EFFECTS OF DIFFERENT HEIGHTS OF BOX DROP VERTICAL JUMP ON THE CHRONIC ANKLE INSTABILITY INDIVIDUALS

Ying-Liang Lai and Heng-Ju Lee
Department of Physical Education, National Taiwan Normal University, Taipei, Taiwan

The purpose of this study was to investigate the effects of different height of box drop vertical jump DVJ) among the healthy control, coper, and CAI groups. Participants were asked to perform a box drop vertical jump and followed with a single-leg landing on the force plate. The DVJ height was 10cm, 30cm, and 50cm. Results from the current study indicated two major findings: Three groups showed difference in frontal plan and sagittal plane when doing 50cm DVJ task, In sequence for CAI ,coper and healthy group. Our findings indicated that different landing strategy of ankle joints exist among 3 groups.

KEY WORDS: ankle sprain, sport injury, single-leg landing, box drop vertical jump

INTRODUCTION: Lateral ankle sprain (LAS) is one of the most common sport injuries. Eighty-five percent of the ankle sprains are caused by ankle inversion. A high relatively proportion of those patients could be turned into chronic ankle instability (CAI). The CAI groups might fell their ankle joint giving way or could not control their ankle joint properly during sports activities. The repeated ankle sprain is the main factor to cause CAI. Ankle sprain often occurred at repeat jump and single leg landing. In addition to CAI, people who have history of ankle sprains but without functional movement limitations have been called “copers”. This group not only could provide clinical evidence when compared to CAI, but also could be used as a comparison to healthy people. Previous study often adopted two groups (CAI and healthy control) to compare but often ignored the clinical importance of copers. Therefore, the purpose of this study was to compare kinematics and kinetics variability among individuals with healthy control, coper and CAI group when performing different heights of box drop vertical jump (DVJ) followed with a single leg landing. We hypothesized that ankle joint kinematics would differ among those who were CAI, copers and healthy controls.

METHODS: Twelve subjects were recruited to participate in this study. Among these 12 subjects,4 subjects who had classified as CAI (CAIT score is less than 23 with repetitive ankle sprains and feeling instability and weakness over ankle joint), served as the experimental group; 4 subjects who had classified as coper (CAIT score is ranged between 25 and 28 with an ankle sprain experience at least 12 months ago); 4 subjects who had classified as healthy control (CAIT score is higher than 28 with no ankle injury history. If the CAIT score is less than 24, the participant needed to be test by an experienced athletic trainer to confirm the severity of ankle functional instability (Liu et al., 2013). Detailed demographic information was present in table 1.

Table 1
Detailed demographic data of each group.

	CAI	Coper	Healthy control
N	4	4	4
Gender	F: 3, M: 1	F: 3, M: 1	F: 4, M: 0
Height (cm)	172.7 (13.5)	181.7 (7.1)	178.5 (7.9)
Mass (kg)	62.0 (3.5)	79.3 (11.0)	71.2 (13.8)
Age (years)	20.7 (2.1)	21.3 (1.5)	21.3 (4.3)
CAIT score	18.0 (2.0)	28.0 (1.0)	28.0 (0.0)
No. of sprains	>3	1	0

The exclusion criteria included an additional ankle injury (multi-ligament injury); osteoarthritis; severe muscle atrophy; or a recent injury to the spine, hips, ankles, or contralateral lower extremity joints in the previous 6 months. Kinematics and kinetics data were collected in a laboratory setting using 10 Vicon infrared video cameras (200 Hz), and one Kistler force platform (1000 Hz) were synchronized to acquire the ground reaction force and kinematic data during jump landing respectively. The marker were placed utilizing plug-in-gait marker set (Sinsurin, Vachalathiti, Jalayondeja, & Limroongreungrat, 2013).

Before data collection, subjects were allowed to warm-up by running on a treadmill at a self-selected speed for approximately 5 min. For the testing task, participants were asked to perform a box drop vertical jump (DVJ) and followed with a single-leg landing (supporting leg only) on the force plate. The box drop height was standardized to 10cm , 30cm , and 50cm. If the participant could not maintain balance or have extra hops during single leg landing, then that trial was considered a failure; at least 5 successful trials were collected.

