GROUND REACTION FORCE OF THE SNATCH MOTION AND KINESIOLIGICAL ANALYSIS BY PHOTOGRAPHY

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INTRODUCTION

THE NEED OF THE STUDY

The training program which emphasizes the reinforcement of body muscle, and acquisition of techniquebased on dynamical principle are thought to be very important factors in obtaining good scores in weight-lifting competitions. In other words, when a person who has the same ability lifts a material of the same quantity, the result will be very different according to the ways in which the lift is accomplished. Thus, the purpose of this study was to help beginners improve their ability by analyzing the motions of the athletes who have competed for more than 5 years as a high ranking prize-winner and finding the dispersion of power exhausted according to his motions and the deficits of his form.

Weight-lifters' scores depend on physical, technical, and psychological elements, and strategic preparation. The basic principle of technique is to lift the heaviest weight with the least power. Primarily, it is to overcome the resistance with the provided skilled motions by displaying the maximum power against the greatest resistance.

Dynamical efficiency over the resistance and the inertia of the bar requires maximum power, maintenance of balance, and finally, the technical ability which works near to the center-line as developed in efficient training programs.

PURPOSE OF THIS STUDY

The aim of this study was to measure and analyze the centers of gravity, the direction of strength, and the amount of torque shown in the snatch actions of three Korean lifters. These participants performed five repetitions of the movement to compare and analyze the differences.

METHOD OF STUDY AND INSTRUMENT OF MEASUREMENT

Subjects

Three players with over five years of competitive experience chosen were chosen as the participants. Demographics of the participants are shown in Table 1.

Table 1. The physical characteristics of subjects.

Subject	Age(Years)	Career (Years)	Height (cm)	Body Weight(kg)	Record(kg)
K. K. N.	19.4	6	162.0	67.0	112.5
L. C. W.	19.7	5	168.0	59.0	100.0
P. S. W.	18.9	5	165.0	95.0	115.0
M	17.0	3.6	165.0	73.6	109.1
SD	0.17	0.47	2.44	5.43	6.56

The instruments of measurement used for this study are shown in Table 2.

Table 2.
Instruments.

Instrument	Type	Maker
High speed camera	16mm	Hitachi
Film	A. S. A. 400	Kodak
Analyzer	106B.350E	Inter-Nac
Computer	16 bit AT	HOST
Bar Bell		Suwon-korea
Pressure plate	self made	
Measurement Board	self made	

2. Method of Practice

The motion analysis and pressure plate analysis procedures of this study are shown in Figures 1 and 2. Figure 3 contains photographs of the equipment used in the study.

1. Camera
2. Film
3. Motion analyzer
4. AID convert
5. Computer
6. Analysis (Displacement, Velocity, Acceleration, Force, Angle, Angular Velocity, Torque)
7. X-Y plot

Pressure plate
Strain gauge
Amplifier

Figure 1. Analysis system.

1. Pressure plate(Self-made)
2. Strain gauge(Type KFC-5-C1-11, length 5mm resistance 120)
3. Dynamic strain amplifier (Type DPM-6E, Kyowa)
4. AID convert (PCL-712, PC-Labcards)
5. Computer (IBM PC/AT)
6. Analysis

Figure 2. Pressure plate analysis system.

RESULTS

1. Angle Variation of Each Joint

Table 3.
The final angle of each unit of movement.

Angle	Thigh and Calf					Thigh and Trunk				
Step	Kang	Lee	Park	M	SD	Kang	Lee	Park	M	SD
Start	30.4	35.9	37.5	34.6	3.04	69.4	66.9	74.6	70.3	3.2
1st-pull	124.7	131.1	127.9	127.9	2.61	116.4	118.4	121.3	118.7	2.01
2nd-puii	180.2	181.2	180.9	181.8	0.53	162.6	165.4	168.1	165.3	2.24
Lock-out	38.6	40.2	52.3	43.7	6.11	37.8	23.6	38.3	33.2	6.81
Stand-up	160.4	152.8	163.5	158.9	4.49	168.3	172.4	156.6	165.7	6.69

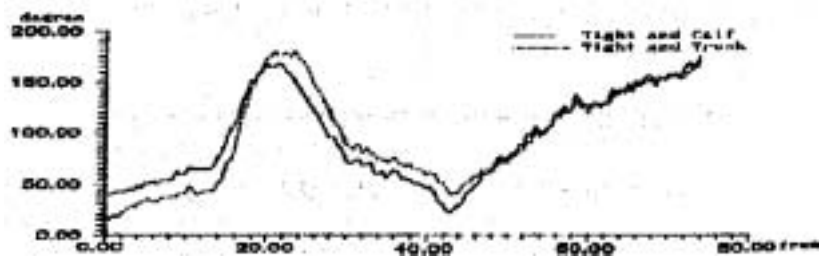

Figure 3. The angle for Kang's thigh and calf, thigh and trunk

RESULTS AND DISCUSSION

The physical variables of the weight-lifting motions of three weight-lifters were compared and analyzed. Each lifter had over five years of weight-lifting experience. The results of the weight-lifting motions were analyzed by two-dimensional film analysis as follows:

(1) The angles at each steps:

When the first motion has been completed, the mean angle of the first pull motions was 127.9(and these angles have little difference among them. At the 2nd-pull, the angle between thigh and calf is 181.8(and Park's thigh and calf and thigh and trunk had the highest increase.

