EFFECTS OF DIFFERENT APPROACH LENGTHS OF THE LAST STRIDE ON VOLLEYBALLER RUN UP VERTICAL JUMPS

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The present investigation quantified differences among maximal-effort jumping performances by a volleyball player with different approach lengths of last stride. Twelve well-trained male volleyball players aged from 17 to 19 years volunteered after informed consent was obtained from all subjects (height:186.18 ± 6.1 cm; body mass:76.6 ± 6.3 kg). Each subject was required to perform a number of maximal-effort run up vertical jump on the force plate (Quattro jump, Kistler Inc.) with different lengths (50, 100, 150 cm) of last approach stride. The results indicated that total vertical impulses of length 150cm (356 N-s) were greater than other two length trials(length 50cm: 329 N-s; length100: 339 N-s) although the time for total impulse were not significantly longer than the others. It also implied that the performance with length 150cm approach had the greatest average force between each trial.

KEY WORDS: approach length, vertical jump, ground reaction force (GRF)

INTRODUCTION: The ability to jump and reach for height is an important factor for the performance of volleyball players. Spike jumping techniques vary considerably according to such factors as whether a hop approach (the feet simultaneously impact the ground) or step-close approach (one foot impacts the ground then the other) performed, and the vary approach speed employed. Previous studies have presented some kinetic differences between the two jumping techniques with hop approach and step-close approach (Coutts, 1979; 1982), and the effects of approach speed have also received a great deal of attention by designing different number of approach steps on experiments (Kayambashi, 1977). Besides, the effects of approach speed influenced by different last approach stride length were rarely investigated specifically. Theoretically, the greater approach length of last stride, the greater horizontal speed resulted at the beginning of takeoff phase. Therefore, the purpose of present investigation was to quantify the differences among the maximal-effort jumping performances with different approach lengths of last stride.

METHODS: Twelve well-trained male volleyball players aged between 17 and 19 years volunteered as subjects after the informed consent obtained from all subjects (height:186.18 ± 6.1 cm; body mass:76.6 ± 6.3 kg). Following a brief warm-up and stretching period, each subjects was required to perform a number of maximal-effort run up vertical jump on the force plate (Quattro jump, Kistler Inc.) with different lengths of last approach stride. Each subject performed three different approach lengths of last stride of 50, 100, 150 cm from force plate, and for each run up method, subjects allowed to use a one-step, self-paced preparing approach. Because all subjects were right-hand oriented, the whole procedures were left-foot impacted at the identified-marks of approach-length, and right-foot planted at the force plate then left-foot. This run up and planting technique (termed the “step-close” technique by Coutts, 1982) was most frequent way used in the vertical jump during volleyball spiking. The pathway of approach was settled as the same height as the force plate. The vertical component of the ground reaction forces during takeoff phase recorded by the force plate with sampling rate of frequency 500 Hz. A total of variables were obtained from the force-t curves. Time measurements indicated the time of the total impulse from initial contact with the force plate until take-off and landing. The time from take-off to landing was used to estimate the vertical take-off velocity($v = T/2 \times g$) , and the mass take the chance of the vertical take-off velocity is equal to propulsive impulse ($m \times v$ = propulsive impulse). Total impulse subtract propulsive impulse is

equal to absorption impulse, and we can estimate the approach vertical velocity by absorption impulse (approach vertical velocity = absorption impulse/m).

RESULTS: The one-way ANOVA analysis yielded an F-value which was significant at the 0.05 level, indicating a difference in the set of variables between the three approach length of last stride on volleyball run up vertical jump. Table 1 presents the Mean and S.D. values for each variable by different approach length. The finding that the values of all variables are greater and greater with increase the length of approach but time for total impulse. Two of the six variables were significantly different at the 0.05- level. Table1 presented the selected variables from the vertical ground reaction force during takeoff phase of spiking jump.

Table 1 Vertical Force-Time Curve Variables for Three Approach Length of Last Stride on Volleyball Run Up Vertical Jump

Distances(cm)	50		100		150	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.
Time for Total impulse(ms)	416	63	399	48	400	45
Total vertical impulse(N-s)	329	42	339	36	356	42
Take-off vertical velocity	3.38	0.13	3.41	0.19	3.43	0.14
Propulsive impulse (N)	259	26.1	261	26.6	266*	26.4
Absorption impulse (N)	70	21.8	78	21.8	90*	21.8
approach velocity (m/s)	0.91	0.27	1.02	0.28	1.17	0.25

Note. *Statistical significant difference was found between the length of 50 and 150 cm

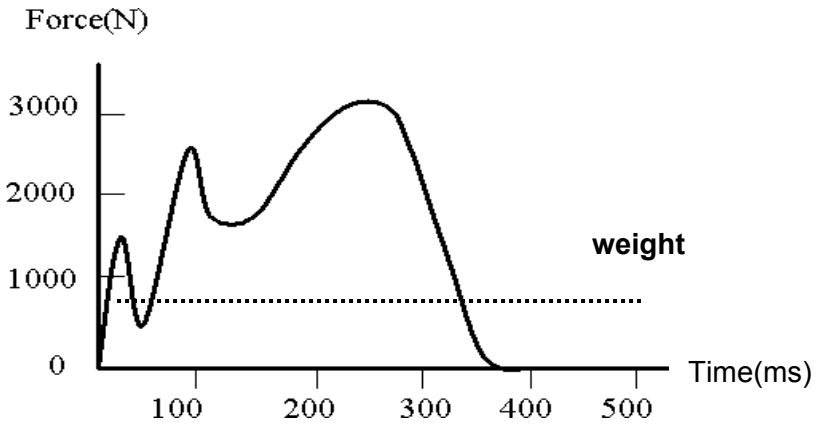

Figure 1 - Force-time curve of selected jumping performance.

