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Letter to the Editor

Variability in Touchdown Technique and Ground Reaction Force Components during Drop Landing of 107 Healthy Adults

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Dear Editor-in-Chief

Gravity always pulls down forward the earth regardless of relationship between projected height and distance of object. Under the situation, excessive external force may cause soft tissue, cartilage, and bone of lower limbs to injure (1). It is necessary to grasp biomechanically on magnitude of impulse and controllability by each leg for proper achievement on processes after jumping. Particularly ground reaction force (GRF) data occurred in the process of landing may be modeled and compared with linear relationship of maximal reaction force using the theta (θ) transformation method (2). Thus, correlation among variables on one leg can induce an optimal combination among GRF force, loading rate, elapsed time and theta to control an impulse during landing. Like this, quantitative data on asymmetric bilateral leg may be provided solution on motor performance, exercise rehabilitation, injury danger etc., but be not cleared on the relationship between variability and variables of GRF components. Consequently, the aim of this study was to quantify GRF components on bilateral legs during landing, and analyze correlation among variables by each landing leg.

Health adult (n=107, mean age; 20.75±2.19 yr, mean height; 1.68±0.09 m, mean weight; 68.11±14.26 kg, mean BMI; 23.88±3.82 kg/m^2) who had not experiment of clinical operation, disorder of muscular skeletal system and normal for landing performance in Jeju, South Korea, 2019 year, participated voluntarily in the study.

All participants agreed on the study details, making an agreement according to Bioethics Committee of Jeju National University and conformation and collection of demographic statistical information on dominant leg based on leg accustomed to ball kick (3, 4)

The experiment for test of landing technique was progressed for 4 d in biomechanics laboratory room at one's preferred time. Enough warming up on the height of 40 cm before landing performed, and then wore half sleeves and pants as experimental attire. Landing by left or right was performed randomly, and data collection occurred on GRF (AMTI-OR9-7, AMTI, Watertown, MA, USA) was collected at 1 min for 10 seconds. All participants was requires to keep eye's direction up forward direction, with both hand on anterior superior iliac spine and with absorption an impulse force with maximal flexion of joint of hip, knee and ankle. Landing motion derailed from GRF plate after landing was excluded from variables analysis. PVF theta was calculated by normalized peak vertical force (N/BW) from GRF data and time function (2). Here, 0 (zero time) means initial touch down on GRF plate of foot.

$$PVF\ theta\ (\theta) = \tan^{-1}(\frac{\mathrm{PVF}}{\mathrm{t}})$$

Then mean ± standard deviation was processed on variables with PASW (IBM Co., Armonk, NY, USA) program and paired t-test. The ground reaction force components between bilateral legs was compared with Pearson correlation coefficients and set at $P<0.05$.

Variability on GRF variables during landing of this study explained and then correlation among variables showed whether the same leg or the other leg has closer relation. High loading rate during exercise shows scarcity of impulse reduction, which means loading of stress during shorter time on lower extremity (5). In this study, Dominant leg showed shorter occurring time of maximal vertical force and loading rate than non-dominant, which followed statistical significance, also theta of peak vertical force showed steep slope (Table 1).

Table 1: Results of kinetic variables between both legs during landing

Section	***Bilateral legs***		***t***	***P***
	Right	Left		
Medial-lateral force (N/BW)	0.14±0.28	-0.15±0.24	6.510	0.001***
Anterior-posterior force (N/BW)	0.41±0.36	0.44±0.30	0.672	0.503
Peak vertical force (N/BW)	6.38±1.57	5.91±1.45	3.985	0.001***
Loading rate (N/BW/sec)	154.47±42.89	131.04±47.92	2.428	0.017*
Elapsed time to peak vertical force (sec)	0.046±0.010	0.047±0.008	0.690	0.492
Peak vertical force-theta (degree)	89.54±0.20	89.50±0.22	2.520	0.013*

Thus the magnitude of loading rate occurred during landing have close relation with magnitude of vertical GRF and elapsed time. This can be proved from correlation of variables analyzed in bilateral leg commonly (Fig. 1, high positive correlation of peak vertical force-theta vs peak vertical force [r=0.803] and loading rate [r =0.623], and reverse correlation of loading rate vs time [r =-0.694]).

