Biomechanical description of the clean and jerk style of an elite Albanian weightlifter

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Abstract

Olympic Weightlifting is the number one sport in Albania considering the numerous medals won in international events, such as the European and World Championships; however, we do not have a biomechanical model of technique performance of our elite lifters. Thus, the objective of this study was biomechanical description of the clean and jerk style, during performance of the elite athlete (EQ), the champion of 77 kg (Body mass) in last European Weightlifting Championships (2014). He was observed during his performance in clean and jerk style, just one month before the event with 194 kg. Three digital cameras were used, and the recorded material was processed by the System for Biomechanical Analysis (Ariel Performance Analysis System - APAS). Among the others we found the trajectory of the barbell, the vertical velocity of the barbell and displacement of the barbell. These results showed that the vertical displacement of the barbell during the first phase (F1) was 103.63 cm, the maximal velocity, which was attained during the second pull was 1.61 m/s, the time from the starting position until the barbell on the chest in the squat position was 0.8 sec, the dip before the jerk (F6) was 14.6 cm, the velocity of the barbell – 0.53 m/s. The results revealed that in the category of 77 kg body mass for men, the Albanian weightlifters have the same biomechanical parameters as the best lifters in the world. These findings can help weightlifting coaches to use these data as a model for other lifters. This study is limited to the analysis of the biomechanical parameters only to 75 % of his best results (194 kg, gold medal in European Weightlifting Championship - 2014).

Key Words*: Olympic Weightlifting, Clean and Jerk, Velocity, Displacement.*

Introduction

The Olympic Weightlifting sport today is widely used not only in competitions, but in fitness and other sports (Chiu, 2007). Both muscular strength and optimal techniques are important determinants to reach high performance in weightlifting. The weightlifting coaches claim that the winner belongs to the one with the best technique during a competition of the same

strength. Other studies have examined the kinematic and kinetic parameters of weightlifting exercises (Hakkinen et.al, 1984; Escamilla and Garhammer, 2000). Different weightlifting technique changes have occurred over the years. The prevailing theory, more than 60 years ago, was based on the idea that the shortest pathway is a straight line. Thus, the vertical displacement of the barbell, from the starting position, the pull, and until moving under the barbell to catch it and place the bar on the chest, was a straight line. This theory was modified over the years, thanks to the biomechanical analyses, to improve the weightlifting technique, and another trajectory in S shape was applied from the Russian weightlifters. The natural alignment of different parts of the body were the prerequisites for these changes, for example, the knees position in the start and in front of the bar are over, and the straight pull in these conditions is impossible (Carr, 2004). Therefore, the lifter has to free the vertical path for the bar, raising the hips as the bar is close to knee level. When the bar passes the knee, which is the most delicate phase, the lifter performs the so called double knee bend, which is a natural reflex, such as when somebody jumps upward. Hence, just before the second pull, the position of the knees is about 10-20 degree downward. This is the first part of trajectory of the bar, which surpasses the vertical line. Of course, these updated techniques were applied by other lifters of the world, including Albanian lifters. In addition to the trajectory of the bar, other elements are important, such as the vertical and horizontal displacement of the bar, the velocity of the barbell and different angular joint displacement. The importance of the optimal technique performance in the Olympic Weightlifting results is well documented in many studies.

Methods

The elite Albanian weightlifter (E.Q., body weight 81.5 kg, height 169 cm), performed the lift in Clean and Jerk Style with 75 % of his maximal result. This study is an analysis performed during the performance in Clean and Jerk Style of the best lifter of Albania (E.Q. - European Champion - 2014), just a month before the event with 194 kg. was performed. The main goal was to determine some kinematic parameters. Three digital cameras were used, and the recorded material was processed by the System for Biomechanical Analysis (Ariel Performance Analysis System - APAS). The measurement included the vertical displacement of the barbell, the linear velocity, and the time for each phase performance. Among others is found the trajectory of the barbell.

Results and Discussion

Table 1 shows the values of the vertical displacement of the barbell (VDB), the maximal velocity of upward and downward movement of the barbell (MVMB), and the time for each phase performance (TEPP).

