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The Full Snatch

A closer look at the mechanics and technique of the fastest lift in the world.

By Zachary Long July 2014

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The snatch is simply lifting a barbell from the floor to overhead in one quick motion. However, this basic description barely begins to explain the complexity of the lift. The snatch requires a combination of strength, coordination, explosiveness, mobility and stability not seen in any other exercise.

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The snatch requires high levels of skill and meticulous practice to perfect its execution, and when an athlete learns to perform the lift properly, it is unparalleled in its ability to build explosive power that translates to athletic performance.

Fortunately for those looking to perfect their snatch technique, researchers have studied the lift extensively, and an examination of the research on the biomechanics of elite Olympic weightlifters can provide insight into the exercise. By reviewing available research, we can determine proper snatch technique and illustrate how it will improve your performance, then explain how one can evaluate technique at home or in the gym.

Starting Position

A proper starting position is essential to performing a snatch with efficiency. While the starting position varies due to each individual's anatomy, there are several general rules of thumb for the setup.

First, the feet are positioned in a "jumping stance," with the feet about as wide as the hips. This is typically the width of stance an athlete would assume if told to perform a max-effort vertical jump. The bar should be positioned over the metatarsal bones, and the feet should be pointed forward or rotated out slightly, with individual variances due to the athlete's height, proportions and mobility. A neutral or slightly arched back with chest up and scapulae retracted is important to reduce risk of injury and increase transfer of power from body to bar. The hips will often be higher than the knees, but an athlete's proportions will dictate exact placement, and some athletes are able to assume start positions with the hips even with or lower than the knees. The shoulders should be positioned directly above or slightly in front of the barbell.

A simple test to determine approximate grip width can be performed by having the athlete abduct one arm to 90 degrees while making a fist and measure the distance from the fist to the opposite deltoid. Other methods involve adjusting grip width to place the bar just below the hips when the lifter is standing tall. All methods should take into account an athlete's mobility and comfort.

The Lift

The research on the snatch breaks the lift up into six phases based primarily on angle of the knee joint. Joint angles of the hips, knees and ankles can be seen in Figure 1.

Starting the snatch with correct positioning is crucial to proper execution of the lift.

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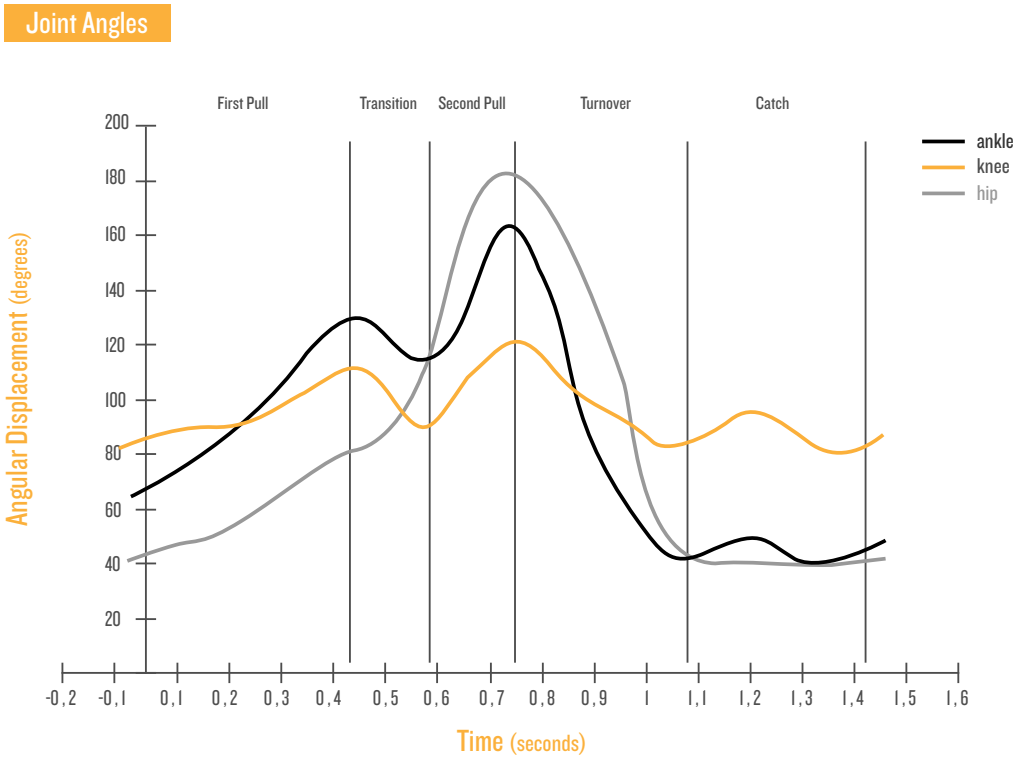

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Figure 1: An example of hip, knee and ankle angles during the snatch.

