EFFECTS OF FUNCTIONAL KNEE BRACE ON BIOMECHANICAL PARAMETERS FROM DIFFERENT HEIGHTS OF DROP LANDING

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The purpose of this study was to investigate differences of the kinematic, and kinetic between wearing FKB and non-braced during the drop landing tasks. Subjects were required wearing FKB and non-braced to perform a single leg drop landing task from heights of 10, 30, and 50cm. Our findings indicated that wearing functional knee braces or not didn't significantly affect biomechanical parameters during drop landing for healthy subjects. As box height increased, body position would change to a softer landing posture to buffer the impacts. This mechanism did not affect by wearing FKB. Therefore, no matter wearing FKB or not, poor landing mechanism, such as stiff landing, was the main reason to increase the possibility of ACL injuries.

KEY WORDS: drop landing, injury, knee brace

INTRODUCTION: A non-contact ACL injury usually occurs within 50 ms after ground contact during the landing phase of the jump task or at the moment of changing directions (Koga et al., 2010). As increasing the height of the jump-landing task leads to an increase in the vertical ground reaction force (McNitt-Gray, 1991). The results of previous studies showed that as the drop landing height increased, a greater vertical GRF, a faster loading rate increased during the landing phase, which could increase the potential risk of ACL injury (McNitt-Gray, 1993; Williams et al., 2004; Zhang et al., 2000). Functional knee brace (FKB) could limit excessive range of motion, as well as provide rotary stability and reduce the risk of ACL injury. Previous research has suggested that FKB might alter knee joint mechanics during jump landings (Lin et al., 2008; Yeow et al., 2010). Research has showed wearing the brace increases in knee flexion at initial contact and decreases in peak knee flexion during a jump landing (Lin et al., 2008). Despite the apparent preventive function, no research is presently available on the potential benefit(s) of using a FKB by healthy subjects during drop landing tasks. Therefore, this study was to investigate differences of the kinematic, and kinetic between wearing FKB and non-braced during the drop landing tasks.

METHODS: Six healthy males (without lower extremity injuries during the six months prior to the experiment) were recruited as subjects for this study. The mean age, height, and body weight of subjects were 19.00 ± 2.45 years, 1.72 ± 0.09 m, and 65.63 ± 6.94 kg. Three force plates (Kistler, Germany) embedded within the floor, were used to collect ground reaction force data (GRF) at a sampling rate of 1000 Hz. Kinematics data were collected using a ten-camera, three-dimensional (3D) motion analysis system (VICON,, UK) at a sampling rate of 200 Hz. During each trial, the positions of 36 reflective markers and 22 tracking makers were collected. The tracking makers were attached to the lateral of tight, leg, and instep of foot. Each subject performed a single leg landing task from drop heights of 10, 30, and 50cm (DL10, DL30, and DL50) respectively. Each drop heights would include five successful trials. To avoid learning effect, subjects were asked to practice before the experiment. Subjects were asked to perform five successful trials at three different heights with FKB on the landing limb, and then followed with non-braced drop landings. The Visual3D™ software (C-Motion, Rockville, MD, USA) was used for data analysis and calculating joint kinematics and kinetics. Kinematics and kinetics data were filtered using a fourth-order Butterworth filter with the cutoff frequency set at 6 Hz. Positive values represented flexion angles for the hip, knee and ankle (dorsiflexion). Internal joint moment was calculated for lower extremities using inverse dynamics equations. Negative values represented extension moments for the hip, knee and ankle (plantarflexion). GRF was normalized to body weight. Sagittal plane joint moments were normalized to body mass and body height. All data were analyzed from landing phase of the supporting leg, which was defined as the time between initial foot contact and maximum knee flexion. All data were analyzed using 2 x 3 factorial design with repeated-measure ANOVA to evaluate whether the means of the test variable differed significantly between FKB and non-brace conditions. The significance level was set at α = 0.05.

RESULTS: Kinematics and kinetics variables at three drop landing heights were present in Table 1. No significant difference was found in all 50ms passive forces, landing , max squat. The non-brace condition had significantly smaller GRF, slower loading rate, and smaller hip moment at 30 cm box height when compared to the FKB condition. ($p < .05$).