The characteristics of the barbell movement in clean and jerk style				
Phases of the lift	**Movement**	**VDB (cm)**	**MVMB (m/sec)**	**TEPP (sec)**
F1	The Clean	103,63	1,61	0,8
F2	Catch in squat position	27,79	-0,95*	0,46

F3	Standing from squat	66,6	0,99	0,99
F4	Gravity	9,08	-0,41*	0,35
F5	Stabilization	2,81	0	1,47
F6	Dip of the knees	14,6	-0,53*	0,4
F7	Jerk	49,91	1,36	0,7
F8	Final position	18,13	0,39	1,21

Table Notes:
*Vertical negative displacement of the barbell (downhill)
Table 1. The characteristics of the barbell movement in clean and jerk style

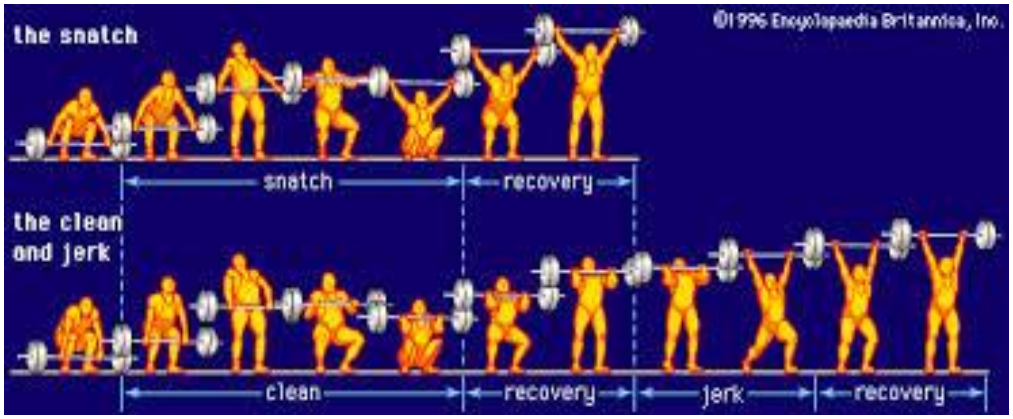


Figure 1. Position of the bar during phases

The analysis of the movement (Figure 1) shows that, during the clean phase (2-4), the bar trajectory is very close to the vertical line. This is due to the strong quadriceps muscles involved in the first pull (take off). The highest point at the end of explosive extension (3), correspond to the highest velocity of the barbell (1,61 m/sec). Shortly after this point, the gravity force pulls the barbell downward in 27.79 cm (4-5), because during this very short moment (0.48 sec), the lifter is without support (jumping phase). Hence, the lifter catches the barbell in half squat position (5), and with the barbell loaded on his chest the lifter stands up (5-7) for 66.6 cm, for less than 1 sec. In the recovery phase (6-7), the barbell has a low negative velocity (- 0.41 m/sec) because of the stabilization movement of the lifter. With the barbell on his chest (8) over clavicle and front deltoid, the lifter deeps his knee in an attempt to execute the final movement, the jerk (9). The jerk movement is in the best optimal condition. The shin is almost vertical to ground (see Fig. 1), and the knee of behind leg is in optimal angle. The recovery phase corresponds to the position 10.

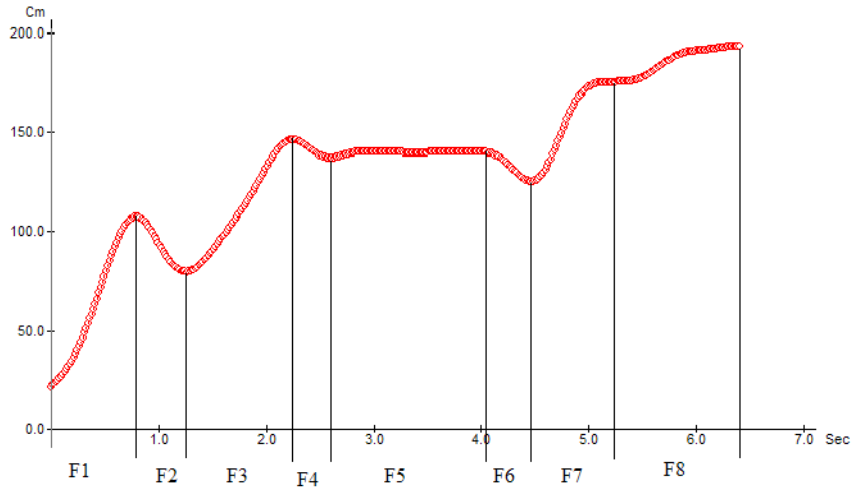
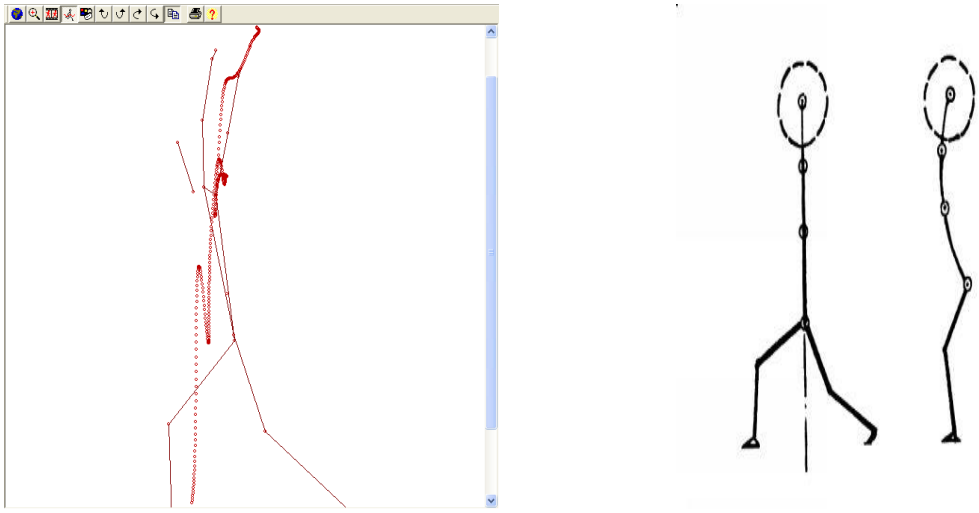


