THE EFFECT OF PASSIVE AND ACTIVE IMPULSE ON THE PERFORMANCES OF DROP JUMPS

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This experiment is to investigate the ground reaction forces of three different heights of drop-jumps (DJ) in order to understand the effect of passive and active impulses on the performance of DJ. Eleven subjects were asked to perform DJs. AMIT force-platform and penny electrical gonio-meter were used to record the ground reaction forces and knee angular displacement. After treating the data and discussion, the conclusions were obtained. The active force as well as the active impulse are that of DJ20=DJ40=DJ60 whose result is consistent with the flight-height of these three different DJ. On the other hand, the higher the jump-altitude is, the larger the passive impulse and passive force are. This result is very different from that of flight-height, so the passive impulsive seems to have no help to prompt the performances of DJs. After further examination of the ground reaction force, we found that the key determinant process is the PARFD that slopes down as the jump-heights increase. The DJ60 induces the largest passive impulse but also accompanies negative PARFD. On other hand, the DJ20 induces the smallest passive impulse but accompanies positive PARFD. Finally, the performances of DJ20, DJ40 and DJ60 have no difference.

KEY WORDS: passive impulse, active impulse, passive force, active force, PARFD, flight-height.

INTRODUCTION: The opinions of which height can present the best performance among different heights of DJs (drop jump) are inconsistent. As we know, the impulse is equal to the force intergrated during the period of action time and determines the performance of jump. The more the impulse is, the higher the flight height is. The impulse of supporting phase is divided into passive and active impulses which are induced from passive and active forces on the curve of ground reaction force. The passive force in human locomotion is a typical force due to the landing of the foot on the ground (Nigg 1985). Rack & Westbury (1974) demonstrated that the force produced at the initial stage of eccentric phase is related to the stretched velocity. The faster the velocity is, the higher the force is. In the studying of different heights of landing, Chang, Ing-Jyh, et al., (1994) discovered that the passive force increased as the jump altitudes was higher. However, for human locomotion (DJs) in sport, the importance of active force is no less than passive force, because active force is a force that is completely controlled by muscular activity. It is the primary reason for locomotion. When initiating a movement out of a standing point (e.g., a jump), an athlete activates the muscle and this muscle activation produces the movement. We wonder if the impulse of passive phase determined by the passive force can affect the performance. For resolving the doubts, we produced different impulse that happen at the initial stage of eccentric phase by adopting Drop-jumps (DJs) from the heights of 20, 40 and 60cm.
For understanding the variation of these two impulses and performance, we examed the rate of force developed between passive and active forces (PARFD). This process needs the ability to buffer the passive force and immediately produce the force voluntarily. This may be a key process to determine the result of active force and finally affect the flight height of DJs.
So, for clearing the mist of influence of impulse produced by passive and active force on performances, we dissolve the passive impulse, passive force, active impulse, active force as well as PARFD and see their effects on fight-height.

METHODS: For producing different passive forces and impulses which happen at the initial stage of eccentric phase, we adopted DJs from the heights of 20, 40 and 60cm, and see the effects on PARFD and active force. DJ at the heights of 20, 40 and 60cm were performed by 11 subjects of jumpers and sprinters with average ages 23.18±2.64 years, heights

173.0±4.03cm and weights 64.31±5.97kg. AMIT force-platform and Penny electrical gonio-meter were used to record the curve of ground reaction forces and angular displacements. The sampling rate was 1000 HZ and the low pass was 10HZ. SPSS software was adopted to calculate the values of the parameters and repeated measures ANOVA was used to test the difference among three different heights of DJ. The significance level was set at .05.