The first pull begins with the barbell at rest on the ground and ends when the knees reach their first maximum extension. During this phase, the knees and hips extend and the ankles plantarflex, but the entire foot remains in contact with the ground. The trunk is also held at a relatively constant angle in relation to the ground. Maintaining this trunk angle is very important for the efficient transfer of force in later phases (2,9).

The transition phase, also known as the "double knee bend," follows the first pull. During this phase, the knees are flexed and pushed toward the barbell. The knees flex about 20 degrees and this phase ends at maximum knee flexion (2). This bending of the knees allows the body to use elastic energy and the stretch reflexes of the knee extensors to develop explosive muscular power. It also positions the body better for the powerful second pull (9).

The second pull is the most explosive and powerful phase of the snatch. It begins when the knees reach maximum flexion during the transition phase. During the second-pull phase, the hips, knees and ankles are all violently extended. The plantarflexion of the ankles results in the heels rising off the ground (2). The end position of this phase is known as "triple extension" as the hips, knees and ankles all approach their maximum extension range of motion.

The turnover phase begins at maximum knee extension and ends when the barbell reaches its maximum height. The lifter begins moving the body downward to be positioned underneath the barbell. The feet leave the ground and jump outward to a receiving or squatting stance, often about shoulder width. The feet then re-establish full contact with the ground before the start of the catch phase. The catch is performed by locking the arms and stabilizing the barbell overhead while slowing its downward movement. Following the catch, the lifter rises from the squat position to stand fully erect at the completion of the lift (2,9).

Shoulder and Elbow Motion During the Snatch

From liftoff until the start of the second pull, the shoulders are extended as the barbell is pulled toward the lifter. During the second pull and turnover, the shoulders are


The angle of the trunk in relation to the ground should remain relatively constant during the first pull.

quickly flexed to position the body to support the barbell overhead (14). During this period, a violent shrug of the shoulders and pull with the arms must occur. This allows for continued elevation of the barbell as the lifter jumps under the bar (2). It should be noted that debate exists regarding the effect of the shrug and pull. Some believe the pull to be able to lengthen the barbell's upward path while others believe its purpose is to pull the athlete under the bar (13). The elbows are flexed to approximately 100 degrees as the weight is raised, and then they are straightened completely for the remainder of the lift. During the catch and rise, shoulder mobility is tested as the shoulders are flexed to greater than 180 degrees (7,14).

Joint Velocities

Knee-extension velocity is significantly greater than velocity of the hips during the first pull, and the hip-extension velocity is greater than knee velocity during the second pull (1). The joint velocities of the hips, knees and ankles are significantly higher during the second pull than they are during the first pull. The faster joint movements during the second pull are the reason the second pull is the most explosive of the phases.

One sometimes-debated aspect of the snatch is the plantarflexion of the ankles during the second pull. While most believe in extending the ankles, some coaches emphasize keeping the foot flat rather than rising onto the toes. They believe rising on the toes increases the distance the athlete must then drop to get under the barbell. Research by Gourgoulis et al. suggests that plantarflexion of the ankles is important as it contributes to 10 percent of the barbell's maximum velocity (9).

Barbell Vertical Velocity

During the first and second pulls, the barbell has a positive vertical velocity (Figure 2). By the end of the first pull, the barbell should reach approximately 70 percent of its maximum vertical velocity (3). A continuous increase in barbell velocity during the transition phase is indicative of effective technique. A noticeable dip in the velocity is said to be due to ineffective technique possibly caused by fatigue or too fast of a starting movement. During the turnover, the barbell's velocity becomes negative as gravity pulls it downward. It is critical the turnover occurs quickly to minimize this

At the end of the second pull, the lifter aggressively pulls under the bar—the third pull—and locks it overhead.

negative velocity so the barbell doesn't have to be lifted further than necessary (2).

Barbell Trajectory

Several studies and books have been written addressing the trajectory of the barbell at various stages of the lift when looking at the snatch from the side. These studies examined the movement of the barbell in relation to a vertical line drawn up from the barbell's starting position.

During the first pull and the transition phase, the barbell moves away from this vertical line and closer to the lifter. The barbell then moves towards, and sometimes beyond, this vertical reference line during the second pull (12). Researches have not come to a definitive conclusion on how much horizontal displacement of the bar is considered optimal technique (2,12). Regardless of where the bar travels in relationship to this vertical line, it is imperative that the lifter keeps the barbell close to the body throughout the lift.

Examining maximum height and the height of the bar during the catch is one of the easier ways to assess lifting technique. Minimizing the difference between these two variables is important to an efficient lift (1). In elite weightlifters, maximum barbell height during max attempts is around 70 percent of the lifter's height (3,9). The distance the bar drops from its maximum height to the catch has been reported to be approximately 11 percent of the barbell's maximum height. Larger drop distances indicate inefficient technique because the barbell was lifted higher than needed for the lifter to jump under the barbell to receive it (9).

