AN EXPLORATION OF BALANCE AND SKILL IN OLYMPIC WEIGHTLIFTING

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INTRODUCTION

For the millions of athletes who train with Olympic weightlifting, safety and greater success are the primary objectives. To date the biomechanical research literature on this activity has been based on national- and international-level competitors (c.f., Barabas & Fabian, 1989; Burdett, 1982; Enoka, 1979; Garhammer, 1985; Garhammer & Taylor, 1984). While there is much to learn from these rare athletes, there is also a need to investigate less skillful performers. In particular, the regulation of balance may be a limiting factor in both safety of lifting and improvement of skill. For example, a) forward-backward stability must be maintained by keeping the line of gravity of the body/bar system over the anteroposterior base of support, b) side-to-side stability must be maintained through sufficient left/right symmetry to keep the line of gravity located over the mediolateral base of support, and c) forward-backward mobility must be adjusted to allow the greatest application of muscle torque. Given the potentially conflicting needs for stability and mobility in the anteroposterior plane and the need for left-right symmetry in the mediolateral plane, it is likely that performers of disparate skill levels resolve these challenges in different manners. Therefore, the purpose of this investigation was to explore how advanced and intermediate weightlifters regulate balance in Olympic weightlifting.

METHODS

Two young adult males served as subjects in this study. The advanced performer (mass = 97.7 kg) competed intercollegiately in Olympic weightlifting. The intermediate performer (mass = 86.4 kg) trained with free weights for fitness and recreational purposes but was only moderately familiar with Olympic weightlifting.

The specific lift that was performed in this study was the high-hang power snatch. This is a commonly used lift from the training repertoire and deviates from the competitive snatch in the following ways: the first pull is eliminated because the bar begins from rest at about knee level and the catch is completed without the squat (see Figure 1). Each subject performed 5 lifts with 75% maximum weight (advanced = 75 kg, intermediate = 39.2 kg), and the most representative trial was selected for analysis.

