# COMPARISON OF LANDING MANEUVERS BETWEEN SKILLFUL AND UNSKILLFUL FEMALE VOLLEYBALL PLAYERS

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This study was to investigate the effect of training to the landing techniques of volleyball spike. Six female subjects were separated into two groups according to their experiences in playing volleyball. Kinematics parameters during landing phase were collected by using three-dimensional motion analysis technique. Pedar insole system with 50 Hz sampling frequency was employed to measure the insole peak force and pressure distribution. Significant differences were found in maximum impact force and peak pressure between the skillful and unskillful group. Skillful group also demonstrated a greater range of motion in the knee, hip and ankle joint respectively. The finding shows that the skillful group, who participated in regular volleyball, demonstrated a greater ability in reducing ground reaction force during landing, thus leading to a protective mechanism in preventing injury.

**KEY WORDS:** volleyball spiking, kinetic, kinematics, lower extremity

**INTRODUCTION:** Volleyball is a game in which success depends on the ability of the athletes to jump high, quickly and explosively during both offensive and defensive maneuvers. These movements include spiking, blocking, jump serving, and even setting. It is important to consider that spikes and blocks are not only jumps, but jump-landing sequences. Particularly, the landing phase of the jump-landing requires dissipation of the kinetic energy generated during jumping. As dictated by Newtonian mechanics, an increase in jump height is accompanied with a proportional increase in the magnitude of kinetic energy which must be safely dissipated at landing to avoid injury (Dufek and Zhang, 1996).
Due to the frequent jump-land movement, volleyball is reported as a sport with high injury rate especially in lower extremities (Briner & Kacmar, 1997; Ferretti et al., 1992). Previous studies investigated the biomechanics of landing mechanism of skillful volleyball players (Dufek and Zhang, 1996; Tillman et al., 2004). However there are few researches relating to the effect of training to the technique of landing of volleyball spike. The purpose of this study is to expand the current knowledge by comparing the kinetic and kinematics parameter of lower extremity joint motion landing maneuvers between skillful and unskillful female volleyball players.

**METHOD:** Six healthy females of the same foot size (ages: 22.17 ± 1.94; height: 1.63 ± 0.05; weight: 57.90 ± 6.79) volunteered to participate in this study. All of them had signed the informed consent. Three of the subjects classified as the skillful female volleyball players were the members of the university women volleyball team and actively involved in regular volleyball trainings for at least five hours per week. The remaining three healthy female who had never involved in formal and regular volleyball training were in the unskillful group. Volleyball spiking was simulated by instructing the participant to hit a hanged volleyball (Figure 1). The volleyball height was adjusted until the subject agreed that the volleyball was in the optimal position for spiking. The subject was then instructed to perform a self directed warm up and performed 5 trials of volleyball spiking. Kinematics data was collected by using three-dimensional motion analysis technique. Two CCD digital video cameras (JVC 9800, Japan) with 100Hz filming rate were used for capturing the spiking motion and the data were analyzed by a motion analysis system (APAS, USA). Seven reflective markers were placed on the right-side of the body of the subject at the following locations: toe, fifth metatarsal head, heel, ankle, lateral femoral condyle, head of the greater trochanter and shoulder (Figure 2).

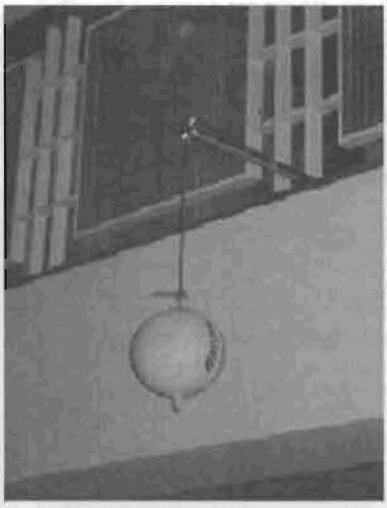

Figure 1 Hanged volleyball.

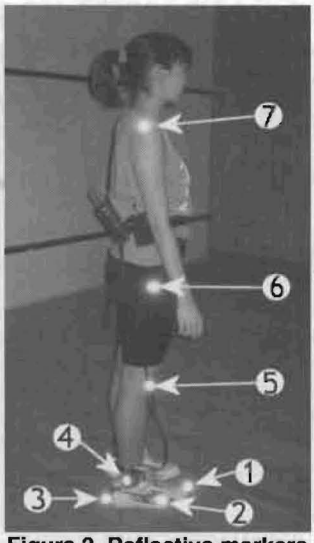


Figure 2 Reflective markers on the body (right).

Pedar insole system with 50Hz sampling frequency was employed to measure the insole peak force and pressure distribution (Novel, Germany). The insoles were fitted in a pair of volleyball shoes with size JP 25.5. The flash of the pedar was used as the synchronized light to synchronize the signal of the pedar insole system and the data of the motion analysis system. Landing Phase was defined from the time of touch down to the time of maximum knee flexion.

