EFFECTS OF POWER GENERATION ON EVALUATING IMPACT ATTENUATION IN LANDING

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INTRODUCTION

A common and acceptable activity used to measure the power output of the lower extremity is the vertical jump [1]. Studies have compared the biomechanical characteristics of landing and jumping with the same level of participation [2, 3] and others have compared the physical activity level or experience in landing and jumping biomechanics [4, 5]. Thus, differences could be observed in the impact attenuation during landing in athletes with different maximum power generation capabilities. Therefore the purpose of this study was to compare the effects of power generation capacity on impact attenuation during a drop landing activity.

METHODS

Twelve male recreational athletes performed five drop landing trials from three heights in two different protocols (PT). Subjects were divided into one of two groups (Grp) based on their maximum vertical jump height: non-elite (Grp 1, N=8) and elite (Grp 2, N=4), which was used as an index for lower extremity power capacity. All subjects performed five landing trials from heights of 40, 60, and 80 cm in the protocol one (PT1) and from 70%, 100%, and 130% of their jump height (H) in the protocol two (PT2).

A force platform (1080 Hz, AMTI) and a 6-camera motion analysis system (120 Hz, Vicon) were used to collect ground reaction force (GRF) and 3D kinematic data simultaneously during the testing session. Kinematic and GRF data were smoothed at 8 and 20 Hz respectively, using a fourth-order Butterworth low-pass filter. The 3D joint kinematic and kinetic variables were computed using Visual3D software (C-Motion, Inc.) in conjunction with a customized computer program. A mixed design three-way repeated measures ANOVA (Grp × PT × H) with Grp as the between-subject factor was used to evaluate selected joint kinematic and kinetic variables ($p < 0.05$).

RESULTS AND DISCUSSION

The mean maximum knee flexion angle was significantly greater in PT2 than PT1 for Grp1. The maximum knee flexion angle increased significantly as height increased for both groups. For Grp1 in PT1 the maximum knee flexion angle increased 11% from H 1 to 2 and 27% from H 1 to 3. However, in PT2 the increases were 11% and 21% from H 1 to 2 and from H 1 to 3 respectively.

The mean peak knee extensor moment was significantly greater in PT1 than PT2 for Grp1 (Table 1). The peak knee extensor moment in PT1 for Grp1 increased 21% and 68% from H 1 to 2 and H 1 to 3 respectively. However, in PT2 the increases were 16% and 31% for Grp1. Conversely, the peak hip extensor moment in PT1 for Grp1 increased 29% and 61% and for PT2 the increases were 31% and 69% from H 1 to 2 and H 1 to 3 respectively. Similarly, the peak ankle plantar flexor moment in PT1 for Grp1 increased 8% and 16% but for PT2 the increases were 16% and 16% from H 1 to 2 and H 1 to 3 respectively.

Table 1: Average peak joint moments (Nm/kg).

Grp	PT	H	Hip Extensor	Knee Extensor	Plantar Flexor
1	1	1	3.4±1.1	2.5±0.4	1.5±0.5
		2	4.4±1.2 [a]	3.0±0.8 [a]	1.6±0.5 [a]
		3	5.5±1.9 [a,b]	4.2±1.0 [a,b]	1.8±0.4 [a,b]
	2	1	2.9±0.9	2.3±0.3 [*]	1.4±0.4
		2	3.8±1.1 [a]	2.7±0.3 [*,a]	1.7±0.5 [a]
		3	4.9±1.3 [a,b]	3.1±0.4 [*,a,b]	1.6±0.3 [a,b]
2	1	1	2.9±0.6	2.3±0.3	1.8±0.3
		2	4.0±0.4	2.8±0.2 [a]	1.9±0.2 [a]
		3	5.0±1.6	3.6±0.8 [a,b]	2.0±0.3 [a,b]
	2	1	4.2±0.9	2.6±0.3	1.8±0.2
		2	4.7±1.0	3.3±0.6 [a]	1.9±0.4 [a]
		3	5.4±1.4	3.8±0.4 [a,b]	2.1±0.3 [a,b]

[*]: Significantly different from protocol 1.
[a]: Significantly different from height 1.
[b]: Significantly different from height 2.

There were greater increases in the hip and ankle moment for PT2 while smaller increases for PT1 in Grp1 but not Grp2. The knee moment demonstrated greater increases for PT1 but smaller increases for PT2 in Grp1 only. The moment data indicates that there is greater effort by the knee musculature for Grp1 to attenuate the impact forces for PT1 but actually less effort by knee and greater effort by the hip and ankle musculature for PT2 to absorb the impact forces.

CONCLUSIONS

Protocol differences were found in individuals who did not participate in jumping sports and who landed from absolute heights. For the PT based on a percentage of maximum vertical jump heights, smaller increases in knee kinematics and knee moments were found in Grp1 only. These results suggest individuals possessing greater power generation capabilities and/or conditioning may be more capable attenuating impact forces in drop landings.

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