Why Snatch?

The complexity of this lift alone is not enough to justify its use in training for athletic performance. Extensive research on the effects of Olympic lifting provides evidence for its ability to improve athletic performance and suggests it has many advantages over other forms of training.

A few studies have examined the similarities between the snatch and vertical jump. In a study comparing forces exerted during the hang snatch and vertical jump, researchers found similar values for both maximum and time-to-maximum force and power. Based on these findings, they concluded Olympic lifting might improve coordination between muscles, power and the ability to rapidly generate force (4). Carlock et al. confirmed these findings by finding that maximum power values during a vertical jump were strongly associated with abilities of elite Olympic-lifting competitors. This provides further evidence for the use of Olympic lifting, as peak power production is crucial for success in explosive movements such as sprinting and jumping (5). Ground-reaction forces during vertical jumps and snatches have also been shown to be similar, further suggesting the snatch's effectiveness in training to improve this variable (8).

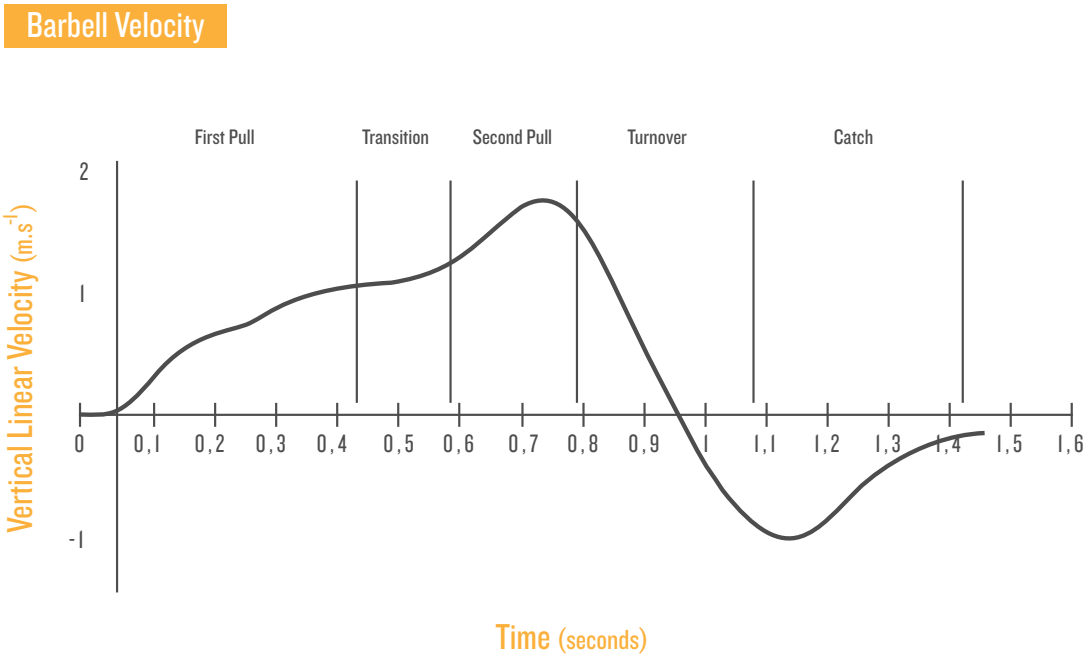

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Figure 2: Typical barbell velocity during the snatch.

Studies have compared Olympic-lifting-based exercise routines to powerlifting regimens. In Division III college football players, athletes performing both types of routines saw significant increases in their 1-rep-max squats. Those performing an Olympic-lifting-based routine saw much greater improvements in their vertical jump compared to those who did not perform Olympic lifting (10)..

Research by Channell and Barfield also suggests Olympic lifting may provide some advantage over powerlifting for improving vertical jump (6). Differences in strength and power were compared between national-level competitors in Olympic lifting and powerlifting. Both groups had similar squat strength, but during vertical-jump testing with varying loads, the Olympic lifters had higher peak force, peak velocity, peak power and jump height. The authors concluded Olympic lifting seems to provide an advantage for utilizing high forces at fast speeds because this is required in many athletic maneuvers (11).

Using This Research to Improve Your Snatch

All of this research means nothing if it does not translate to improved performance at the gym and athletics. While some of the variables that have been discussed would require expensive equipment to examine your own technique, others can easily be assessed using various smartphone, tablet and computer applications.

The place to begin when analyzing your own technique is the starting position. From a side view, examine back positioning, shoulder location in relationship to the barbell, and hip vs. knee height. Common errors in the setup include the shoulders being behind the barbell, starting with the shins against the bar as if performing a deadlift, and hips being set too low relative to the lifter's anatomy. From the front, assess your stance width and foot angle.