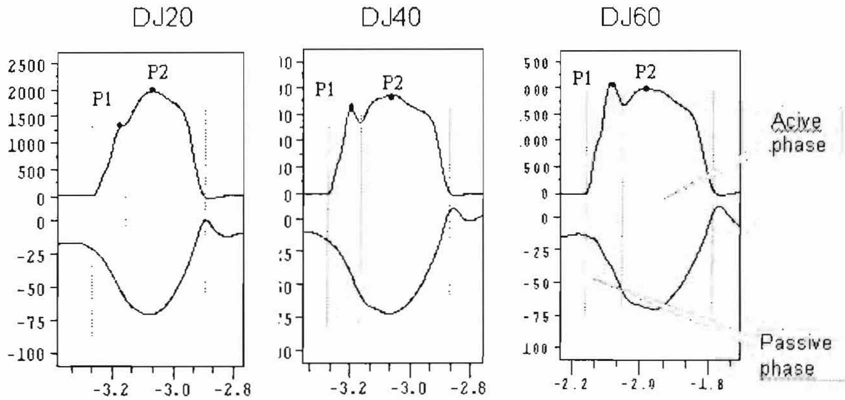

Figure 1: This is a representative figure of ground reaction force of DJ20, DJ40 and DJ60. P1 (peak force 1) is the passive force and p2 (peak force2) represents the active force. The slope between P1 and P2 is the rate of force developed between passive and active force (PARFD).

RESULTS AND DISCUSSION: The supporting time and stretch amplitude among different heights of DJ: When implementing the DJs, the subjects were told to jump with a knee angle smaller than 75 degrees and to jump as high as possible. The kinetic parameters must be compared under equal condition. The supporting time and stretched amplitude were manipulated to be equal under different heights of DJs. The average of angular displacement of DJ20 was 71.1±3.5 degrees, DJ40 was 71.1±5.2 degrees and DJ60 was 72.8±4.8 degrees. The supporting time between landing and take-off of DJ20, DJ40 and DJ60 were 447±44ms, 440±43 ms and 448±39ms respectively. There are no difference existing on supporting time and stretch amplitude among different heights of DJ.

Table 1 The angular displacement and supporting time of different height of DJ.

DJ heights / parameters	DJ20	DJ40	DJ60	F value	The groups reaching the significance level
Angular displacement (deg.)	71.1±3.5	71.1±5.2	72.8±4.8	1.47	
Supporting time (ms)	441±44	440±43	448±39	1.00	

The comparison of impulses and DJ performances among different heights of DJ: Besides force, the action time is the other key element of impulse. So the duration of passive and active phase among DJ20, DJ40 and DJ60 had better be equal for further comparison of the parameters. The action duration of passive phase of DJ20 is 110±12ms, DJ40 is 111±10 ms and DJ60 is 115±11ms. The action time of active phase of DJ20 is 330±41ms, DJ40 is 333±48 ms and that of DJ60 is 332±31.6ms (table2). The action times of passive and active phases of three different heights are equal. Under the same action durations, the comparisons continue. Impulse is the key element for performance. This section is to see the impulses of passive and active phase and compare with the results of performance. The flight-heights of DJ20, DJ40 and DJ60 are 37.3±4.6cm, 37.1±4.5, 36.5±5.5, and the differences are not significant (table2). The impulses of active phase of the three DJs are DJ20=DJ40 =DJ60 (table2) which is the same as that of flight-height. At the passive phase, as the higher the jump-altitude is, the larger the impulse is (DJ60>DJ40>DJ20), but the performance of higher altitude of DJ (DJ60) doesn't be enhanced therefore. So the results show that the active impulse is consistent with the results of performance, but the increased passive impulse didn't help enhance the flight-height. Now let's explore the further details that affect the variation of impulses.

Table 2 The comparison of impulse and performances among the different heights of DJ.

heights / parameters	DJ20	DJ40	DJ60	F value	The groups reaching the significance level after comparison
duration of passive phase (ms)	110±12	111±10	115±11	1.96	
The passive impulse Kg • m/s	98±22	136±17	178±29	84.46	H1-H2 H1-H3,H2-H3
duration of active phase (ms)	330±41	333±48	332±32	.326	
active impulse (Kg • m/s)	501±64	522±81	502±58	.01	
flight- height (cm)	37.3±4.6	37.1±4.5	36.5±5.5	.394	

p<.05, H1= DJ20 H2= DJ40 H3= DJ60

Table 3 The comparison of forces induced during supporting phase among the different heights of DJ.

