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Snatch Technique of Collegiate National Level Weightlifters

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ABSTRACT

Bar trajectory during weightlifting movements is related to the position of the body during the lift and the displacement of the feet during the drop-under phase. The purpose of this study was to examine anterior-posterior foot displacement and its relationship with performance in the snatch of collegiate weightlifters. Snatch attempts of men weightlifters from the 1998 U.S.A. Weightlifting Collegiate National Championships were analyzed for horizontal displacement of the feet by video analysis. Lifts were analyzed under 2 conditions: all lifts combined and the heaviest successful attempt for each lifter. Lifts ($n = 74$) were placed into 4 groups: forward displacement (FD, >2.5 cm); no displacement (ND, ±2.5 cm); rearward displacement (RD, >2.5 cm); and those that showed asymmetric (AS, >7 cm difference in right and left foot) displacement of the feet. Chi-square revealed no significant difference in success rate between groups for all attempts. No statistically significant differences were noted between groups in body mass to bar mass ratio or Sinclair formula for heaviest successful attempts. Results indicate that foot displacement did not significantly affect snatch success or lifting ability in collegiate national level lifters.

Key Words: Sinclair score, drop-under, bar trajectory

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Introduction

The snatch is one of the 2 lifts contested in the sport of weightlifting. The snatch consists of pulling the bar from the floor to the overhead position in 6 phases: the start position before liftoff, the first pull, transition, second pull, the catch position and the recovery (7). The position of the body during the snatch affects both the path that the bar takes during the lift and the subsequent displacement of the feet as the lifter drops under the bar into the catch position.

Three main types of bar trajectories were proposed by Vorobyev (15), shown in Figure 1. The trajectory resembling path A and its variants have been touted as correct by previous authors (5, 8, 15, 16). But Hiskia (6) demonstrated that only 8.5% of elite male lifters exhibit this trajectory. The trajectory closely resembling type B and its variants has been regarded as irrational (15). Type-B trajectories are characterized by not intersecting the vertical reference line after liftoff. The type-B trajectory results in rearward displacement of the lifter in the drop-under phase to catch the bar (2, 3, 13), although lifter displacement has not been investigated to the same degree as bar path. Vorobyev (15) associates type-B trajectories with a technique flaw, primarily the movement of the shoulders behind the bar prematurely. It is argued that the shoulders move behind the bar too soon in the second pull, and that the strongest and largest muscles are not used to the best of their ability (15). Barton (1) has also called this type of motion ''dangerous'' for the success of the snatch.

But one pulling method that can be used resulting in type-B trajectories is accomplished by shifting the foot's center of pressure toward the heel at liftoff and staying flat footed as long as possible, then beginning the second pull with hips over or behind the ankles (13). This point is not addressed in Vorobyev's (15) description. Moreover, Stone et al. (13) described this technique as possibly advantageous because a greater portion of the force production during the pull would be directed vertically.

With the center of gravity moving rearward during the first pull, the barbell can move (sometimes considerably) toward the lifter (3). Keeping the center of gravity back during the second pull can result in a backward lean to the body (13) and could cause type-B trajectories. This type of trajectory has often been observed in international level weightlifters. For example, Isaka et al. (7) found that the bar trajectories of all but one of the winners from the 77–108+ kg class at the 1993 Japan International Friendship Tournament

