Weightlifting elite's power snatch technique

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Abstract

Objective of the study was to analyze and improve the power snatch techniques applied by the modern elite weightlifters.

Methods and structure of the study. Special studies at Moscow State Academy of Physical Culture in 2010-2020 showed that the modern elite weightlifter's power snatch technique excellence research and the relevant individual progress recommendations need to be based on analyses of the individual weightlifting technique micro-structuring studies – that require modern expertise and technologies. Since 2006 our research team has analyzed sports techniques using a high-speed video capturing toolkit, analysis of the reference literature, mathematical modeling tools, digital filters and modern software packages Matlab, Tema, MaxTraq, etc. The study was designed to: (1) Analyze the relevant theoretical and practical literature; (2) Make high-speed video captures (by a single of few cameras including the synchronized ones) to analyze some 100-plus snatches in the elite weightlifting trainings and top-ranking competitions including the World and European championships; (3) Select the most informative execution elements and indices; (4) Analyze the power snatch technique biomechanics; (5) Describe the best power snatch technique of the elite weightlifters; and (6) Come up with practical power snatch technique improvement recommendations.

Results and conclusion. Our power snatch technique phasing analysis showed benefits of the following execution sequence for the weightlifting elite: toes-standing in the acceleration phase with a powerful push on the weight. We would also recommend a focused training of the aerial phase in the power snatch technique with a special attention to the arms straightening in the elbow and shoulder joints.

Keywords: *power snatch biomechanics, mathematical modeling.*

Background. As things now stand in the weightlifting sport, specialist training programs for the coaches, athletes and researchers are governed by the studies dated back to the 1970-80s and largely irrelevant and outdated. Efforts to advance the specialist training service show a growing demand for modern expertise and technologies. Since 2006 our research team has analyzed different sports techniques using a high-speed video capturing toolkit, analyses of the reference literature, mathematical modeling tools, digital filters and modern software packages Matlab, Tema, MaxTraq, etc.

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Results and discussion. We made an analysis of the snatch phases and microstructure with a special priority to the key technical elements with the relevant execution indices (approach; beginning with an emphasis on tips; dip-under; final acceleration startup phase with top speed of the barbell butt; and computed the snatch spacing, timing (spatial-temporal indices), kinematics and dynamics.

It is traditional for the weightlifting research community to apply the notion of movement phase structure. We made herein a detailed power snatch technique phasing analysis with a national elite weightlifter I sampled for the study. His 170kg weight power snatch technique was video captured by a single lateral camera at 250 fps to analyze the following movement phase structure.

Phase I: approach moves, with the athlete handling the weight till the takeoff moment.

Phase II: pre-acceleration moves from the takeoff moment to the full extension of the knee joints taking 0.444 s. The pre-acceleration phase includes microphase 1 from the full extension of the knee joint to the knee joint flexion startup taking 0.024s on average.

Phase III: shock absorption moves from the knee joints flexion startup to knee joints flexion taking 0.15 s; with microphase 2 (transition from shock absorption to final acceleration i.e. from the flexion startup to the knee joints extension startup taking 0.008s). Catch is the moment at the shock absorption end and final acceleration startup when the horizontal speed of the barbell butt equals zero (see Figure 3) taking 0.094s in the case.

Phase IV: final acceleration from the knee joints extension start to finish taking 0.15s; with microphase 3 that (a transition from final acceleration to squat 1 i.e. from the extension finish to the knee joints flexion startup) taking 0.012s.

Phase V: squat 1 from the knee joints flexion start to the second heel takeoff moment, with the front foot mov, taking 0.06s.

Phase VI: aerial move from the second heel takeoff/ front foot move to the first heel contact with the ground (front foot move stoppage) taking 0.13s.

Phase VII: squat 2 from the first heel contact with the ground (front foot move stoppage) to the weight fixed in the squat, taking 0.30s.

Figure 1-3 shows the power snatch technique pacing, timing, kinematics and dynamics [1], with the points marking the above phases and acceleration moments as follows: point 1 is the takeoff moment; point 2 is the shock absorption startup; point 3 is the final acceleration startup; point 4 is squat 1 startup; point 5 is the aerial phase startup; point 6 is the squat 2 startup; and point 7 is the weight stop moment. Points O1 and O3 mark the acceleration startup and finish; and point O2 is the maximal horizontal speed of the barbell butt.

