KINEMATIC ANALYSIS OF THE BAR DROP DISPLACEMENT IN THE SNATCH

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The purpose of this study was to analyze drop-under time, maximum vertical barbell displacement, vertical barbell drop and maximum vertical barbell velocity during the 1999 United States National Weightlifting Championships. The performance of ten female lifters performing 30 lifts was recorded and analyzed using a Peak5 2D Motion Analysis System. These variables were observed for lifters who successfully performed multiple lifts to determine the trends that take place as the load of the barbell increases. Average maximum vertical barbell displacement was 101.5(cm) with a SD of 7.4. Average vertical barbell drop displacement was 20.8(cm) with a SD of 5.9. Average maximum vertical velocity of the barbell was 164.8(cm/s) with a SD of 19.1. Average drop-under time was .47(s) with a SD of .09.

KEY WORDS: weightlifting, snatch, female, displacement, velocity, time

INTRODUCTION: The popularity of women's athletics has grown in recent years and weightlifting does not seem to be an exception. As a result women athletes have earned the right to compete in weightlifting at the Olympic games. As with their male counterparts, weightlifting competition consists of the snatch and the clean and jerk, two of the most mechanically powerful of all athletic competitions. Attempting to single-out a specific variable that can reliably predict a successful lift is a challenge. Stone, O'Bryant, Williams, Johnson and Pierce (1998) state that many factors can influence the outcome of a snatch attempt and whatever determines success is likely to be multifactorial in nature. Hakkinen, Kauhanen and Komi (1984) found that the average duration of the drop-under times for male elite and district level lifters as the load increased were significantly different. It was also noted that the vertical heights of the barbell decreased as the load increased. Drop-under time values were found to be in the range of .30 to .38 seconds by Garhammer (1985). In 1983, Roman and Treskov found the drop-under time to last .33 seconds and the vertical barbell drop was approximately 9 centimeters. Bauer and Isaac (1987) also examined vertical displacement of the barbell and found it to range between .85 and 1.19 meters. Vertical bar velocities were reported by Garhammer (1989) to be between 194 and 215 centimeters/second for female lifters. The variables addressed in this body of literature does not examine the myriad of factors involved in performing the snatch, however, they do apply to the scope of the present study. All of the studies cited above analyzed the male lifter except for the 1988 study by Garhammer. A considerable amount of research has looked at the variables involved in weightlifting for the male athlete. However, relatively few studies have examined these variables in the female lifter. Understanding the factors involved in a completing the snatch is important for both the coach and the lifter in order to improve performance. Therefore, the purpose of this study was to analyze the drop-under time, maximum vertical barbell displacement, vertical barbell drop and maximum vertical barbell velocity for the snatch as performed by female weightlifters.

METHODS: The data for this study were collected at the 1999 USA Men's and Women's Weightlifting Championships held in St. Joseph, Missouri (USA). All female competitors at this national competition were filmed, but only the 69kg class (n=10) was analyzed for this study. The 69kg class was considered one of the elite classes with the potential for setting the national record in this event. The camera was set to record at 60 fps, and it was placed perpendicular to the competitive platform and the lifter's sagittal plane. The performance of the 10 female lifters in the snatch was recorded and analyzed with the Peak5 software package. Sixteen of the thirty snatch attempts were completed successfully and were analyzed for this study. Drop-under time was measured as the time from maximum vertical bar velocity at the end of the second pull until the lifter halted the downward movement of the bar during the catch. Vertical barbell drops were calculated as the difference between maximum vertical displacement of the bar during the second pull and the lowest vertical displacement of the bar during the catch. Maximum and

minimum vertical bar velocity data were collected and calculated with the Peak5 software. These were compared to the load of the lift to determine the effect of the load on the variables.