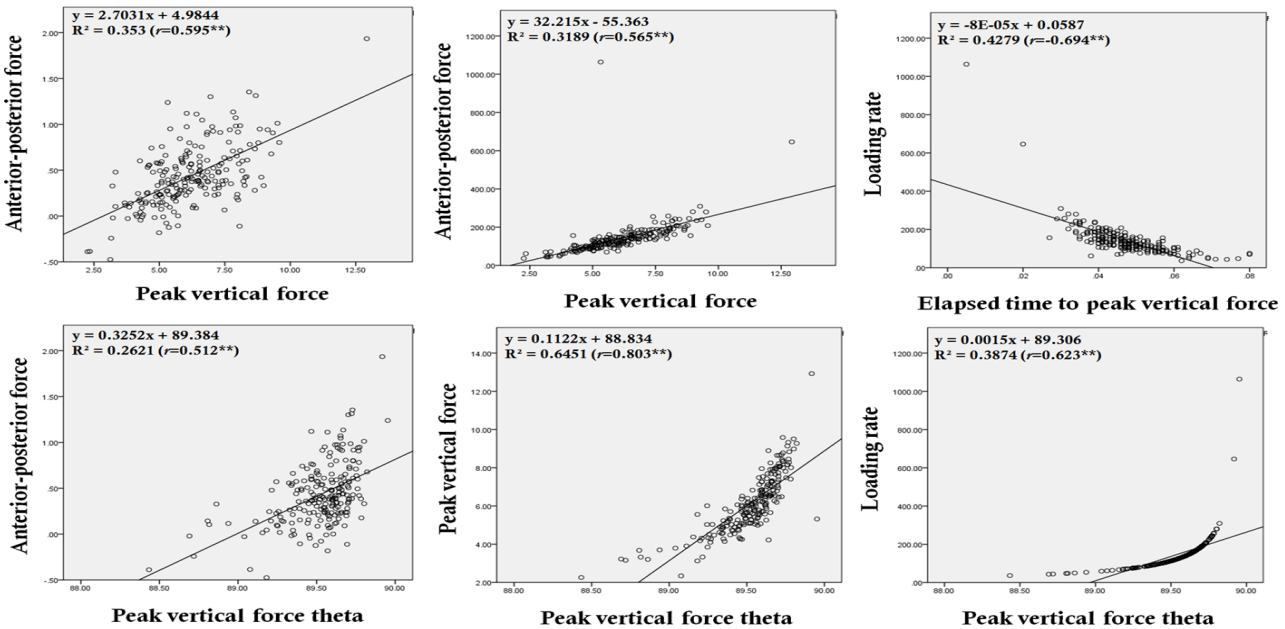

Fig. 1: Association between the same ground reaction force relationship parameters obtained from the bilateral leg during landing. *y*, regression equation; R², r square; *r*, Pearson's correlation coefficient; Significant correlations: **$P<0.01$

While non-dominant and dominant leg independently showed high correlation in between theta of maximal vertical force and the other variables. In other words, type of impulse force between two leg showed significant difference, but effect of impulse absorption of each leg was accomplished by controlling (increase or decrease) properly magnitude of anterior-posterior and vertical force, elapsed time, and velocity of loading rate, etc.

This mechanism could be utilized to reduce the imbalance of posture between dominant and non-dominant leg when considered successful landing of all participants. Consequentially landing strategy is integration of biomechanics, neurophysiology, and motor control (4).

Conflict of interest

The author declares that there is no conflict of interest.

References

1. Mizrahi J, Susak Z (1982). Analysis of parameters affecting impact force attenuation during landing in human vertical free fall. *Eng Med*, 11(3):141-7.
2. Ryew CC, Hyun SH (2015). The Theta Analysis on the Components of Ground Reaction Force According to the Ground Conditions During Gait. *Korean Journal of Sport Biomechanics,* 25(3):241-8.
3. Edwards S, Steele JR, Cook JL, et al (2012). Lower limb movement symmetry cannot be assumed when investigating the stop-jump landing. *Med Sci Sports Exerc*, 44(6):1123-30.
4. Sadeghi H, Allard P, Prince F, Labelle H (2000). Symmetry and limb dominance in able-bodied gait: a review. *Gait Posture*, 12(1):34-45.
5. Hargrave MD, Carcia CR, Gansneder BM, Shultz SJ (2003). Subtalar pronation does not influence impact forces or rate of loading during a single-leg landing. *J Athl Train,* 38(1):18-23.