DJ heights / kinetic parameters	DJ20	DJ40	DJ60	F value	The groups reaching the significance level after comparison
Peak passive force (B.W.)	2.1±0.8	2.9±0.1.	3.4±0.2	24.82	H1-H2 H1-H3, H2-H3
The passive average force (B.W.)	1.28±.21	1.79±.26	2.18±.34	49.94	H1-H2 H1-H3,H2-H3
Peak active force (B.W.)	2.69±.13	2.69±.14	2.61±.14	.59	
The active average force (B.W.)	2.29±.21	2.29±.31	2.21±.27	1,77	H1-H3
PARFD (B.W.)	4.7±1.1	-1.0±0.8	-5.4±0.8	36.30	H1-H2 H1-H3, H2-H3

p<.05, H1= DJ20, H2= DJ40, H3= DJ60

The comparison of forces induced during passive and active phase from the different heights of DJ: The two peak forces occurred on the curve are passive and active force. The passive force is tenser as the height of DJ increase, as we can see on table3 which shows that the passive forces of different heights are DJ60> DJ40> DJ20. The phenomenon of larger force induced by higher altitude of DJ maybe due to the intensity which is emphasized by the velocity under the same mass, because the higher the DJ altitude is, the falling velocity is faster and the intensity is heavier when touching the ground. The passive forces also have positive effect on the passive average forces of three different heights of DJs and make them be DJ60 > DJ40 > DJ20 (table3).

The other peak force of curve is active force and there are no differences among those of the three different heights (e.g.DJ20=DJ40=DJ60). The average active forces that are influenced by peak active forces are slightly different (DJ20=DJ40 and D40=DJ60, DJ20> DJ60). That of

DJ20> DJ60 implies the exercise intensity of DJ60 may be too high for the subject to tolerate and influence the following active force developed. For the other important parameter, as the heights of DJ increase, the force between passive and active force developed (PARFD) from different heights of DJ slopes down as shown on table3 (DJ20>DJ40>DJ60). The reason may be that when jumping from the higher altitude, the muscles need to buffer the high passive force and doesn't have enough strength (the recruitment of fast muscle) to develop the active force, so the rate of force is developed negatively (e.g. PARFD of DJ40 and DJ60). In other words, under the effect of passive force, especially from the higher jump-altitude, the intensity is too heavy. The muscles need more protection and the activation is inhibited, so the rate of force developed is reduced. When jump-altitude is lower and the intensity is lighter and easy to conquer, force can be developed positively (e.g. PARFD of DJ20).

CONCLUSION: After treating the data and discussion, the conclusions were obtained. The flight-heights of DJ20, DJ40 and DJ60 have no difference. The impulse of active phase are DJ20=DJ40, DJ40=DJ60 whose result is consistent with the altitude of flight-height. On the other hand, the higher the jump-altitude is, the larger the passive impulse (DJ60>DJ40>DJ20) is. This result is very different from that of flight-height, so the passive impulse seems to have no help to prompt the performances of DJs. After further examination of the curve of ground reaction force, we found that the higher the DJ altitude is, the tenser the passive force and the average passive force are. As for the active phase, the peak active forces and active average force are in accordance with the performance of three different heights of DJ. What makes this result may be due to the PARFD which is the key determinant process of force developed on the curve of ground reaction force. PARFD slopes down as the jump-heights increase. Therefore DJ60 induces the largest passive impulse but also accompanies negative PARFD. DJ20 induces the smallest passive impulse but accompanies positive PARFD. The final result is that the active force, active impulse as well as performances have no difference among DJ20, DJ40 and DJ60.

In short, the passive force and passive impulse doesn't contribute to the promotion of performance. Instead, active forces are consistent with the performances of different DJs. Under the influence of passive force, PARFD may play the key roles to develop the active force and make the finally result of flight height. When adopting adequate exercise intensity, PARFD can be developed positively. But as the exercise intensity is too heavy, the PARFD is developed negatively. So when adopting the DJ practices, for maximizing the active force and impulse we should take the exercise intensity that induces large passive force and develops positive PARFD or we shouldn't take the altitudes that are too high to tolerate, because the PARFD will be developed negatively and won't do any good to performance.

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