MEASUREMENT OF KNEE MUSCLE BALANCE DURING DROP JUMPS- COMPARISON BETWEEN DIFFERENT JUMP HEIGHTS

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INTRODUCTION

Drop jumping is widely used for athletes to enhance their neuromuscular ability of lower extremity. However, it is known to generate greater moments and power at the knee [1] which means the knee muscles may sustain greater force. The balance of knee mucle is important for knee stability where the imbalance of vastus medialis obliquus (VMO) and vastus lateralis (VL) would cause the anterior knee pain [2], and the imbalance of quadreiceps (QUA) and hamstring (HAM) would cause the ACL injuty [3]. Limited knowledge was known if training from different height would interference the knee muscle performance. The purpose of this study was to explore the EMG activation of knee muscles during drop jumping from different heights.

METHODS

Twenty six collegiate students of physical education department – 16 males (age: 21.1 ± 1.9 years; height: 172.9 ± 6.7 cm; mass: 73.1 ± 14.1 kg) and 10 females (age: 20.7 ± 1.3 years; height: 163.0 ± 3.9 cm; mass: 56.7 ± 7.1 kg) voluntarily participated in this study. All volunteers had no prior knee pain or any history of trauma of the lower extremity. All subjects performed 3 drop jumps from each of the 20, 30, 40, 50 and 60-cm jump height randomly. They were asked to immediately and maximally jump off the ground after landing.

Kinematic data were collected at 200 Hz using 11 Eagle cameras which were synchronized to force platforms (sampling rate= 2000 Hz). Surface EMG activity was detected at 2000 Hz from the VMO, VL, QUA, HAM of subjects' preferred legs which were determined in relation to the foot normally used to kick a ball. A reference electrode was placed on the tibia. An additional input single was triggered to synchronize the EMG and kinematic data.

The supporting phase was determined between landing and jumping off the ground where the threshold of ground reaction force was set as 10N. The supporting phase was then divided into the eccentric and concentric phases where the eccentric phase was from the landing to maximal knee flexion, and the concentric phase was from the maximal knee flexion to jumping off the ground.

The averaged IEMG (aIEMG) of each muscle was calculated over the entire time interval of the concentric or eccentric phases, and were normalized to %MVC. To display the change in the relative activity of VMO and VL, the VMO/VL and QUA/HAM ratio were calculated. The two-way repeated ANOVAs were used to compare the differences between drop jump heights and muscles during eccentric and concentric phases. The significance level was set at α=0.05. When significance was found, the *post-hoc* analysis was performed with the Bonferroni adjustment.

RESULTS AND DISCUSSION

The study showed the imbalance of knee muscles during drop jumps, especially in the eccentric phase, regardless the jump heights. The greater lateral pull of VL onto the patella, especially in the concentric phase, and the greater anterior pull of QUA on the tibia may put athletes prone to knee injury. Furthermore, drop jump from 60-cm height may result in greater ACL strain which should be considered during training.

REFERENCES

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Table 1: aIEMG of VMO, VL, QUA, and HAM during drop jumping

aIEMG (%MVC)	Heights (cm)				
	20	30	40	50	60
Eccentric					
VMO	94.9 ± 37.4	101.3 ± 44.2	104.2 ± 48.8	115.4 ± 53.1 [a]	130.2 ± 75.5 [abcd]
VL	105.2 ± 40.1	112.0 ± 53.4	120.3 ± 49.0	122.4 ± 46.6 [a]	141.5 ± 60.3 [abcd]
VMO:VL	0.93 ± 0.22	0.95 ± 0.25	0.89 ± 0.25	0.96 ± 0.20	0.92 ± 0.24
QUA	81.9 ± 29.7 *	89.0 ± 37.3 *	97.2 ± 37.1 *a	94.9 ± 36.9 *	106.6 ± 44.0 *ab
HAM	22.6 ± 9.9	24.2 ± 12.3	23.8 ± 8.7	26.1 ± 9.3	27.1 ± 13.9
QUA:HAM	4.28 ± 2.48	4.25 ± 1.96	4.54 ± 2.03	4.00 ± 1.78	4.72 ± 2.50
Concentric					
VMO	131.3 ± 47.4	120.6 ± 48.9	127.7 ± 58.5	134.2 ± 52.9	141.6 ± 73.1
VL	154.7 ± 57.5 †	151.2 ± 64.8 †	150.4 ± 60.2 †	153.2 ± 77.6 †	154.4 ± 69.5 †
VMO:VL	0.86 ± 0.25	0.80 ± 0.19	0.83 ± 0.22	0.88 ± 0.19	0.87 ± 0.22
QUA	105.6 ± 35.9 *	109.8 ± 41.9 *	102.8 ± 39.3 *	113.0 ± 49.3 *	108.9 ± 46.5 *
HAM	45.2 ± 15.6	48.5 ± 24.3	48.5 ± 20.1	46.5 ± 17.4	49.0 ± 27.0
QUA:HAM	2.67 ± 1.48	2.68 ± 1.20	2.33 ± 0.83	2.71 ± 1.27	2.66 ± 1.39

[a] Significantly greater than 20 cm; [b] Significantly greater than 30 cm; [c] Significantly greater than 40 cm; [d] Significantly greater than 50 cm; * QUA significantly greater than HAM; † VL significantly greater than VMO.