The Vicon Nexus software was used to collect data of 3D marker trajectories and ground reaction force, respectively. Kinematics and kinetics data was processed using Visual 3D (C-motion, Rockville, MD, USA). The 3D marker trajectories and GRF data were filtered by a fourth-order zero-lag Butterworth digital filter at cut-off frequencies of 8 Hz and 40 Hz, respectively (Sinsurin et al., 2013). The sagittal and frontal plane lower extremity kinematics and kinetics data during landing phase were used for analysis.

One way ANOVA with Tukey's post-hoc test was used to identify significant differences among the healthy control, coper, and CAI groups. Statistical analyses were performed using SPSS statistical software (SPSS Inc., Chicago, IL). Significance levels were set at $\alpha = .05$.

RESULTS: At 50 cm DVJ task, ankle inversion angle had significant differences among three groups at initial contact from single leg landing. CAI had a significant greater ankle inversion angles (13.2±2.1 degrees) than copers (11.4±1.2 degrees) and healthy controls (9.6±1.3 degrees). At 50 cm DVJ task, ankle planta flexion angle had significant differences among three groups at ininital contact from single leg landing. CAI had a significant greater ankle plantar flexion angles (18.8±2.8 degrees) than copers (15.4±2.2 degrees) and healthy controls (14.6±1.8 degrees). However, there were no ankle kinematics significant differences at 10cm and 30 cm DVJ tasks among three groups.

DISCUSSION: The purpose of this study was to compare kinematics and kinetics variability among individuals with healthy control, coper and CAI group when performing different heights of box drop vertical jump (DVJ) followed with a single leg landing. From results of the current study, CAI group had a greater ankle plantar flexion and inversion angles than two other group when performed DVJ task at 50 cm box height. Typically, lateral ankle sprain occurred when ankle was plantar flexed and the foot rotated inward at single leg landing. When the challenge level increased, such as box height increased, CAI tended to demonstrate a higher risk of landing mechanism with greater ankle plantar flexion and inversion angles. This result indicated that CAI had a poor neuromuscular control than two other groups. A greater challenge of DVJ task could trigger or force CAI to display ankle mechanism flaws. This mechanism could have a higher chance leading to another ankle sprain and causing more severe injury. In addition, the ankle kinematics patterns of coper were just in between CAI and healthy controls. This indicated that chronic ankle instability was built up from multiple ankle sprains. When athletes suffered more than 3 times of ankle sprains, chronic ankle stability might be developed and could get worse as the challenge level of functional task increased. Therefore, a better way to prevent coper turning into CAI should be studied in the future.

CONCLUSION: CAI group showed a susceptible ankle injury mechanism when functional task challenge increased. Ankle mechanism of coper was in between CAI and healthy control. A better way to prevent coper turning into CAI should be added in the training program and further research should also be focus on how to make poor ankle mechanism returning to it's normal form.

REFERENCES:

Delahunt, E., Monaghan, K., & Caulfield, B. (2007).Ankle function during hopping in subjects with functional instability of the ankle joint. *Scandinavian Journal of Medicine & Science in Sports*, *17*(6), 641-648

Caulfield, B. M., & Garrett, M. (2002). Functional instability of the ankle: Differences in patterns of ankle and knee movement prior to and post landing in a single leg jump. *International Journal of Sports Medicine*, *23*(1), 64-68.

Caulfield, B. M., & Garrett, M. (2004). Changes in ground reaction force during jump landing in subjects with functional instability of the ankle joint. *Clinical Biomechanics*, *19*(6), 617-621.

Brown, C. N., Padua, D. A., Marshall, S. W., & Guskiewicz, K. M. (2009). Variability of motion in individuals with mechanical or functional ankle instability during a stop jump maneuver. *Clinical Biomechanics*, *24*(9), 762-768.