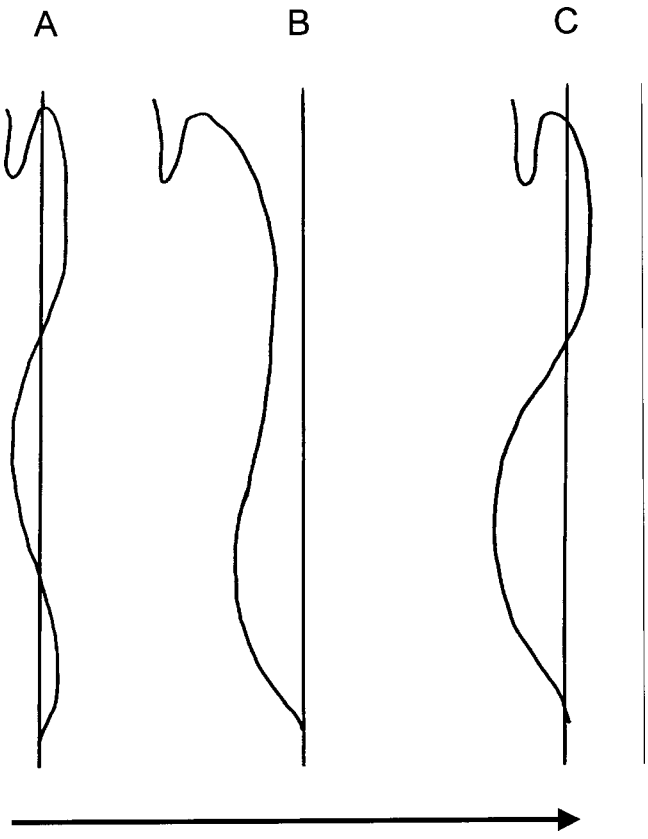

Figure 1. Proposed variations in bar trajectory.

did not cross the vertical reference line that is determined by the position of the barbell at liftoff, suggesting a type-B trajectory.

Observations of elite Olympic weightlifters indicate that many of these lifters display a backward displacement of the feet during the drop-under phase. This is because when the bar takes on the trajectory closely resembling type B, it requires the lifter to displace the feet backward to bring the center of gravity under the barbell during the drop-under phase (2, 3, 13). From a coaching perspective, this foot movement is contrary to how Medvedyev (9) and Takano (14) describe the drop-under phase. Garhammer (4) examined the snatch at the 1984 Olympic Games and found that large positive (toward lifter) values for the horizontal distance from the bar to the vertical reference line during the final decent necessitates a jump backward during the drop-under to catch the barbell. The bar trajectories analyzed by Isaka et al. (7) suggest that most of these lifters move the feet rearward during the drop-under phase. The degree that the barbell and the feet travel rearward varies considerably. Roman and Shakirzyanov (11) demonstrated rearward displacement of the feet ranging from 10 to 18 cm in elite lifters.

Type-B trajectories (and rearward displacement of the feet) have been demonstrated by many successful weightlifters, including 3 of the ten 1996 Olympic champions in the snatch, one of which is 3-time Olympic Gold medallist Naim Suleymanoglu (10). These 3 won gold medals in the 3 lightest weight classes. Hiskia (1997) demonstrated type-B barbell trajectories in many of the medallists at the 1996 Olympic Games: H. Mutlu (54 kg), N. Peshalov (59 kg), T. Ningsheng (59 kg), P. Lara (76 kg), M. Huster (82.5 kg), A. Petrov (91 kg), and T. Tiamazov (108+ kg).

Stone et al. (13) suggested that no single variable could explain success or failure in the snatch, thus weightlifting success is a multifactorial phenomena. The many variables that effect bar trajectory and foot displacement leave many unanswered questions concerning snatch technique.

Methods

Experimental Approach to the Problem

That successful lifters show variations of supposedly ''inefficient'' technique demands more research into bar path analysis and horizontal displacement of the feet. These 2 variables may be very closely linked and they also may affect performance. The purpose of this study was to quantify foot displacement in American collegiate level weightlifters and examine its relationship with lift performance.

Subjects

Subjects included 25 men participants in 7 weight classes (62, 69, 77, 85, 94, 105, and 105+ kg) at the U.S.A. Weightlifting 1998 National Collegiate Weightlifting Championships. All participants gave informed consent for use of their video image as approved by the University of Memphis Institutional Review Board, and all lifters were required to lift a qualifying total for their weight class and show proof of enrollment at a university to enter the competition. Subject body mass was ($X \pm SD$) 85.96 ± 19.0 kg. All trials were recorded on October 10, 1998.

Experimental Methods

Seventy-four snatch trials were video taped with a Panasonic video camera model AG-450 placed 2.14 m from the lifting platform, perpendicular to the saggital plane. Lens height was 0.76 m from the competition surface. Sampling frequency was 60 Hz and shutter speed was set at 1/250 s with the camera manually focused by visual means. The barbell plate diameter (0.45 m) was used as the reference scale. The right and left toes were digitized manually at the end of the second pull (moment the bar stops accelerating) and immediately before the recovery (return to standing position) using the Peak 5 video analysis system (Englewood, CO). Both video frames were determined visually by the investigators.

Statistical Analyses

Using the video, all lifts were classified into 4 groups on the basis of the average displacement of the right

Table 1. (M ± *SD*) Descriptive and heaviest successful attempt data.