RESULTS AND DISCUSSION: The data from the 16 successful snatch attempts is listed in Table 1. Average maximum vertical barbell displacement was 101.5 cm with a standard deviation of 7.4 cm. Average vertical barbell drop displacement was 20.8 cm with a standard deviation of 5.9 cm. Average maximum vertical velocity was 164.8 cm/s with a standard deviation of 19.1 cm/s. Average drop-under time was .47 seconds with a standard deviation of .09 seconds. The changes that occurred with the variables for those lifters who completed multiple lifts are shown in Table 2. Maximum vertical barbell displacement will be different among the lifters due to the height of the lifter. The researchers did not have the height of the lifter but thought it was necessary to record the vertical barbell displacement to observe any changes that may have taken place between successful lifts. The data in Table 2 show that the vertical displacement of the barbell decreased as the load of the barbell increased. The vertical drop displacements of the barbell were substantially larger than the drop displacements that have been recorded for male lifters in the snatch (Hakkinen, et al., Garhammer, Roman et al., & Bauer, et al.) Maximum vertical velocities of the barbell fell below that reported by Garhammer, however his subjects were Olympic and world-class female weightlifters. The subjects involved in the present study were competing at the national level, which may have some bearing on the variables analyzed. Drop-under times were slightly higher than male drop-under times, which have been reported to fall between .30 and .38 seconds (Garhammer, 1985). The change in the variables between the successful lifts at different loads seems to follow the changes that have been stated in the aforementioned literature. As the load of the barbell increases the lifter will decrease the maximum vertical displacement of the barbell, the drop-under displacement will decrease, maximum vertical velocity of the barbell decreases and the drop-under time increases. Some changes occurred that were not anticipated and did not follow the trends found in the literature. The lifts performed by Orko produced the exact opposite change in the variables than one would expect. With the load of the barbell increasing, she increased the max height of the barbell, decreased her drop distance, increased the vertical velocity of the barbell and decreased her drop-under time. Looking at the other lifters in Table 2, we see that maximum vertical barbell heights between lifts by the same lifter decreased due to the increased mass of the barbell. However, vertical barbell drop displacements did not seem to follow a predicted pattern of increasing as the load of the barbell increased. The other variable that acted differently than expected was drop-under time. Two lifters made no change in this variable, two decreased their drop-under time and two lifters increased their drop-under times.

Table 1 Variables Examined in the Sixteen Successful Lifts

Lifter	Load (kg)	Max Vertical Displacement (cm)	Drop Displacement (cm)	Max Vertical Velocity (cm/s)	Drop-Under Time (s)
Hawo	57.5	108.7	26.1	173.8	0.5
Sist 1	60	103	23.8	169.1	0.5
Sist 2	65	99.5	20.7	161.2	0.5
Redc	65	93	18.7	127.3	0.7
Orko 1	72.5	110.6	25.5	184.7	0.5
Orko 2	75	111.6	17.6	189.7	0.4
Blas	75	104.3	5.3	192.6	0.4
Bohi 1	80	89.3	22.5	137.9	0.3
Bohi 2	82.5	88.6	24.9	135.3	0.5
Leat	92.5	100	19.5	153.3	0.4
Head	92.5	94.1	13.7	158.3	0.4

Hunt 2	92.5	106.2	18.6	179	0.6
Hunt 3	95	105.1	19.4	160.8	0.5
Fore 1	92.5	110.7	27	176.6	0.4
Fore 2	95	99.9	30.3	171.4	0.4
Fore 3	98	99.8	18.8	166.1	0.5

Table 2 Change in Variables between Successful Lifts

Lifter and Attempt	Load (kg)	Max Height (cm)	Drop Displacement (cm)	Max Vertical Velocity (cm/s)	Drop-Under Time (s)
Orko 1&2	+2.5	+1	-7.9	+5	-0.10
Sist 1&2	+5	-3.5	-3.1	-7.9	0.0
Bohi 1&2	+2.5	-0.7	+2.4	-2.6	+0.2
Fore 1&2	+2.5	-10.8	+3.3	-5.2	0.0
Fore 2&3	+3	-0.1	-11.5	-5.3	+0.1
Hunt 1&2	+2.5	-1.1	+0.8	-18.2	-0.1

CONCLUSION: The majority of the weightlifting literature now uses the male lifter as the research subject. The present study attempted to bridge the gap between research on both the female and male weightlifter. Knowing if there are differences in technique for the male and female weightlifter is advantageous for the coach. Putting these pieces together with the other factors that have been examined in the present group of studies will provide some insight to apply to the female weightlifter. Training techniques should focus on producing greater vertical barbell velocity. This may allow the lifter to move under the bar with minimal vertical barbell drop and decrease the drop-under time. This study found small differences between the selected variables for the female and male weightlifter. However, further study is warranted to examine why these differences are present. Understanding these and the many other aspects of the Olympic lifts will help both the coach and the athlete to optimize performance.

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