Figure 2. Phases of the lift and time of technique execution

The barbell begin to move upward in a liftoff phase (start of F1). The distance 25 cm corresponds with the vertical distance from the bar to the platform. The most complicated element from the weightlifting coaches is the so called the double knee bend, which corresponds to F2, and reflects negative vertical displacement of the barbell due to gravitational forces (Garhammer, 2001). It is precisely this double knee bend where the lifter takes advantage to finish the most important phase, the explosive pull or second pull (F3). At the end of F3, the trajectory of the barbell gets down again, and at this moment, the lifter moves under the bar. Now, it is the moment when the lifter prepares to push up the barbell and at this phase the bar is on the clavicula of the lifter. At the end of F5, the lifter dips his knee in an attempt to perform the jerk (F7). During phase (F6) it is noticed the negative vertical displacement (14,6 cm), and the negative (downhill) velocity of the barbell (-0,53 m/sec). Immediately afterwards, at the end of F6, the lifter pushes the barbell up with the vertical displacement (49.91 cm) with 1.36 m/s.

The optimal jerk technique model of the best lifters in the world (Figure 3) is very important for the lifter to feel in the vertical line, the hand, the elbows, the shoulder and ilio femoral joints. Some lifters fail in this style for a slight mistake, where the center of gravity of the barbell does not fit the COG of the lifter body. In addition, the placement of the feet is of great concern. The right (or left foot should be in the position where the shin is vertical to the platform, and the behind leg (left or right) should be very little bend (Kipp et al., 2011). In some cases, where the bend is more than optimal, the lifters fail to stand with the barbell upward, while in the case where the leg is straight, the chances are the barbell will drop forward.



a) b)

Figure 3. a). The trajectory of the barbell of an elite Albanian weightlifter, b). The optimal model of jerk technique by the best lifters in the world

Conclusion

The biomechanical parameters of clean and jerk lift of this elite lifter were similar with those of best in the world. The Maximum Velocity during the pull (1.61 m/sec) was lower in clean than the best lifter of the Olympic Games (1.72 m/sec). The change of velocity of the barbell in different phases of the lift is caused by different factors, such as the strength exerted, the length of the limbs. It is in the interest of the lifter not to use extra energy during the lifts. Thus, the concept, such as the attempts to minimize the loss of energy is to minimize the use of energy that is not related to performance. In clean performance the lifter should not execute an unnecessary movement. The results of this study are with the alignment of recent literature concerning the importance of power output during the explosive phase of the clean, where the forces applied from the lifter on the barbell are quite large, but only for a brief moment. The application of this phase movement is crucial not only in Olympic weightlifting, but in other sports as well, because of the so called triple extension that occurs (ankle, knee and hip joint) regarding the biomechanical parameters of optimal level in clean and jerk (Waller et al., 2007). Identifying these generic characteristics may help coaches in training weightlifters to overcome shortcomings in their performance (Carr, 2004).

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