During the first pull, watch to see if the angle of the trunk in relation to the ground remains relatively constant and that the spine remains in a neutral position. Oftentimes, lifters will shoot the hips up too fast, raise the torso too high, or round the back. These will lead to inefficiency during the powerful second pull.

During the second pull, watch for plantarflexion of the ankles as you finish the pull to ensure you are not losing barbell velocity. Also ensure the hips and knees are both fully extended and then that the shoulders are aggressively shrugged. Frequently, inexperienced lifters will not reach full hip and knee extension and begin pulling with their arms early, severely limiting the amount of power

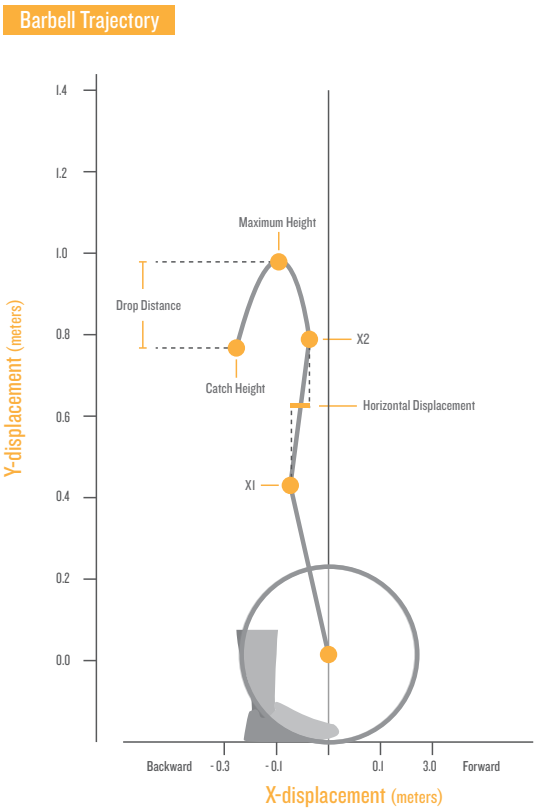

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Figure 3: Trajectory of the barbell during the snatch.

Research has shown Olympic-lifting programs to be effective for improving vertical jumping ability. Note the extension of the hips, knees and ankles at the end of a vertical jump is similar to that seen in the snatch.

they generate. Many times they will also not pull with the elbows high and back, instead allowing their arms and the barbell to drift away from the body.

To assess barbell trajectory, video your snatch from the side and draw a vertical line up from the barbell's starting position. During the first pull and transition phase, the barbell should be pulled toward the lifter and away from the vertical line. This helps keeps the barbell properly positioned in relation to the lifter's center of gravity. In the second pull, the barbell will be closer to the line, but despite this forward movement, the barbell should be kept close to the body. Finally, the barbell trajectory should hook at the top of the lift (see Figure 3), which moves the barbell directly over the lifter. This prevents the athlete from having to jump forward to catch the weight, which would frequently result in missed lifts.

Finally, maximum barbell height and the drop distance during the catch phase should be measured if performing the full snatch. If the barbell is lifted too high, then the athlete could have lifted a heavier weight and not pulled as high. If the drop distance is excessively great, then the lifter is forced to move the weight further than is needed. Inexperienced Olympic lifters often pull higher than necessary and overemphasize the drop under the bar by squatting to low depths. This results in a crashing of the barbell as the lifter catches it. Instead, focus must be put on quickly moving under the barbell, thus minimizing its downward velocity.

In conclusion, an examination of the snatch technique of elite weightlifters can provide insight into this lift and tips on how to improve your own form. The combination of strength, speed, and coordination required of this lift make it one of the best exercises available for improving athletic performance. The references on Page 10 are a great starting point for any athlete or coach who is looking for greater understanding of this complex lift.

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An athlete's exact proportions will determine the optimal start position.

As the bar leaves the floor, the back remains in extension.

As the bar passes the knees, the hips start to open and the chest rises more quickly.

The knees side under the bar as the athlete prepares for triple extension.

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At the end of the second pull, the ankles, knees and hips are extended.

A split second after the athlete hits full extension, he or she begins to pull under the bar.

Meeting the bar minimizes the distance it drops and helps the athlete increase stability.

The athlete stabilizes the bar in the squat before standing to complete the lift.

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About the Author:

Zach Long is a physical therapist and strength-and-conditioning coach in Monroe, North Carolina. He attended the University of North Carolina at Chapel Hill, where he majored in exercise and sport science, and East Carolina University, where he received his doctorate in physical therapy. Long's research related to physical therapy and athletic rehabilitation has been presented at multiple state and national conferences. He currently runs www.activePTblog.com and trains at CrossFit MNC.