Weight Lifting for Sports Specific Benefits

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Abstract

Top-level sports performance is based upon the need to develop power (the product of force x velocity). The basis for power generation in many sporting contexts is the stretch-shortening cycle (or plyometric response). In order to train the recruitment of maximum numbers of motor units (a motor unit is a motor nerve and all of the fibres innovated by that nerve), multi-joint, multi-muscle exercises that allow maximum force generation in minimal time have formed the cornerstone of training exercises for sports performers. The snatch and clean weightlifting movements and derivatives of these exercises, are the major resistance training exercises for developing power in sports performers. If there is to be an effective transfer of training effect between sports performance and training action, these movements need to facilitate a plyometric action: This can be done if the strength and conditioning coach teaches his/ her athletes to perform a double-knee bend (DKB) action within the training movement for both the snatch and clean lifts. The DKB allows a greater force to be transmitted more effectively, greater transfer of training effects to other sports and also it is a safer lift with less potential risk to the back.

This article explores the importance of explosive weight training to the sports performer and illustrates the action of the DKB and explains its importance in both power generation and transfer of training effects. The paper also expands upon the first pull phase of these lifts: If this stage of the lift is completed appropriately, the DKB is more likely to happen.

Why should explosive lifting be done with sports performers?

Effective strength training for sports performers begins with a working knowledge of basic movement mechanics. Kinesiological (the study of joint and muscle actions in movement) analysis of any sporting movement will indicate that the primary basis of strength-power training exercises for an athlete in most sports should be closed-kinetic-chain exercises that allow maximum force in gross muscle structure (especially around the legs, hips and trunk) to be reached in minimum time (Wilk & Reinold, 2001).
Fig. 1 illustrates an example of kinesiological analysis in action, identifying the nature of joint and muscle action required in sports performance (and conversely the training methodologies for that sport): Video 1 also demonstrates the push-start action for the bobsleigh. Look closely at the nature of the ankle-knee-hip actions during the exercise to obtain a further picture of the nature of training modalities that might be needed for this athlete: Relate the actions here to those that can be seen in later video of the weightlifting movements.