The lifts were performed on a portable Kistler force plate (40x60x4 cm) with

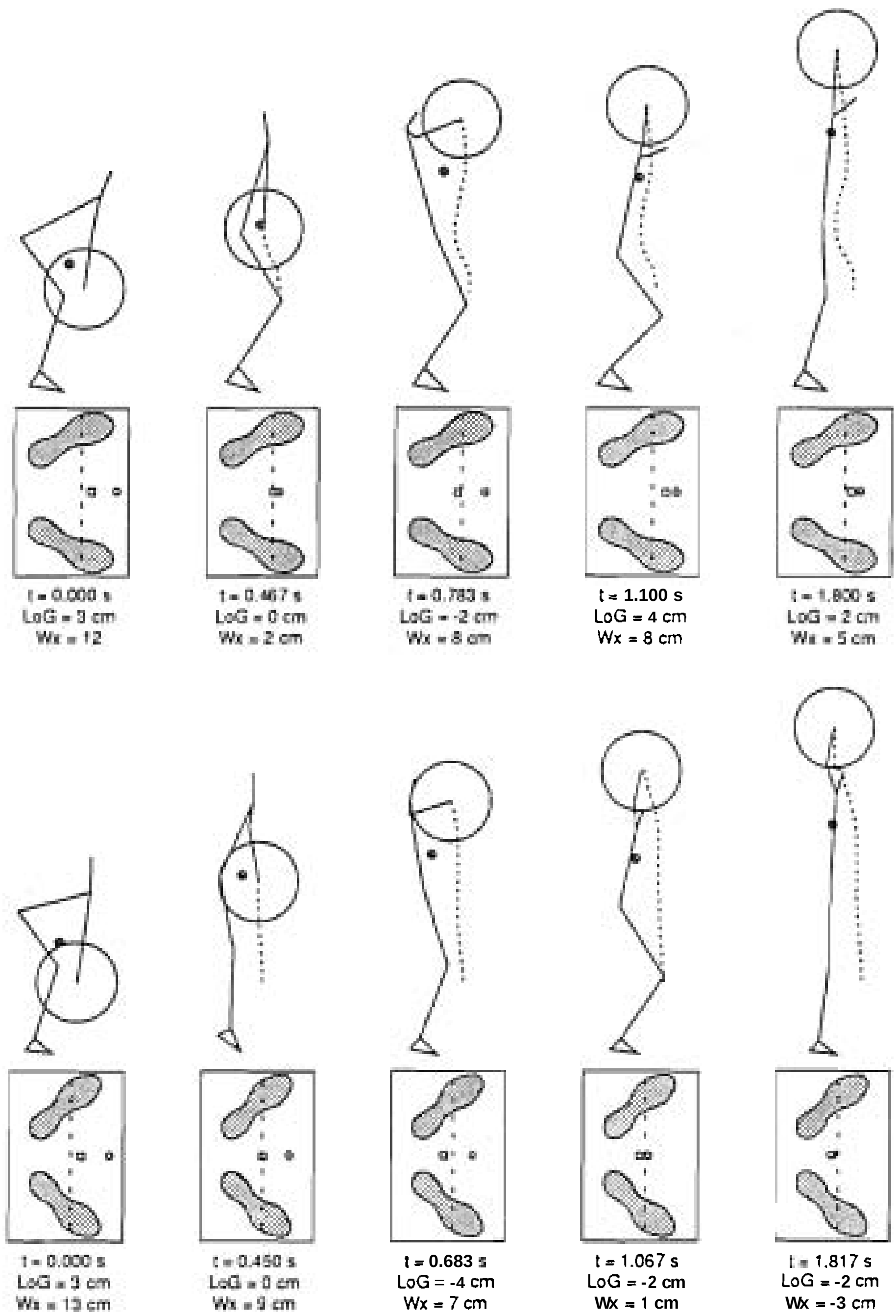

Figure 1. Key positions of the high-hang power snatch for the advanced performer (above) and the intermediate performer (below). System line of gravity is denoted by ⊕, □; horizontal position of the weight is denoted by ---, **O**. Distances are relative to the forefoot (dashed) line.

a sampling rate of 250 Hz. Anteroposterior (A-P) and mediolateral (M-L) forces and center of pressure (CoP) locations were generated with Bioware software. The right side of the lifter was videotaped at 60 Hz. Using Peak5 software the center of the bar and segmental end points were digitized and optimally smoothed with a Butterworth filter; also, horizontal positions and velocities of the weight (W) and system center of gravity (LoG) were calculated. Base of support (BoS) was computed from the most extreme A-P or M-L points of contact during stance. For reference the A-P BoS was subdivided by a forefoot line (FFL) which connected the heads of the fifth metatarsals of each foot.

RESULTS AND DISCUSSION

In Figure 1, the starting position, the initiation of the explosion phase of the second pull, a sample from the nonsupport phase, the rack position, and the end of recovery are depicted for each subject. The A-P base of support was 28 cm for the advanced performer (AdP) and 22 cm for the intermediate performer (ImP). Generally, the LoG was near the FFL but slightly ahead for the AdP and slightly behind for the ImP. In total, the LoG moved through a range of 6 cm for the AdP and 8 cm for the ImP. Thus, the AdP used 20% and the ImP 35% of his BoS. As for the A-P CoP, the AdP had an excursion of 13 cm during the second pull. This is similar to the 14-cm excursion reported by Garhammer and Taylor (1984) for elite lifters and dissimilar to the 1-cm excursion exhibited by the ImP during the second pull. The ImP, however, had a 13-cm excursion of his CoP during the latter stages of recovery.

The M-L base of support for both performers was 55 cm, and each had a rapid 9-cm excursion of the CoP. Again, for the AdP this occurred during the second pull (and was likely related to one foot being briefly off the ground at the end of the explosion phase), and for the ImP this occurred during late recovery. Because the LoG excursion is typically less than the CoP excursion, it is likely that for each lifter the LoG remained within a small area of his M-L BoS. Throughout each lift M-L forces remained at or below 5% of system weight.

For the AdP the bar moved 10 cm backward during the second pull and then 6 cm forward during the explosion and nonsupport phases. This pattern is comparable to that of elite lifters (Barabas & Fabian, 1989; Garhammer, 1985) and allowed the bar to pass favorably near the hip joint (Enoka, 1979). In fact, as the explosion began, both bar and body were aligned with the FFL. Peak bar velocity was .6 m/s in both backward and forward directions. By moving the bar and the body in opposite directions at strategic times, peak velocity of the system was .3 m/s backward and forward. As for A-P forces, the AdP initiated backward movement of the bar with a force of .1 system weight (SW) and braked the backward movement of the bar with a force of .34 SW; subsequently there were three other rearward forces of about .15 SW.

The ImP did not follow the recommended pattern of posterior then anterior bar movement. Rather the bar moved incrementally backward until the recovery when it moved somewhat abruptly backward. In general the bar and body moved in the same direction at the same time; the peak backward velocities for the bar and system were .4 and .35 m/s respectively. The A-P forces for the ImP were less than .05 SW until midway through the recovery; then there were A-P forces of ± .10 SW oscillating at 5 Hz.

CONCLUSIONS AND APPLICATIONS

Given that both lifters had good M-L stability, this may be the easiest of the balance problems to master in this task. Next, the AdP had better A-P stability than the ImP whose stability was adequate. Finally, the ImP had too little A-P mobility early in the lift, especially of the bar in the second pull, and too much mobility late in the lift in the form of oscillations. If the ImP adjusted stability by keeping his LoG anterior to the FFL, he might reduce the oscillations, and then he could begin working on greater mobility of the bar during the second pull. Safety precautions should be instituted to minimize problems related to the apparent and real threats of backward loss of balance. For the AdP, balance may not be the limiting factor at this stage of skill acquisition.

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