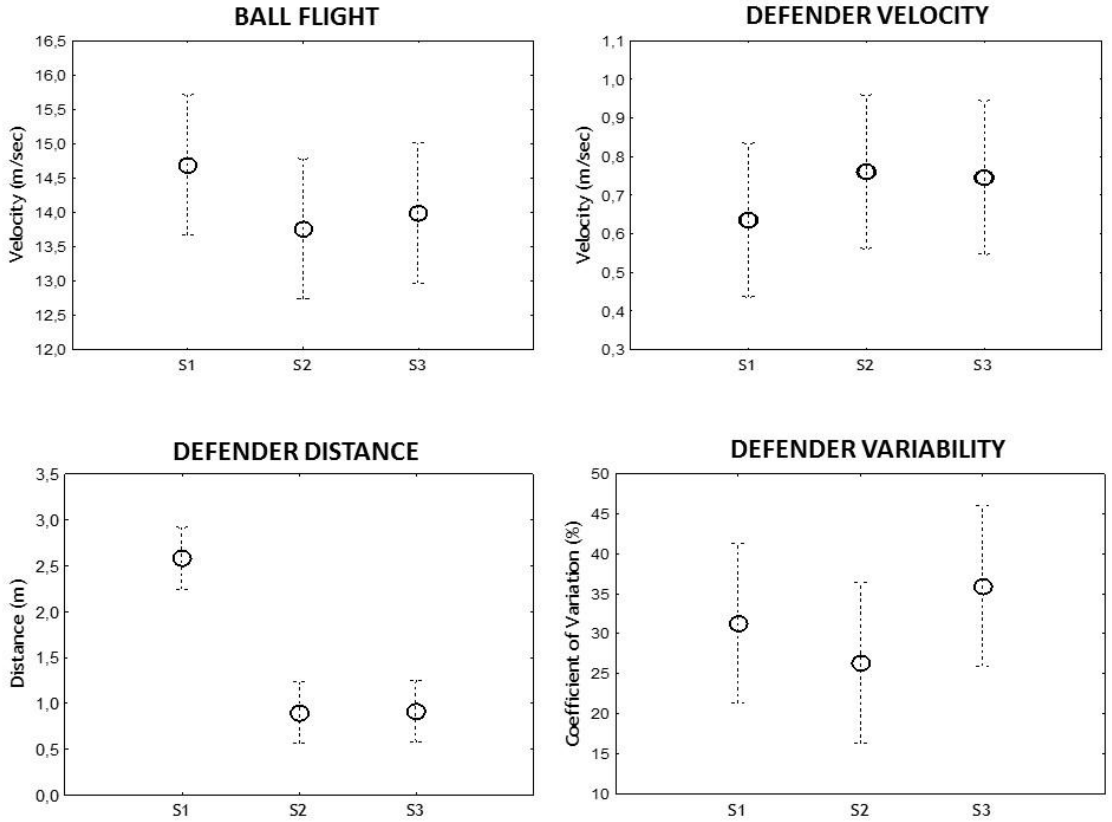

Figure 2. Means of defender's distance to the place of serve finalization, velocity of defender's displacement to the place of serve finalization, variability of defending player's displacement, and serve velocity in the three experimental conditions.

The inferential analysis confirmed these observations. The MANOVA found Wilks' $\lambda = 0.19$, $F(4, 8) = 10.35$, $p < 0.001$, $\eta p^2 = 0.56$. The univariate analysis revealed effects for the defender's distance to the place of serve finalization [$F(2, 36) = 33.60$, $p < 0.001$]. Moreover, the $Tukey_{HSD}$ test showed that S1 had higher distance than S2 and S3 situations ($p < 0.001$).

DISCUSSION AND CONCLUSIONS

This study aimed to investigate the influence of the defending players' positioning on the service outcomes. Our hypotheses were partially confirmed, since results showed that the defender's distance to the place of serve finalization in the aces in which the ball hit the ground of the opponent's court without being touched by any defending player were greater than in the both other situations.

The decision-makings on receiving a service has been considered as an important aspect influencing the rally outcomes[3]. This is because, in the successful case, the reception can give raise to counterattack organization or, in the unsuccessful case, result a point for the opponent team[11,24]. Any of these results as well as the volleyball game dynamic are not a consequence only of skills with ball, but also of those without ball, including the way in which players occupy their space on the court[25,26].

Interestingly, our results provided support for the finding that only a spatial variable of defending players' positioning influenced on the service outcomes: distance of the closest player to the place of service finalization. Maybe, differently from the many team sports of invasion as basketball[27], rugby[28], futsal[29], and soccer[22], in volleyball the space alone can have greater influence power on the defender's response to the service than in conjunction to temporal variables.

One could thought that the defending player did not perceive the gap near her as affording risk for ace and, for this reason, did not position herself in order to better prepare for receiving the service. Also interestingly, the ball velocity did not affect the service outcomes. We waited that this variable, at least, would differ between aces and those received successfully. However, in both situations the average of ball velocities were similar, 52.92 and 50.36 km/h, respectively, which strengthens the inference of the defender's positional gap as a factor influencing the aces occurrence. Obviously, the fact of ball velocity be dependent on type of service and player's position in the team[4] may require further investigation.

The findings of this study allowed us to conclude that in competitive performances in the sport of volleyball, the defender's distance to the place of serve finalization determined the service outcomes. Specifically, results showed that the defender's distance to the place of serve finalization in the aces was greater than in the both other situations. In terms of practical application, this study provides useful insight into the design of practice tasks in volleyball by suggesting that defending players should be attuned to their positioning on the court in order to avoid aces.

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