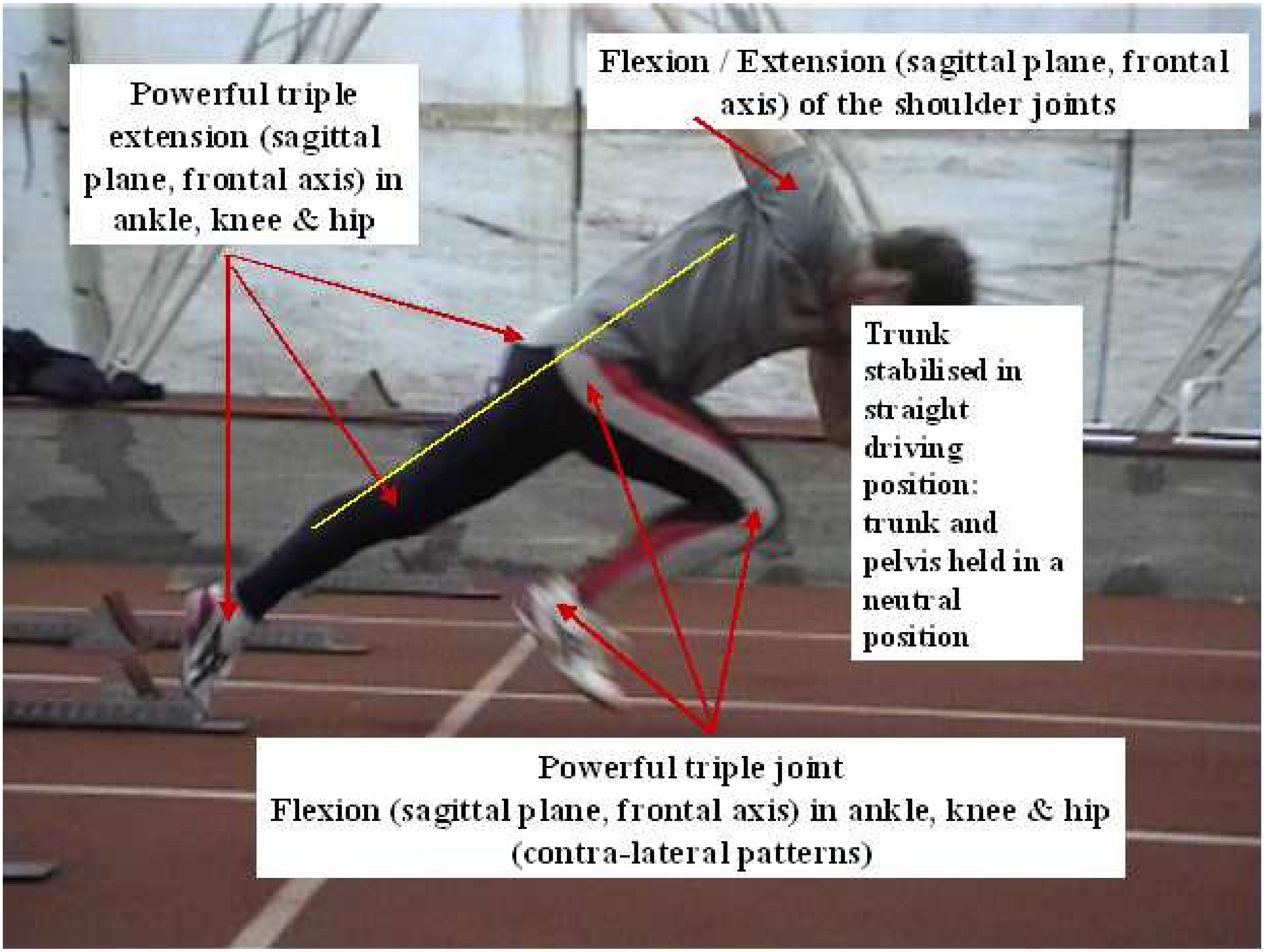

Fig. 1: Kinesiological analysis of the sprint start:

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Video 1: The bobsleigh push start

Force Production

It is well documented that strength (the ability to produce force) and power (the product of force x velocity) gain is specific to the angle of the joint at which training occurs (Durstine & Davis, 2001), and therefore training actions should be utilised that reflect the total dynamic range of movement that an athlete might require in sports performance. Consequently, exercises such as squat, snatch and the squat clean (and derivatives of these exercises) should form the cornerstone of the resistance training routines for sports performers . Indeed, there is considerable evidence indicating a high degree of efficacy of using these movement specific training exercises in order to produce superior performance gains in strength / power oriented sports (Stone, 1990, Stone et al. 2002b). These exercises (weightlifting movements and jumps) also facilitate the incorporation of the triple extension of the ankles, hips and knees, counter movements in both relatively slow (squat) and very explosive (power clean, snatch) movements, and also dead-stop start accelerations. These characteristics have a large potential to transfer into improved neuromuscular efficiency which, in turn, have been demonstrated as being exceptionally beneficial to performance in biomechanically similar movements (Brewer, 2003a).

Not only does this type of movement reflect the joint / muscular recruitment patterns imposed during skill performance, but the requirements for strength, power and force development for such exercises are similar to those required in sports. For example: because technique is dependent upon appropriate force production, training the athlete’s ability to generate force is arguably the biggest training priority (factors that primarily influence winning and losing) for the strength & conditioning coach. The importance of force generation is illustrated by Newtons 2nd law (Force = Mass x acceleration). Acceleration is important as this results in a velocity: velocity is a vital component of power and is often a determining factor in superior performance.

Rate of Force Development

Another important characteristic that accompanies force generation is rate of force development (RFD). What is also very important to realise is that RFD can be associated with acceleration capabilities in athletes (Schmidtbleicher, 1992), and this can also be a determining factor in generating superior athletic performance. Most critical aspects of sports performance occur in very short time-frames (<250ms): If athletes can be trained to produce greater forces within that time frame, then greater accelerations, and therefore velocities, can be achieved. Therefore, the ability to produce force (strength) and its related component RFD, is an integral part of power production and therefore may be a key component in determining athletic success (Schmidtbleicher, 1992, Stone et al. 2002a).

