Back to Table of Contents

DYNAMIC VALGUS DURING DROP LANDING RESULTS IN DECREASED LATERAL PLANTAR PRESSURE

[1] Christopher Ferrigno, [1]Jade He, [1] Philip Malloy, [1] Markus A. Wimmer

[1] Rush University Medical Center, Chicago, IL, USA
email: christopher_ferrigno@rush.edu, web: http://asb2017.org/

INTRODUCTION

Anterior cruciate ligament (ACL) injuries are highly debilitating and commonly occur in sporting activities involving sudden stops and change of direction. Following ACL reconstruction (ACL-R), re-injury rates to the ipsilateral or contralateral knee are as high has 31% [1]. Movement asymmetries such as increased dynamic valgus at the knee during sport-specific tasks such as the box drop vertical jump test (DVJ)) are associated with ACL rupture and persist following ACL-R. These aberrant movement patterns place high demands on the ACL, increasing the likelihood of re-injury three-fold [2]. Such patterns are modifiable [3]; therefore, detecting asymmetries during sport-specific tasks is crucial for determining at-risk individuals.

Clinically, identifying lower limb movement anomalies using semi-quantitative two dimensional (2D) video recording or 3D analysis is time consuming and impractical for most settings. Detecting plantar pressure is quick and affordable, making it clinically feasible. Faulty kinematic responses during the DVJ have a large frontal-plane component; therefore, similar medial-lateral pressure shifts likely occur during dynamic valgus.

The purpose of this proof-of-concept pilot study was to explore the plantar pressure response to three different landing strategies during the DVJ. We hypothesized that healthy subjects demonstrate higher lateral plantar pressures during hip abducted landing, while demonstrating lower lateral pressures during hip adducted landing.

METHODS

Eight healthy participants were enrolled in this institutional review board approved study at Rush University Medical Center (29.9±4.6yrs, 2 women, BMI=25.3±2.9). All subjects were healthy with a self-reported absence of knee pathology, surgery to the lower extremities, or current pain in their lower extremities.

All subjects wore a standardized shoe (Dr. Comfort, FlexOA, Mequon, WI, USA) containing a pair of fully-integrated pressure-detecting shoe insoles (OpenGo, Moticon GmbH, Munich, Germany) with built-in 13 capacitive sensors (Figure 1).

Figure 1. The Moticon OpenGo Insole.

Subjects completed a total of 6 DVJs from a box (31cm high) (Figure 2). For all jumps, subjects were instructed to drop forward off the box and immediately perform a sub-maximum vertical jump. During the first set of 3 jumps, subjects performed their jumps according to previous work [3] with their feet initially positioned 35 cm apart on the box. To increase the dynamic valgus for the final set of 3 jumps, a foam block was placed between the distal thighs. Subjects were instructed to perform the DVJs without releasing the foam block from between their knees.

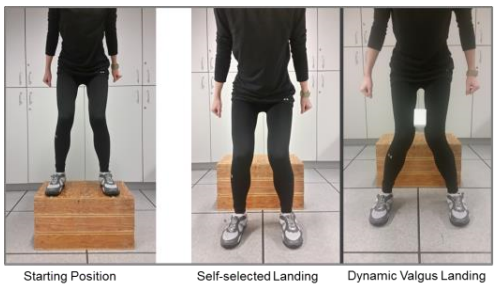

Figure 2. The DVJ. The subject preparing to drop from the box (left) and landing with a self-selected technique (center) or with dynamic valgus (right).

Plantar pressure data was wirelessly downloaded and processed with OpenGo Software (Moticon GmbH, Munich, Germany). The maximum pressure from each of the 26 total sensors was recorded from each during the first half of the initial landing following the drop from the box. The three trials for each DVJ condition were averaged. To examine whether imparting a dynamic valgus resulted in a change in medial or lateral foot pressure, select sensors were grouped to represent the entire lateral foot, medial foot, or different regions of interest during landing (Figure 3). For the medial foot, sensors 0, 2, and 6 were selected since they are likely to contact the floor during the first half of stance (far left). For the lateral foot, sensors 5 and 9 were selected and grouped to capture the plantar loading on the lateral surface for the 5th metatarsal heads (sensor 5) and heel (sensor 9) during the first half of stance (far right). Comparisons were made for these specific pressure sensor groupings.

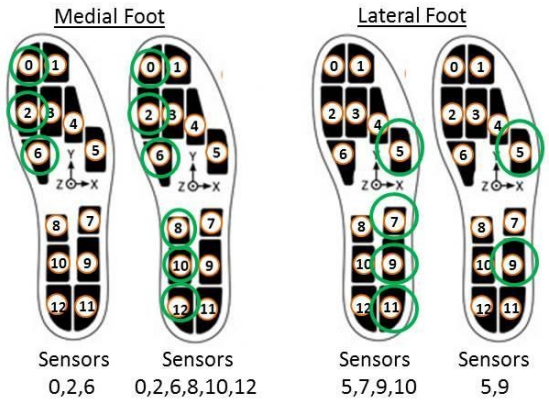

Figure 3. Locations of sensor groupings on the OpenGo Insole.

Statistical analyses were performed using SPSS 23 (IBM, Armonk, NY). Paired t-tests were used to compare the plantar pressures of sensor groupings.

RESULTS AND DISCUSSION

Paired t-tests revealed that jumping with knees directed medially using a foam block resulted in a considerable decrease in plantar pressures in the sensor group representing the entire lateral foot (sensors 5,7,9,11) and select sensors (sensors 5,9) (Table 1). No significant changes were measured in the sensor groupings of the entire medial insole ($p > 0.152$) or selected sensors 0, 2, and 6 ($p > 0.071$).

In this proof-of-concept study, lateral plantar pressure reduced bilaterally during the induced dynamic valgus landings. A larger study to further explore the changes in plantar pressure, as well as the potential for using plantar pressure-based as a feedback training tool, are warranted.

CONCLUSIONS

This pilot study suggests that plantar pressures decrease in the lateral foot during a landing position which places the athletes at risk for ACL injury or re-injury during sport.

REFERENCES

1. Leys T, et al. AmJSportsMed, **40**, 595-605, 2012.
2. Paterno MV, et al. AmJSportsMed, **38**, 1968-1978, 2010.
3. Hewett TE, et al. AmJSportsMed, **33**, 592-501, 2005.

Table 1: Plantar pressures in select Moticon OpenGo Insole pressure sensors during undirected (normal) and directed (genu valgum position) initial landings of the drop vertical jump. All pressure values are in N/cm2.

	Sum of ALL Lateral Sensors (Sensors 5,7,9,11)			Sum of Sensors Under Lateral Midfoot and 5th Metatarsals (Sensors 5 and 9)		
	Normal Position	Genu Valgum Position (with foam)	p-value	Normal Position	Genu Valgum Position (with foam)	p-value
Right Foot	13.62 (3.63)	6.76 (6.08)	**0.014**	7.02 (1.27)	3.60 (2.72)	**0.008**
Left Foot	14.11 (6.14)	7.66 (5.85)	0.067	6.49 (2.74)	4.00 (3.07)	**0.021**