VERTICAL JUMP PERFORMANCE DURING VIDEO SIMULATED BLOCKING AND MAXIMAL EFFORT JUMPING IN FEMALE COLLEGIATE VOLLEYBALL PLAYERS

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This study's purpose was to compare jump height, velocity and force production between video simulated blocking, [reactive timing (RT) jump], and maximal effort vertical jumping, [self-select timing (SST) jump]. 10 female collegiate volleyball players performed both jumps onto a force plate in a laboratory while being videotaped with one camera. Jump heights(cm), velocities(m/s), and forces(%BW) were calculated using Peak Motus. A RM-MANOVA identified differences in the dependent variables across the two jumps. Jump height and peak velocity were significantly higher in the SST jump, 52.20+8.43 v 38.33+11.76 cm, and 5.69+0.71 v 5.4+0.61 m/s, respectively, $p<.05$. No differences were found in peak vGRFs, $p<.05$. Results indicate jump characteristics of the maximal effort VJ do not mimic those of a simulated volleyball block.

KEY WORDS: reactive timing, self-selected timing, vertical jump, volleyball block

INTRODUCTION:

In volleyball, a good blocking maneuver is an essential part of success in the game. During the blocking maneuver, a high vertical jump (VJ) and an extended arm position are needed for a desired blocking height along with the proper timing against an opponent's attack. Volleyball blocking is a reactive movement, meaning the player responds to another player's stimulus. Thus, the jump occurs at different reactive timings (RT), and it may even occur multiple times in one play.

If athletes who can reach 70cm vertical height in a maximum VJ test, but can only reach 30cm during the blocking maneuver, it is possible they may lack jump efficiency in RT. Use of the maximum VJ test (also referred as self-selected timing (SST) jump in this study) is a measure of lower extremity power output (Aragon-Vargas, 2000). Factors such as jump trajectory, jump speed, and force production to maximize jumping height have all been previously investigated in laboratory settings (Aragon-Vargas, 2000; Salci et al., 2004; Tillman et al., 2004; Tokuyama et al., 2005). However, results of the VJ test in the laboratory setting may not always simulate the jumps in the real game situations. Mackenzie (2003) stated that proper technique of jumping is similar in both vertical and long jumps to reach maximum height and distance, and the only difference is the direction of force. Hara et al. (2005) found the importance of total work coming from ankle and hip joints, which provide the major contribution to increase in jump height and velocity. Others have found that the right timing of the arm swing can also contribute to the height of the jump (Hara, et al. 2005; Payne et al., 1968; Shetty & Etnyre, 1989). Recently, Lees et al. (2004) compared the height of the VJ with no-arm swing condition and arm swing condition. They reported 28% height increase and 72% velocity increase with the arm swing condition as compared to the no-arm swing condition. Although important characteristics of the VJ in both kinetics and kinematics were studied, those findings do not necessarily describe what needs to be trained for improvement. The laboratory test results should lead to the proper advice for training application to improve one's athletic performance. Further, although selected kinetic and kinematic measurements were used to analyze the VJ maneuver, actual jump height, jump speed, and force production between SST jump and RT jump has not been comparatively studied. Therefore, the purpose of this study was to compare the biomechanical characteristics of SST jump and RT jump performed by female collegiate volleyball players. The SST jump was a process of maximum VJ test, which allows participants to jump with their own timing to reach maximum height, whereas the RT jump was similar to a blocking maneuver by watching an opponent's attack in videotape. We hypothesized that jumping on

their own timing (SST) would produce higher jumping heights, greater peak vertical ground reaction force (vGRF), and faster peak velocities as compared to the RT jumping.

METHOD:

Ten (N=10) female healthy collegiate volleyball players volunteered in this study (age = 20.5+1.2 yrs; ht = 1.78+0.05m; mass = 63.80+6.83kg). One JVC 60 Hz camera (JVC Professional Products Company, Denver, CO) was used to capture the two VJ conditions. The camera was placed on the left side of participants to capture a reflective marker that was placed on the left anterior superior iliac spine. Jump height and velocity were determined using the hip height from standing position to the maximum reached height (Hara, et al. 2005; Shetty & Etnyre, 1989). Peak vGRF was collected by using an AMTI force plate (Advanced Mechanical Technology, Inc., Watertown, MA) sampled at 600Hz. All data were calculated and analyzed using Peak Motus software (ver. 8.2, Vicon-Peak, Centennial, CO). After a warm-up consisting of stretching the lower extremity, participants performed an SST jump to reach the maximum height. Secondly, they performed an RT jump by watching a life-size opponent's attacking video on a wall-screen (simulation of blocking maneuver). These were maximal effort jumps and were only performed once in each condition. Dependent variables for this study were peak jump height (cm), peak vGRF as normalized to body weight (% BW), and peak linear velocity (m/s) of the VJ. Data were reduced in the Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL) using a repeated measures multivariate analysis of variance (RM-MANOVA).

