Acceleration and Deceleration Phases in the Pull

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One of the key tasks of coaches is to provide "error information", that is feedback, to their athletes. Feedback is an essential element of learning. The athlete must receive on a regular basis information which enables a comparison to be made between their own performance and that of an ideal or a model performance. As a result of this comparison, the athlete will gain knowledge of their performance(s) and be able to work on correcting their error(s). It is therefore necessary that coaches understand the ideal or model performance otherwise there is no reliable reference point from upon which a comparison can be made.

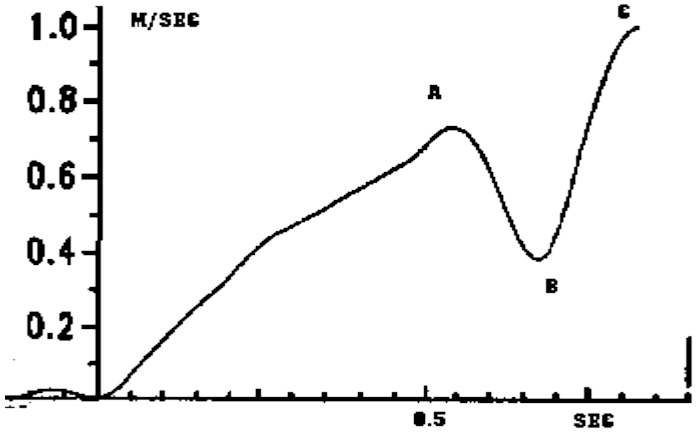
To build up a picture of what is good technique coaches rely on their observations of countless thousands of lifts. In this regard the video camera/VCR is a powerful tool which enables repeated observation of performances and to see performances slowed down to a rate that makes the information more easy to process by the human brain. The video also allows athletes to view their own performances and as the saying goes "a picture is worth a thousand words".

The force platform is another weapon in the coaching armoury. The apparatus consists of plates, usually one under each foot, that can measure forces produced by the lifter and the information is collected and stored by a computer. The force platform is not as readily accessible to the coach as a video camera due to cost factors and its reliance on highly skilled people to make it work. Nevertheless there are many force platforms in tertiary education establishments and centres of excellence in sport throughout Australia.

The force platform provides information to the coach that cannot be gleaned from observation alone, with or without the use of slow motion replays on video. Whilst it is possible to detect errors in the movement of the bar or the positioning of the body by observation, coaches are limited in their ability to measure the technical efficiency of lifters. By being able to measure force, acceleration and velocity, the force platform adds a new dimension to the provision of feedback by the coach.

As an example of what can be achieved and what questions can be answered using a force platform, this article focuses on determining the effectiveness of lifters to produce acceleration of the bar in the pull. As a basis for discussion the author draws upon a force platform study involving sixteen (16) weightlifters of novice to intermediate experience at the Australian Institute of Sport, Canberra. As a result of the study in which lifters performed the Clean some very interesting graphs were produced, particularly "SYSTEM VELOCITY".

Figure 1. - The System Velocity Graph



Important features of this System Velocity Graph are labelled A,B and C where:

A - peak velocity of 1st pull

B - minimum velocity of transition phase

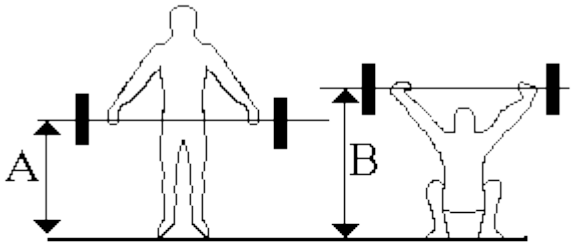
C - peak velocity of 2nd pull

In Weightlifting parlance, it is normal to talk about 1st pull (pull from the ground to the knee) and 2nd pull (pull from the knee to full extension). With the advent of such technology as the force platform it has become possible to discern a phase of the pull between the 1st pull to the 2nd pull which is of considerable importance. This phase has been termed the "transition phase".

The results of the study conducted at the AIS in 1991 indicated that the transition phase is a problem for many individuals. Evidence suggests that there is a point in the middle of the pull (the transition phase) where every Weightlifter suffers a deceleration of the upward motion of the bar. However Weightlifters differ widely in their abilities at this point. For some lifters the deceleration is dramatic and as a result the upward velocity of the bar falls almost to zero. Other lifters on the hand cope much better and there is only a slight drop off in velocity.

Before considering the coaching implications of the evidence arising from this force platform study, it is necessary to consider what is the essence of a technically efficient pull. It is obvious that the bar must reach a critical height to enable the lifter to drop under the bar and attain a body position which will support the bar and prevent it from falling back to the ground. In the case of the snatch the critical height the bar must reach is greater than is reached when the lifter is at full extension in the pull (see figure 2).

Figure 2 - Critical height in the snatch



A = Height (amplitude) of pull finish
B = Height required to "squat under"

In Figure 2 the critical height the bar must reach is B. Any less higher than this and the lifter will not be able to assume a squat position. But as can be seen from Figure 2, at full extension in the pull the bar has not reached this height.