Group	Body mass (kg)	Lifter height (m)	Sinclair score	Bar mass/Body mass
FD (n = 7)	73.5 ± 9.8	1.68 ± 0.1	116.8 ± 18.1	1.27 ± 0.2
ND (n = 6)	81.9 ± 11.8	1.7 ± 0.1	120.6 ± 23.4	1.26 ± 0.3
RD (n = 7)	92.6 ± 12.8	1.78 ± 0.1*	125.3 ± 30.5	1.24 ± 0.3
AS (n = 4)	111.6 ± 25.9†	1.83 ± 0.1†‡	109.0 ± 16.4	0.94 ± 0.1

* RD significantly greater than FD ($p \leq 0.05$).
† AS significantly greater than FD ($p \leq 0.01$).
‡ AS significantly greater than ND ($p \leq 0.05$).
FD = forward displacement; ND = no displacement; RD = rearward displacement; AS = asymmetric displacement.

Table 2. (M ± *SD*) All attempts.

Group	Success rate (%)
FD (n = 17)	58.8
ND (n = 17)	64.7
RD (n = 24)	66.7
AS (n = 16)	37.5

FD = forward displacement; ND = no displacement; RD = rearward displacement; AS = asymmetric displacement.

and left foot: forward displacement (>2.5 cm) of the feet during the drop-under phase (FD), no horizontal displacement (±2.5 cm) of the feet during the drop-under phase (ND), rearward displacement (>2.5 cm) during the period of time when the lifter moves under the bar (RD), and asymmetrical foot displacement (>7.0 cm difference between right and left feet; AS). The heaviest successful lift for each lifter was also grouped in the same manner.

Analysis of variance ($p \leq 0.05$) was used to examine the differences between groups taking in all lifts and also the heaviest successful lift for the following variables: average displacement, body mass to bar mass ratio, weight class, Sinclair score (a method of comparing performance of weightlifters in different weight classes), weight lifted, and body mass. Tukey's post hoc was used to examine significant differences between groups. Chi-square was used to examine successful snatch frequency between the different groups.

Results

Subject characteristics are shown in Table 1. Forty-four of 74 attempts sampled were successful. Results are shown in Table 2. No significant differences were noted in Sinclair score, success rate and body mass/bar weight. Success rate for the 4 groups were 58.8 (n = 17), 64.7 (n = 17), 66.7 (n = 24), and 37.5% (n = 16), respectively. When examining the heaviest successful attempts (n = 24), RD had the highest Sinclair score (125.3 ± 30.5, n = 7), followed by ND (120.6 ± 23.4, n = 6), FD (116.8 ± 18.1, n = 7), and AS (109.0 ± 16.4, n = 4). A scatterplot of attempts by group is shown in Figure 2. RD had the largest mean absolute displacement of the feet, 11.5 cm. As hypothesized, horizontal displacement of the feet was significantly correlated with the horizontal displacement of the bar (r = 0.75, $p \leq 0.01$) for all groups.

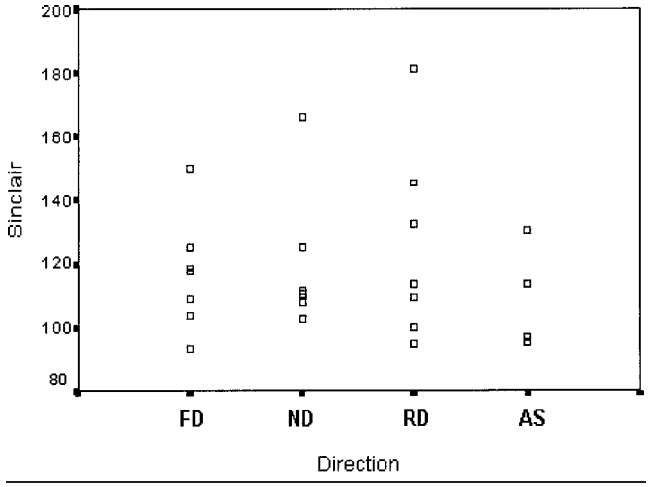

Figure 2. Scatterplot of attempts by displacement.