The importance of the stretch-shortening cycle in sports specific training

The need to incorporate speed-strength exercises (such as the snatch, clean, jerk and derivatives of these exercises), and to perform these at high power outputs and velocities has been well documented for power-based sports (Stone, 2004). Similarly, when considering pre-habilitation of injuries, we need to ensure that the neuromuscular system is adequately trained to tolerate the imposed strains during functional tasks (Brewer, 2003b). Many explosive movements in sport (such as running, kicking or throwing) involve the reflex/elastic properties of the muscle-tendon complex and are ballistic in nature, even when initiated from a static position. These elastic properties allow a stretch-shortening cycle to occur: This is where a muscle is forcibly and rapidly lengthened by a stretch or countermovement, then stretch receptors (muscle spindle fibres, golgi tendon organs) sends signals to the central nervous system, stimulating concentric contraction of the involved muscles which then contract forcefully as elastic energy is released from the muscle fibres and connective tissue. This process is commonly referred to as a myotatic reflex, which forms the basis for all plyometric-training actions.

Training for maximum strength alone will not adequately develop these elastic properties within a muscle, therefore training for sports should not only encourage the inclusion of rapid stretch-shortening (plyometric) methods, but it should also incorporate stretch-shortening cycles into training movements often to enable the athlete to produce maximal forces in training movements. Typically, amortisation or reactive phases of the stretch-shortening cycle (the transition phase between eccentric lengthening and concentric shortening) should be as short / rapid as possible: this is trainable within athletes who are subject to the correct coaching and training methods.
A stretch-shortening cycle can be observed in experienced lifters performing both the snatch and clean lifts, and it is this action that needs to be developed in athletes if the maximum benefits of the lift are to be carried over to sports performance (Garhammer, 1980). This stretch-shortening cycle occurs during the transition phase immediately following the first pull, and is often referred to as the double-knee bend (dkb).

The double knee bend

In both the snatch and the clean, pulling movements are used to raise the bar from the floor, up the front of the body, to a position where the athlete squats under the bar and catches it an overhead (snatch) or in front of the neck (clean) position. In both of these lifts, the most efficient pulling technique has been observed over time to be the double knee bend. Not only does this introduce a sudden forceful stretch-shortening cycle into the lift, but the unweighted position also reduces tension on the back (Favre, 2003)

Photos 1a,b,c show Peter Kelly (USA weighlifting) performing a snatch lift. This sequence of photos demonstrates clearly the 3 key positions associated with the execution of the double knee bend lift.

Start position

The feet are flat on the floor, hips positioned slightly higher than the knees, back is held straight and the athlete's shoulders are positioned over, and in front of, the bar. The arms should be straight, with the elbows rotated outwards and pointing along the length of the bar.