How therefore does the bar increase in height from A to B? It is not the case that the lifter is able to pull the bar higher by the use of the arms because after the moment of full extension the lifter is rapidly descending under the bar. The answer in the word is MOMENTUM something that we all experience on a day to day basis. All of us must wear seat belts in motor vehicles to prevent our momentum from carrying us through the windscreen if a collision occurs. Momentum is a product of MASS and VELOCITY. Once in motion, heavier objects take longer to stop than light ones. Cars can break much more quickly and easily than trucks. Therefore the Mass (the object's weight) is of crucial importance in determining Momentum. But velocity is equally important. A car travelling at 100Kph takes much longer to bring to a halt than the same vehicle at 50Kph.

Applying this knowledge to Weightlifting, what is required is that at the moment of full extension, that is the last moment where there is effective pulling force, the bar is travelling as fast as possible. The faster the bar is travelling up at the end of the pull, the more momentum it will acquire. The more momentum the bar acquires, the higher the bar will go.

But what has this got to do with the transition phase, I hear you say? Well, we might start by asking some questions.

1. What causes the bar to slow in the middle of the pull?

2. Why are some lifters more effective in the middle of the pull?

3. Would a better understanding of the mechanics of the pull, especially the deceleration in the transition phase, help coaches and athletes to set the right strategies and training methods to be fast WHERE IT COUNTS at the top of the pull.

The idea for this article came about when the author heard that a lifter had been told to pull the bar as hard as possible off the ground (as the best possible strategy to get a successful lift). Is this the case? Let's answer the questions above.

Point 1. The bar tends to slow in the middle of the pull (in the transition phase) because during the first pull the quadriceps (muscles on the front of the thighs), which produce most of the lifting force, contract and cause the legs to straighten at the knees. By the time the bar reaches knee height the quadriceps are almost fully contracted and cannot,

for the moment, contribute further lifting force (see Figure).

As the bar reaches knee height the lifter begins to "shift" into an upright position which causes the knees to be thrust forwards and under the bar. This action also causes the knees to re-bend. This re-bending of the knees allows the lifter to re-utilise the quadriceps once more to produce upward force at the end of the pull. This shifting of body position takes place during the transition phase. At the start of the transition phase the bar is decelerating but by the time the lifter has completed the shift into a more upright position (see Figure) the bar begins to markedly increase in velocity.
Point 2. Why so some lifters exhibit a marked decrease in velocity of the bar in the transition phase almost to point where the bar comes to a grinding halt? The most likely cause for this is that the lifter either starts with their hips too high or that their first pull is characterised by an excessive raising of the hips in relation to the movement of the bar. In other words the lifter's hips rise faster than the bar. As a result the lifter obtains a very horizontal position of the back when the bar reaches knee height. The effect of this is two-fold. Firstly, if the legs straighten too soon in the first pull the lifter loses some potential of the quadriceps to apply force. Secondly, because the lifter straightens the knees too soon, the bar has not yet reached a height where he/she can shift position by driving the knees under the bar. The bar is too low to do this. The lifter is then left in an awkward position where he/she can neither apply much force nor shift into a more mechanically efficient position. The transition phase is elongated and as a result the bar rapidly decelerates.

Point 3. Yes, hopefully an understanding of the mechanics of lifting will help the coach and athlete to pursue the right training strategies and methods. The system velocity graphs arising from the 1991 AIS study indicate there is much to be gained by using force platforms to measure the efficiency of lifters. Whilst such studies often raise more questions than answers, the evidence suggests the advantage gained by a fast start to the pull can be easily lost if it causes the lifter to lose good body position in the middle of the pull. There is not necessarily any relationship between velocity at the start and velocity at the end of the pull. An alternative strategy, and maybe more successful strategy, is to aim at a more smooth and constant force at the start and during the middle of the pull. Such a strategy seeks to avoid losing velocity in the middle of the pull and thereby directly improve the final velocity. It has been said that "the job of the first pull is to get into the right position for the second pull" (W.Baszanowski 1991). If the lifter's strategy is to pull as hard as possible at the start of the lift, chances are that lifter does not have knowledge of what is the most effective part of the lift in terms of producing upward velocity.

In conclusion

1. Momentum of the bar in an upward direction at the end of the pull is the all important factor. The final velocity of the bar is the determining factor of momentum. All training methods in the pull must have the aim of increasing the *final* velocity of the pull.

2. Achieving the maximum possibility for velocity of the bar at the end of the pull is more likely to be achieved by concentrating on body positions which effect a smooth and constant acceleration of the bar.

3. Attempting to obtain a fast start may lead to a premature straightening of the legs in the first pull. The lifter's efforts to gain velocity of the bar at the start may be lost in the transition phase.

4. The lifter must be coached to keep hips low and for the bar and the hips to rise in unison at the start of the pull. This allows the lifter to utilise the strongest muscles of the body (the quadriceps) to their fullest potential.