(2) The velocity at each joint:

The experiments required a 0.16 - 0.18 sec readiness period. At the first pull motion Kang's was 1.46 m/sec, Lee's 1.54 m/sec, and Park's 1.47 m/sec. The times needed for the first pull motion were 0.57 sec, 0.33 sec and 0.51 sec, relpectively. The times needed for the 2nd pull motion were 0.45 sec, 0.33 sec and 0.36 sec. The times needed for the lock-out step were 0.78 sec, 0.66 and 0.69 sec.

(3) Ground reaction force:

The vertical force of first pull motions were 154.1 kg, 147.5 kg and 190.4 kg. The phenomenon that ground reaction force of the 2nd-pull action has the sudden increase in spite of the decrease of first pull action can be caused by the reaction force from the strong push off the ground. The phenomenon of small reaction force was broken out just after the lock-out action might be caused by the jump action.

(4) Torque which has an effect on all physical joints:

The torque which has an effect on every physical effect was a related continuance. Every weight from the bodies is supposed to work on the peak of each joint, and the torque related with the bodies should be affected by the weight of the bar and the trainer. Kang's first pull action was 2444 kg-cm at the hip joint, 1410 kg - cm at knee, and 685 kg - cm at shoulder. Lee's were 2476 kg - cm, 572 kg - cm and 1222kg - cm. But the torque value decreased at the second-pull. Kang's was highest at 2820 kg - cm of shoulder at the lock-out step, Lee's was 276 kg - cm. Lee's was the highest at 2440 kg -cm of the first pull action at hip joint.

CONCLUSION

As to the snatch motion in weight lifting, the structural mechanism and quality of motion was analysed by camera and force analysis. For producing pressure plate, which make more generalizations the structural mechanism and quality of motion technologic theory is introduced. Some conclusions of this research are:

(1) Motion of bar, coax, and articulation of the knee, are similar to one another in S-forms but in standup process all the weights of three participants showed a tendency to drop behind.

(2) To lock out in the snatch motion, the weight was pulled up to about 67% ofparticipant's height.

(3) When the snatch motion was completed, the angle between thigh and trunk was about 181.8 and the angle between thigh and calf was about 165.3. The angle velocity of the former was about 174.9 deglsec, that of the latter was about 254.9 deglsec. The final angle velocity between thigh and trunk was similar to that of Park but that of Lee is 199.9 deglsec. The final angle velocity between thigh and trunk of Lee was the greatest.

(4) Right after the beginning of 2nd pull, the velocity of weight was maximum, 2.31 m/sec and the acceleration of the weight is 5.01 m/sec2.

(5) Right after lock out in the snatch motion the velocity of each articulation was maximum -- especially that of shoulder articulation which was maximized at 3.4 m/sec and the acceleration of that was 17.89 m/sec2. The degree of the velocity of each articulation was as follows: coax > elbow > knee > ankle

(6) In the snatch motion, the maximum vertical ground reaction force appeared at the and of the lock out motion. That of Kang was about 2.8 times (194.21kg) as heavy as his weight. That of Lee was about 3.2 times (193.4 kg), and that of Park was about 2.5 times (237.5 kg). Right after the beginning of 2nd pull, the maximum of vertical ground reaction force of Kang was about 2.5 times (167.5 kg) as heavy as his weight, that of Lee was about 2.9 times (171.1 kg) and that of Park was about 2.4 times (228.1 kg).

(7) Comparing torque peaks of hip and knee joint in the snatch motions, the shoulder articulation in Kang's and Lee's lock out motion was the maximum, 2820
kg - cm and 2726 kg - cm. But the hip joint in Park's first pull motion is the maximum of 1440kg - cm, which was higher than that of the shoulder articulation.

In addition,a follow-up should be able to realize the mean result achieved by efficient motion analysis by means of the more practical and easier motion analysis machine and materials.

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2. Velocity Variety of Each Joint

Figure 6. The Velocity of bar

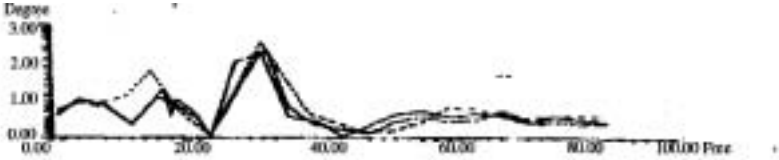

Figure 7. The velocity of hip joint

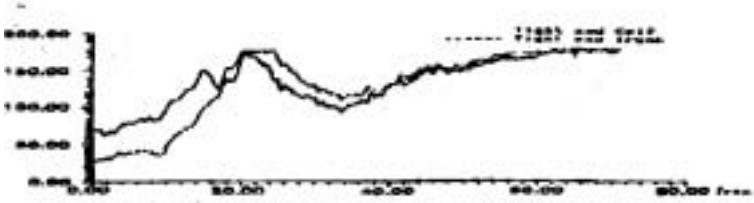

Figure 5. The angle for Park's thigh and calf, thigh and trunck

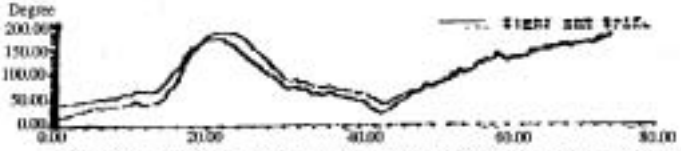

Figure 4. The angle for Lee's thigh and calf, thigh and trunk