Photo 1a: The start position for the snatch lift

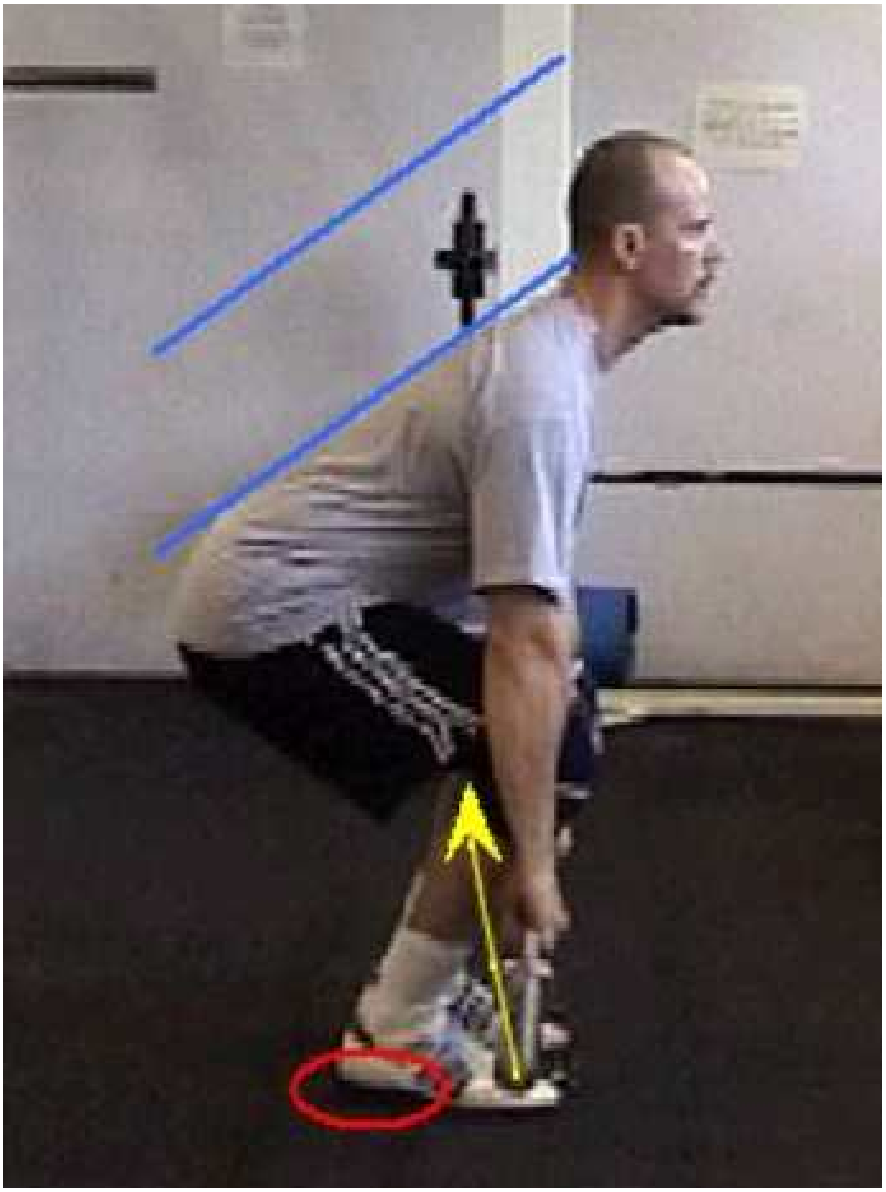

Photo 2a: The start position for the clean: The annotated lines indicate the position of the trunk in relation to the bar and the ground (from Favre, 2004).

The back should be held straight (with a normal lordotic curve in the lumber spine). This is aided by the shoulder blades being pulled back towards each other ("imagine holding a £5 note between them") and the chest pushed out at the same time (photo 2a). Indeed, a coach standing in front of the player lifting should be able to see the whole of the chest from the front. The head should also be up at all times.

First Pull

Teaching the 1st Pull phase of the lifts correctly can be the key to ensure that the double knee bend happens. With proper execution of the 1st Pull, the athlete is more likely to perform a double knee bend (Favre, 2004). The importance of correctly executing the 1st Pull is to get the bar moving with minimal energy expenditure, achieving an optimal combined centre of gravity, and setting up the 2nd Pull. The bar must be initially moved without "ripping" or "jerking" the bar from the floor. The bar is moved by extending the knees ("knees back") through a pushing action of the feet through the floor.

Meanwhile, the player must have the hips and back rise as one while maintaining a relatively constant angle between the floor and back throughout the 1st Pull. The knees are extended until they are in a position that is slightly behind, and underneath, the bar. At this stage, the centre of pressure of the bar is towards the heel of the foot as it is planted on the floor.

End of the first pull

The bar is at the knees: The bar and the lifter have been raised primarily as a result of the lifters knees being extended. The athletes hips and back have risen “as one unit”, maintaining a consistent angle between the floor and the back throughout this phase of the lift. The lifters shoulders are still in front of the bar, with the feet still flat on the floor and the centre of pressure back towards the heel of the foot (Favre, 2004). This position is the start of the double knee bend, or transition phase of the lift.

Photo 1b: The ends of the first pull, with the bar level with the top of the knees

Photo 2b: The position of the trunk at the end of the first pull: Note that the angle between the trunk and the ground has not changed.

The transition phase

From this position, and without stopping the upward movement of the bar, the athlete should now rapidly re-bend the knees and push them under and in front of the bar. At the same time, the trunk is brought into an upright position, with the bar moving to a position close to the waist at the upper thigh level (photo 1C). The centre of pressure of the bar moves forward to the middle of the foot, in preparation for the following stage.