Discussion

To our knowledge, this is the first study to quantify foot displacement in a large group of lifters. Assuming all the lifts in the RD group were synonymous with the type-B trajectory, this would account for 32% of the lifts sampled. This is a smaller percentage than the findings of Hiskia (6) who found that 42.9% of the 669 snatches sampled in international competition showed type-B trajectory. Garhammer (5) also noted about 45% of the lifts he sampled in international competition from 1978 to 1984 were of the type-B trajectory. The lifters in these studies include Europeans and Asians, and Stone (13) showed that trajectories of these lifters can vary considerably from what can be typically observed in the U.S.A. Male lifters in the U.S.A. have had limited success in senior international com-

petition (4 medals in World Championship and Olympic events since 1976), suggesting that trajectory may be related to performance.

Although there were no significant differences in success rate and Sinclair score, one must note that the margin of victory in elite sport is very small and differences that do not reach statistical significance my actually have a meaningful effect in sport results. The Sinclair formula is used to indicate the best athletes irrespective of differences in body mass (12). The Sinclair coefficients are calculated in the spring of each Olympic year. They are derived statistically and are based on the World Record Totals in the various bodyweight classes of the past several years as of December 31.

Thus, when body mass is obviated by using the Sinclair formula, RD contained the better lifters although this did not reach significance. Most of the lifters sampled herein are not of international caliber (1 lifter sampled qualified for and competed at the world championships in Lahti, Finland, November 1998). This makes it difficult to compare the results of our study with those of Baumann et al. (2), Garhammer (3–5), Hiskia (7), and Isaka et al. (7). Average Sinclair score for the snatch was only 118.92, which is considerably less than the average Sinclair score of the current Olympic champions, 208.66. The Collegiate Nationals is also the lowest level national meet in the U.S.A., meaning that there may be more beginner and intermediate level lifters. Lifters of this caliber may be prone to exhibit a wide range of techniques, not all of which are a result of coaching.

To make reasonable conclusions about the proper bar trajectory, anthropometric factors of the lifter must be considered. Stone et al. (13) found that the smaller athletes showed a larger (7–12 cm) rearward displacement of the bar when compared with the larger lifters. Assuming foot and bar displacements are closely related, as found in the present study, their results (13) indicate that lighter lifters may have more large rearward foot displacements. One possible explanation for their observation is because lighter lifters must stay on their heels longer to prevent themselves from being pulled forward by the bar weight. Thus, these lighter lifters have learned to lean back to use their body mass as a ''counterweight.'' Thus, it is possible that at the elite level, lighter lifters who lift considerably more bar mass relative to body mass than heavier athletes may exhibit type-B trajectories more. The results of the present study may disagree with the findings of Stone et al. (13). Our results indicate that the heavier lifters could jump more backward when compared with lighter lifters. But this may be partly a function of the level of athlete (international vs. collegiate) rather than body mass. Additional data on the training experience would be needed to make this comparison.

Future research in this area should concentrate on combining bar path and foot displacement data. Three-dimensional analysis of bar trajectory would help explain asymmetries in foot displacement, and give more detailed descriptions of trajectory by reducing the error caused by transverse rotation of the bar. This type of analysis should be carried out on elite international level lifters, as their technique is often superior and shows little variation within lifters. Combining this technology with force plate to examine the center of pressure on the foot during different phases of the pull, electromyography (EMG), and ultrasound/infrared (V-Scope) technology (a method that gives immediate feedback on bar trajectory with far less data processing time than video) would give a more comprehensive view of the snatch technique and its effect on success. Further analysis of the entire body should be examined to determine the cause of the rearward displacement, i.e., the incorrect technique of ''hipping'' the bar or deliberately keeping the COM over the heels in the second pull. The results of this may clarify the effectiveness of this technique.

Practical Applications

Foot displacement and bar displacement are closely related. This study shows that rearward foot displacement may not be an indicator of success or lifting ability in the snatch for the collegiate level lifter. As stated before, the collegiate nationals are a low level national meet and lifters of this caliber may exhibit a wide variety of techniques. Rearward displacement is being exhibited by elite lifters and coached around the world, and seems to be a preferred technique of many lifters in international competition (7). Although this technique (i.e., pulling trajectory B and rearward foot displacement) may be a natural trait in some lifters, it is also taught as proper technique by many coaches. Because of its prevalence in international level lifters and because rearward displacement has been shown by this investigation to be as good as other techniques, it should be considered by coaches and athletes of all levels as a viable variation in snatch technique.

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