A TEMPORAL ANALYSIS OF THE SQUAT LIFT AT THE AUSTRALIAN POWER LIFTING CHAMPIONSHIPS MELBOURNE JULY 1990

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The squat lift was analyzed at the Australian Power Lifting Championships conducted in Melbourne in July 1990. Successful squat lifts of all competitors were compared to the squats of lifters in the Elite I and II category. The Elite grading is part of the system of grading designed by the power lifting association to determine skill level between weight categories. This comparison will develop a profile of a successful lift.

The squat is the first lift in a power lifting competition. The bench press and the dead lift are the other lifts. With the squat. the lifter moves the bar to the shoulders from a rack positioned at shoulder height. The lifter steps away from the rack and commences the lift by flexion of the knees. The lifter flexes the knees until the surface of the legs at the hip joint are lower than the tops of the knees. The lifter then pushes upward until the knees are locked and then replaces the bar on the rack. A lift is judged as successful by three referees. The chief referee faces the front of the lifter and controls the start and the end of the lifting movement. The other two referees are situated on either side of the lifter.

There is a qualifying standard in order to compete at these championships. Some weight divisions had few competitors, due to insufficient lifters having qualified to enter. Thus, many lifters were competing against their personal best lift, rather than another competitor. This was the first Australian power lifting championship to have drug testing. One competitor was found to have taken an illegal drug. That lifter's results are not included in the analysis.

A 17-minute video was produced that could be used in coaching to emphasize the findings of the report. The video showed the comparison of poor lifts and good lifts. The video repeated the lifts of good lifters selecting various cues for technique analysis. The video highlights the lifts of many of the women. in an attempt to promote the women's side of the sport

METHODOLOGY

Each lift was divided into three components - the descent, the pause at the bottom of the lift, and the ascent The start of the descent was marked by the flexion of the knees. not the first movement of the bar, as most lifters had an initial upward movement of the bar before descent. The pause was started when the thighs were in position as defined by the power lifting rules, that is when the surface of the legs at the hip joint are lower than the tops of the knees. With many lifters the bar was still moving at this point due to hunk flexion. The ascent started with the movement of the thigh upward and finished at the end of the upward movement

Each lift was filmed in the frontal and sagittal planes by National M7 video cameras. The timing of the lift was analyzed by counting frames (each frame being 0.020 sec) utilizing the frame counting facility of the PEAK 2D Biomechanics computer package.

The sport of power lifting has a rating system from beginner to international, with the highest rating being the Elite I and Elite II categories. These are lifters who are deemed to be international. Lifters who had an international rating were selected as the skilled group for comparison against all the other successful lifts.

RESULTS

The successful lifts were divided into 10 Elite and 51 non-elite lifts. The average for the pause for the elite was 25% less than for the non-elite. There was great variation in the non-elite pause time. The Descent, Ascent and Total are not significantly different, though the Descent time for the non-elite is shorter by 7.5% and the Ascent time is shorter by 4% (see Table 1).

DISCUSSION

Two aspects of the squat lift separated the elite lifters from the non-elite lifters. First, subjectively, the elite lifters were able to exert more effort, and energy during their lifting. They seemed more able to get more out of their body. Secondly they had a shorter pause time. While the difference had a very low co dence limit, the nature of the sampling across a range of competitors would preclude higher confidence limits.

There are physiological/biomechanical reasons for a short pause time. Models of muscular contractions involve parallel connective tissue and the contractile element. The force-length curve for the contractile element is an inverse hyperbola, with the maximum farce at approximately 2.5 micro meters. The parallel elastic component has a non-linear farce-length curve. This component acts like an elastic band where length is parabolically related to length. It is important to note that the parallel elastic component is time dependent. There is a reduction of muscle tension over time, despite a constant muscle length.

This means that a lengthened muscle, such as in the lowest part of the squat, if held

Table 1. Temporal Structure of Squat

ELITE (Seconds)

	Descent	Pause	Ascent	Total
Average	0.94	0.09	1.22	2.26
Standard Deviation	0.17	0.04	0.34	0.39
Range	0.63-1.26	0.04-0.20	0.87-2.07	1.82-3.24

NON-ELITE (Seconds)

	Descent	Pause	Ascent	Total
Average	0.87	0.12	1.17	2.16
Standard Deviation	0.27	0.15	0.31	0.50
Range	0.44-1.83	0.00-0.78	0.78-2.13	1.31-3.57

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Descent	Pause	Ascent	Total	Pause
	1.13	1.32	0.49	0.70

stationary, will lose force. Thus, if a power lifter wishes to make maximal use of the parallel component of muscle, she/he needs to make the pause at the bottom of the movement as short as possible. This theory is confirmed by the elite lifters having a shorter pause time.

There was no statistical difference between the descent time of the elite compared to the non-elite. There was a shorter descent time for the non-elite, however with a larger variance. The range for the elite was 0.63-1.26 seconds and for the non-elite 0.44-1.83 seconds. The elites maximum is double the minimum and the non-elite is five fold. One may conclude that the descent time is competitor dependent, relying on personal requirements and competition skills taught by the coaches. The only physiological/ biomechanical requirement for the descent time is that a faster descent may cause the lifter to lose balance at the bottom of the lift. An observation of the elite lifters is that they had a consistent descent time for all their lifts irrespective of weight. The sample size, however, was insufficient to justify this contention.

There was no statistical difference between the ascent time of the elite compared to the non-elite. The average, standard deviation and the range are comparable for both

the elite and the non-elite. An observation of the ascent time is that it is dependent on the weight to be lifted. The closer the weight is to the lifter maximum, the longer the ascent time. Obviously, a constant movement is more beneficial in order to make use of the parallel connective effect of the muscle.

CONCLUSIONIRECOMMENDATION

The analysis of the lift showed that the elite were consistent in their time of descent, despite a varying load. There was a negligible pause at the bottom of the lift, perhaps in a effort to make best use of the parallel connective effect of the muscle. The ascent time made no difference to the success of the lift, though a constant movement was more beneficial. Generally, the lifters ascent time lengthened with the increase in load.

This report shows that though the descent and the ascent for the squat lift are dependent on the competition skills learned or personal factors, the pause phase should be as short as possible in order to make best use of the muscles parallel connective effect. The elite lifters made better use of this effect than the non-elite.