Table 1. Mean and standard deviation of kinematics and kinetics variables at three heights and two bracing conditions

	DL10			DL30			DL50		
	Brace	Non-brace	*P*-value	Brace	Non-brace	*P*-value	Brace	Non-brace	*P*-value
GRF (BW)									
	1.13 ± 0.97	1.13 ± 0.12	.869	1.15 ± 0.31	1.21 ± 0.14	.513	1.10 ± 0.15	1.18 ± 0.15	.034*
50ms passive forces									
	0.06 ± 0.01 [ab]	0.05 ± 0.01 [ab]	.462	0.09 ± 0.03	0.08 ± 0.03 [c]	.505	0.11 ± 0.02	0.11 ± 0.03	.739
Landing rate									
	29.07 ± 10.09 [ab]	27.07 ± 12.54 [b]	.661	45.85 ± 18.62 [c]	35.49 ± 13.82 [c]	.033*	66.54 ± 20.60	62.62 ± 20.71	.357
Landing (degrees)									
Hip	17.02 ± 5.66	16.61 ± 6.29	.403	18.13 ± 6.31	17.40 ± 6.96 [c]	.352	19.38 ± 6.63	19.99 ± 6.30	.616
Knee	-15.69 ± 2.44 [ab]	-17.13 ± 1.91 [ab]	.079	-24.51 ± 2.82 [c]	-24.60 ± 3.14 [c]	.934	-30.86 ± 2.94	-32.43 ± 3.12	.253
Ankle	-18.01 ± 3.66 [ab]	-17.81 ± 2.24 [ab]	.863	-14.15 ± 4.24 [c]	-13.86 ± 3.96 [c]	.773	-9.43 ± 4.81	-9.08 ± 3.87	.749
Max squat (degrees)									
Hip	28.65 ± 10.74 [ab]	28.60 ± 10.75 [ab]	.961	38.81 ± 12.86 [c]	39.13 ± 15.05 [c]	.872	46.64 ± 14.58	49.70 ± 16.45	.380
Knee	-55.44 ± 4.29 [ab]	-58.61 ± 4.76 [ab]	.171	-77.39 ± 9.90 [c]	-78.82 ± 4.82 [c]	.644	-88.44 ± 8.45	-89.99 ± 7.59	.645
Ankle	23.74 ± 2.31 [ab]	25.89 ± 2.82 [ab]	.129	34.00 ± 6.44	34.16 ± 4.70	.885	35.93 ± 6.04	36.08 ± 6.06	.853
Moment (Nm/Kg*BH)									
Hip	-0.26 ± 0.43 [b]	-0.20 ± 0.31 [ab]	.475	-0.49 ± 0.51	-0.53 ± 0.49 [c]	.728	-0.53 ± 0.46	-0.88 ± 0.39	.019*
Knee	1.69 ± 0.29 [b]	1.71 ± 0.33 [ab]	.638	1.99 ± 0.42	2.18 ± 0.36	.111	2.11 ± 0.31	2.13 ± 0.31	.699
Ankle	-0.64 ± 0.20 [b]	-0.80 ± 0.24 [b]	.206	-1.01 ± 0.37	-1.08 ± 0.27	.431	-1.08 ± 0.24	-1.22 ± 0.17	.050*

* represented significant difference between brace and non-brace ($p < .05$).
[a] represents a significant difference between DL10 and DL30.
[b] represents a significant difference between DL10 and DL50.
[c] represents a significant difference between DL30 and DL50.

DISCUSSION: The purpose of this study was to investigate differences of the kinematic, and kinetic between wearing FKB and non-braced during drop landing tasks. These results suggest that the FKB used in this study did not significantly affect subjects drop landing performances. Wearing the functional knee brace was to alter lower extremity kinetics and kinematics and to reduce the load on the ACL in functional tasks by increasing the knee flexion angle at the landing. When landing in DL10, the smaller range of motion at the knee was likely to represent a stiffer landing strategy. In general, a stiffer landing might result in greater GRF (Devita & Skelly, 1992). In DL50, hip and knee had larger flexion angles, which represented as a softer landing strategy (Zhang et al., 2000). The results of this study showed, as the box height increased, 50ms passive forces and Landing rate also increased, same as previous studies. The greater GRF and faster loading rate during the landing phase could result in increasing the potential risk of ACL injury (Williams et al., 2004; Zhang et al., 2000).

CONCLUSION: Our findings indicated that wearing functional knee braces or not didn't significantly affect biomechanical parameters during drop landing for healthy subjects. As box height increased, body position would change to a softer landing posture to buffer the impacts. This mechanism did not affect by wearing FKB. Therefore, no matter wearing FKB or not, poor landing mechanism, such as stiff landing, was the main reason to increase the possibility of ACL injuries.

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