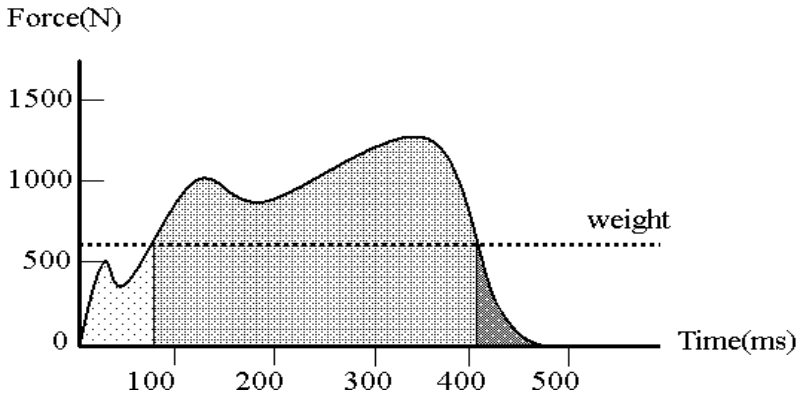

Figure 2 - Step-close style vertical force-time curve (from Coutt, 1982).

Figure 1 showed the typical pattern of the force-time curve of the performance in this study, and Figure 2. , which used to compare with Figure 1., was the curve with the same style of jump performance from previous study (Coutts, 1982).

DISCUSSION: Technically, the approach speed was considered as how fast the initial velocity gained at the instant of planting (termed as the “planting speed” in later). Thus, to change the number of approach-steps was not only way to determine the planting speed, and to lengthen the length of last stride was also the technique to increase the planting speed. By observing the methods of approach run the volleyball spikers used to jump with two feet, two-steps approach run was the most frequent one among other steps approach. But for the new developed skill of spike — one-foot jump spike, the number of approach steps may extend to three or four. The descriptions above were the reasons why the experiment designed in presented study.
The time from take-off to landing was used to calculate time in the air, and then estimate the take-off vertical velocity and propulsive impulse .Try to deduce the error from estimation, the subjects were asked not to bend their leg during the flight phase especially at the instant of landing. The table 1 showed that the total vertical impulses of length 150cm (356 N-s) were greater than other two length trials(length 50cm: 329 N-s; length100: 339 N-s) although the time for total impulse were not significantly longer than the others. It also implied that the performance with length 150cm approach had the greatest averaged force between each trial. From the definitions by Coutts (1982), propulsive impulse and absorption impulse could be consider as the active part and passive part of total impulses, respectively. Furthermore, it maybe relative to the muscular contraction styles of concentric and eccentric contractions during takeoff phase. The results revealed that the propulsive and absorption impulse performance of length 150cm approach were both significantly greater on than other approaches. It means that the greater lengths of approach last-stride, the more strength load would be produced by muscular- skeletal system. In order to gain longer length of approach last-stride, there would be two different way to reach the purpose: the first one is to increase the projection angle of CM (or simply jumped some more higher), and the second is to increase the horizontal velocity of CM and keep the projection angle as horizontal as possible. From the experiment of this study, almost all the subjects performed the second one described above. The reason could be explained that the second method of increasing the velocity and keep the horizontal projection angle spent the less duration of fight time, and it was a kind of benefit to volleyball spikers. The approach velocity calculated from the absorption impulse showed that the length 150cm approach have the larger value, and means that the subjects may perform the length 150cm approach higher than others, and owned greater downward vertical velocity. The reason maybe the length 150cm was a little bit greater than the own-length of subjects, and the practice time were not longer enough to get used to. The length 150cm approach also have larger horizontal velocity and momentum than other trails, and the absorption horizontal approach momentum may make a significant contribution to the stretching of muscles prior to the propulsive phase(komi & Bosco, 1978)
After compared the selected pattern (length 150cm of approach stride) of this study (Figure 1.) with the pattern of step-close jumping (Figure 2.) from previous study (Coutts, 1982), there were some differences the two patterns. First, the author separated the curve of Figure 2. into three components: onweigthing phase, positive phase and unweighting phase (from left to right, respectively); but from the present study, figure 1 showed the first peak value of the curve was higher than weight level, and then down below soon. Thus, the categorization of impulse to vertical jumping was not generalized for volleyball spike. Second, the duration of takeoff phase was also significant different between the two curves.
All the curves from this study appeared three peak-value of vertical force. and the phenomenon was probably caused by the reactions of right-foot, left-foot and both feet flexing, respectively. Because of the planting technique, this pattern was differing from that of countermovement

jump, squat jump. Besides, the performance will perform differently according to such factors as whether how close the two feet planted on ground, whether the length of last-stride was “optimal” or not, and even whether what’s the motion of swinging arm. It’s worth to go on focus the issue by designed the experiments more completely, cinematography analysis maybe helpful to involve to study.

CONCLUSION: According to the results of present investigation, which was to quantify the differences among the maximal-effort jumping performances with different approach lengths of last stride, it is suggested that lengthening the approach length of last stride was also the technique to increase the planting speed. And during approach, increasing the horizontal velocity of CM and keep the projection angle as horizontal as possible is the suggested way to reduce the approach time and produced more propulsive impulse to create the takeoff velocities. When designing a training drill, extending the approach length of last stride and without velocity-decay until planted on ground.

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