RESULTS:

A significant effect was found (Lambda (4,6) = .06, $p<.001$). Follow-up univariate ANOVAs indicated that peak jump height ($F(1,9) = 79.04$, $p<.01$) and peak velocity ($F(1,9) = 12.80$, $p<.01$) were significantly different (see Table 1). Peak vGRF ($F(1,9) = 1.29$, $p>.05$) was not significantly different between the two jump conditions.

Table 1 Jump height, peak velocity, and peak vGRF in the two jump conditions

	SST jump	RT jump
Jumping height (cm) *	52.20 ± 8.43 SEM, 1.05	38.33 ± 11.76 SEM, 1.46
Peak velocity (m/s) *	5.69 ± 0.71 SEM, 0.22	5.40 ± 0.61 SEM, 0.19
Peak vGRF (% BW)	2.13 ± 0.55 SEM, 0.17	1.98 ± 0.53 SEM, 0.17

Note: * denotes significant difference ($p < .05$)

DISCUSSION:

The purpose of this study was to compare selected VJ characteristics between a maximal VJ (SST jump) and a video simulated blocking maneuver (RT jump) in female collegiate volleyball players. We sought to determine how a commonly used VJ task would compare to a sport specific VJ skill in volleyball. The VJs were classified by timing stimulus with the maximal effort VJ being executed at the timing discretion of the participant, and the volleyball blocking VJ being executed in response to a life-size video image of an opponent the participant was to block. Results supported the two hypotheses that SST jump would produce higher jump height and faster jump velocity as compared to RT jump. However, peak vGRF was not significantly affected across jump conditions. Previous research (Hara et al., 2005: Lees et al., 2004), indicates that jumping with an arm swing produces higher jump heights and faster velocities than jumping with no-arm swing. The SST jump may allow a performer to jump higher because of the desired preparation time and full arm swing to carry momentum. Conversely, the RT jump may not allow a performer to fully prepare the body position and limit arm swing, thus affecting jump characteristics. While arm swing variables

were not measured in this study, visual differences in arm position were noted across jumps and warrant further investigation. Figures 1 and 2 show arm position at descent position of both jumps.

Figure 1 Descent position of SST jump

Figure 2 Descent position of RT jump

Although we expected that SST would show greater peak vGRF because of more preparation time to jump, maximum force production was not significantly different. This may indicate that desired preparation time and a full arm swing do not necessarily contribute to higher force production. In fact, half of the players produced greater peak vGRF during RT jump. Some players may be able to rely more on lower extremity strength when preparation time and arm swing are limited. Other players may rely on the arm swing in the preparation to produce maximum force. This difference can be referred to individual motor control difference and possibly how they were coached to jump before. Based on the overall results, proper instruction in jumping technique and proper training are necessary to close the gap between SST jump and RT jump. If a player shows significant decrease in RT jump, this may indicate that the player is likely to lack on jump height and speed to block an opponent's attack. The data could be evaluated with coaches and strength and conditioning coaches to design effective training modules, specific to RT (plyometrics) to enhance overall lower extremity strength and explosiveness off the floor. In this study, participants were female collegiate volleyball players. However, other sports such as basketball players may benefit from similar testing to understand their jump ability during various tasks. Future implications such as adding treatment (training period) may reveal effectiveness of sport-specific training as well as general conditioning. In addition, this type of data can be analyzed qualitatively with coaches to revisit each player's mechanics in a blocking maneuver. In this study, blocking maneuver was used to compare the difference with SST jump. The results revealed that there were significant differences in jump height and velocity. The future studies could involve treatment periods to identify the effectiveness of proper training to improve the blocking jump in volleyball players.

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