**RESULTS AND DISCUSSION:** Mean values of the of maximum flexion angle of the knee joint, hip joint and ankle joint and the Range of Motion (ROM) of the joints of both skillful and unskillful groups during landing phase are shown in Table 1. Independent T-test was used to contrast the above kinematics variables. For the skillful group, the means of maximum knee flexion angle, maximum hip flexion angle and maximum ankle angle were 92.75° (SD17.19), 127.3° (SD16.07) and 57.06° (SD2.24) respectively. The angles were 110.18° (SD7.89), 138.86° (SD6.87) and 71.32° (SD8.99) for the unskillful group. Although there were apparently great differences between the means of maximum joint angle: knee (d = -17.43°), hip (d = -11.56°) and ankle (d = -14.26°), no statistical significant result was found between groups ( $p$ = 0.17, 0.14, 0.10 > 0.05). This might be because of the small subject size in this study. Therefore larger subject size is recommended in future investigation. Skillful group demonstrated similar but greater ROM in all the three joints when compared with the unskillful group. In addition to the greater flexion of all the three joints angles, skillful group was more capable in dissipating energy by performing softer landing (Zhang et al, 2000). Great dispersion of kinematics parameters shown by the skillful volleyball players indicated great differences of landing techniques were adopted.

**Table 1 Means (SD) of kinematics variables during the landing phase.**

| | Maximum flexion Angle (degrees) | | | Range of motion (degrees) | | |
|---|---|---|---|---|---|---|
| | Skillful | Unskillful | Sig. | Skillful | Unskillful | Sig. |
| Knee | 92.75 (17.19) | 110.18 (7.89) | 0.17 | 41.17 (11.33) | 37.38 (2.60) | 0.07 |
| Hip | 127.30 (16.07) | 138.86 (6.87) | 0.14 | 20.64 (8.86) | 18.75 (3.31) | 0.35 |
| Ankle | 57.06 (2.24) | 71.32 (8.99) | 0.10 | 27.93 (5.02) | 25.31(2.83) | 0.22 |

Group means and standard deviations of kinetics of landings are given in Table 2. Statistically significant was found in maximum force ($p$ = 0.039 < 0.05) and peak pressure ($p$ = 0.034 < 0.05) between the skillful and unskillful groups. Skillful group showed a significantly lower maximum impact force and peak pressure during landing. These results showed that skillful group was more capable in reducing impact force during landing which

might prevent them from getting injury in the landing phase of volleyball spiking. Figure 3 shows the change of ground reaction force during landing phase. The sampling frequency was only 50Hz in the study. It seemed that it was not sensitive enough to detect the typical 2 peaks ground reaction force. The values of the impact forces were similar to the findings of Decker (2003).

**Table 2 Means (SD) of Kinetic Variable during the landing phase.**

| | Skillful | Unskillful | Sig. |
|---|---|---|---|
| Max Force | 3.770 (0.082) | 4.320 (0.600) | 0.039* |
| Peak Pressure | 0.988 (0.038) | 1.082 (0.334) | 0.034* |
| Pressure time integral | 0.132 (0.016) | 0.110 (0.022) | 0.440 |

*p<0.05; all the kinetic variables were normalized with body weight and jumping height

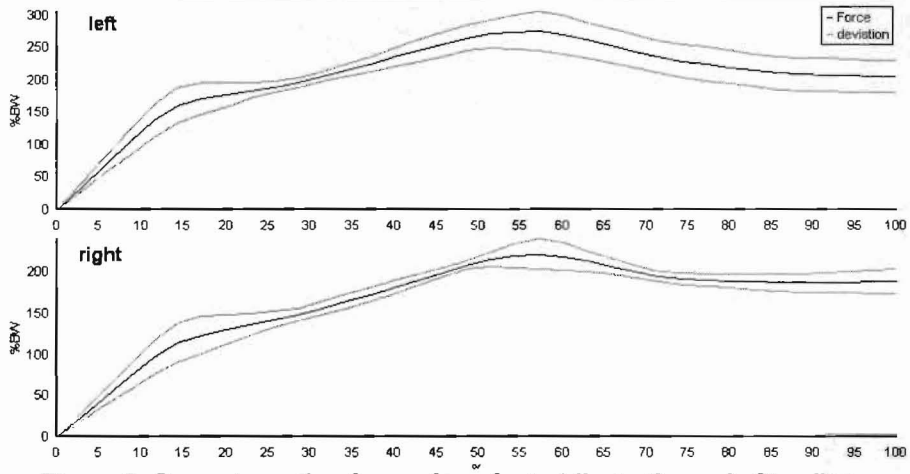


**Figure 3 Ground reaction forces from foot strike to the end of landing.**

**CONCLUSION:** Significant differences were found in maximum impact force and peak pressure between the skillful and unskillful. Skillful group also demonstrated a greater range of motion in the knee, hip and ankle joint respectively although no statically significant difference was found. The finding shows that the skillful group, whom engaged in training regularly, demonstrated a greater ability in reducing ground reaction force during landing; this may be a protective mechanism in preventing injury.

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