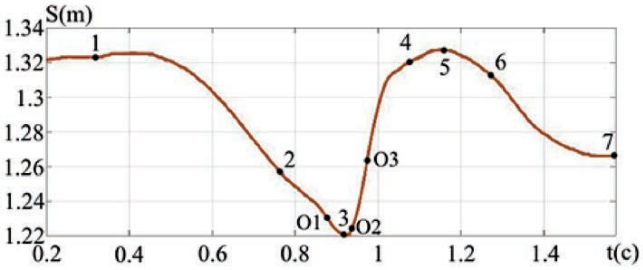

Figure 1. *Horizontal speed of the barbell butt*

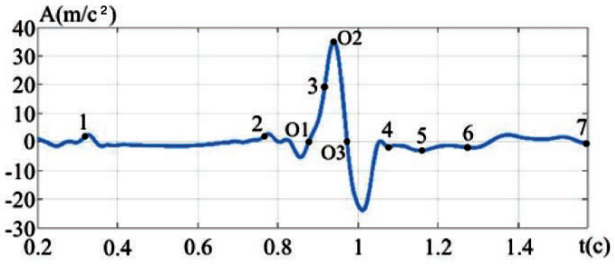

Figure 2. *Horizontal acceleration the barbell butt*

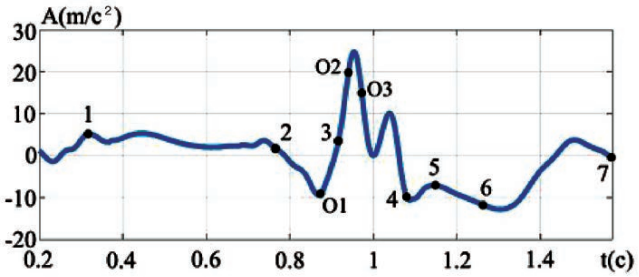

Figure 3. *Vertical acceleration the barbell butt*

Let's now consider the power snatch technique elements still underexplored, as we believe, by the theoretical and practical study reports. Note that the knee joints height in the heel takeoff phase is higher than when this element is executed with a full-foot contact. In the toes-standing technique the knee joints angle is

1. Acceleration startup point

2. Maximal horizontal speed of the barbell butt in the acceleration sequence

3. Acceleration finishing point

Figure 4. *Snapshots of the acceleration sequence*

lower than in the full-foot contact technique. Minimal vertical acceleration of the barbell butt was 9.2 m/ s2 in shock absorption phase – indicative of the eased athlete's action on the barbell and, hence, faster knee and ankle joint flexion, with the shock absorption stage taking 0.15s. The athlete's executes acceleration (final acceleration) on the toes with a high amplitude and power and vertical acceleration coming to 24.8 m/s2, and with the ankle joint used to lever forces. Note that the toe-standing acceleration phase requires the foot extensors being strongly trained.

Figure 4 analyzes the weight acceleration element. In the shock absorption and final acceleration the athlete pulls the barbell to the groin level (Fig. 1). This is the point where the weight acceleration starts with the legs extended in the knee joints, ankle joint and hip joints, and the back straightened. The ankle joint would develop maximal vertical (t= 0.95, a= 24.8 m/s2, Fig. 3) and horizontal (t=0.94, a= 36.5 m/s2, Fig. 2) forces acting on the weight (Fig. 4, snapshot 2) [2]. The athlete-weight system energy would grow, with the athlete's body moved backwards to shift the weight forward to a degree and develop an extra force acting upward, with the vertical component of this force pushing the weight up.

The strength variation and energy rating method are described in study [3]. Strength of the weight contact with the hips was estimated at 390 kg, with the extra energy in the acceleration phase making 15% of the total athlete-weight system energy.

Aerial phase: One of the key goals of the power snatch technique is to extend the arms in the shoulder and elbow joints in coordination with the knee and hip joints flexion. It should be noted that the aerial phase time depends on the vertical speed of the weight – that was estimated at 0.13s in this case. When the athlete fails to fully extend the arms at the end of the aerial phase, he would try an extra push or lose the attempt.

Conclusion. Our power snatch technique phasing analysis showed benefits of the following execution sequence for the weightlifting elite: toes-standing in the acceleration phase with a powerful push on the weight. We would also recommend a focused training of the aerial phase in the power snatch technique with a special attention to the arms straightening in the elbow and shoulder joints.

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