End of the transition (double knee bend) phase

Photo 1C demonstrates the end of the transition phase of the pull, and is the strongest point of the lift. The bar has been moved to the top of the thigh, and is very close to the body (in fact, it should actually touch the thigh). The greater the distance between the bar and the lifter, the bigger a moment arm is created between the resistive mass and the lifting effort. Not only does this create an inefficient position from which force can be exerted, but it also will cause the athlete to need to bring the bar back towards him / her at later stages of the lift in order for the bar to be successfully caught in the correct position.

Photo 1c: The end of the transition phase of the lift

Photo 1c also demonstrates a knee angle of approximately 130-140o: This has been consistently demonstrated to be the optimum knee angle for the generation of vertical power in the legs / thighs (Bartonietz, 1996). Indeed, this can be observed if you try and perform a maximum vertical jump: The base of the countermovement component of the take-off phase would correlate to a knee angle of approximately 130-140o.

From this position, the hips are fully through, the trunk is in a near vertical posture and the athlete is in the optimum position for performing a powerful jumping motion, resulting in a powerful triple extension of the ankles, hips and knees which will enable the continuation of the upward momentum of the bar.

Coaching the double knee bend

Over time, some coaches have stated that the double knee bend “just happens” in experienced lifters. However, it is our and most coach’s observation and opinion that the double knee bend does not always “just happen.” Indeed, evidence indicates that the double knee bend can be taught and the proper teaching results in a more efficient pulling technique (Winchester, et al. 2005). Although we could debate whether to teach or not to teach the double knee bend until we’re blue in the face, one thing is not debateable, the fact that the DKB must happen if the lift is to be optimal. It is the optimal technique that is necessary to derive the benefits these lifts offer. Some coaches will say you can’t teach the DKB because it is stretch reflex. But why does this stretch reflex happen? Again, the first pull technique was executed correctly thus placing the athlete in the proper position to elicit the stretch-shortening cycle: This certainly can, and should, be coached. Waiting for the athlete to “stumble” upon the technique, as an “accidental phenomenon” will only allow incorrect motor patterns to establish themselves. We are what we repeatedly do; therefore proper technique should become a habit rather than an “accidental phenomenon.”

It is hard to imagine taking the same approach when teaching a squat, where many athletes that find a full range of movement hard whilst keeping their heels on the floor. Do we just allow them to squat on their toes because they weren’t able to execute proper technique right away? How about a gymnastics coach taking the same approach to coaching a hand-spring vault, or the sprints coach not teaching correct body position during the first few steps out of the block, leg recovery during sprinting, or the hitch kick in the long jump. It is hard, in fact, to argue a case for any coach not wanting to develop “correct” technique in his / her performers from the outset of learning a skill. We have yet to work with an athlete that couldn’t execute the correct technique on the clean or snatch after proper instruction (Brewer, under review). How quickly they learn the technique depends upon the individual as well as the experience and ability of the coach.

This is not simply a discussion about technique for competitive weightlifting: It is far more fundamental than that for practitioners working with athletes from any sport. The DKB allows a greater force to be transmitted more effectively, greater transfer of training effects to other sports and also it is a safer lift with less potential risk to the back (Winchester et al., 2005; Favre, 2003; Bartonietz, 1996). Therefore the way the coach teaches the athlete to perform these pulling movements in training should lead to the correct (double knee bend) execution of the lift from the onset of learning the lift, otherwise they are doing their athletes a disservice.

Summary: Key points

- Rate of force development is a crucial factor in force generation and can be a determining characteristic in generating superior athletic performance. Most crucial aspects of sports performance occur in time frames that are less than 250ms.
- Achieving greater forces in the shortest possible time frame can produce greater accelerations, and therefore greater velocities.
- Training to improve sports performance should encourage the incorporation of rapid stretch-shortening cycles into training movements to enable the athlete to produce maximal forces. This occurs in plyometric actions, where the amortisation phase needs to be as rapid as possible.
- The snatch and clean lifts are multi-joint, multi-muscle movements that allow maximum force to be generated in minimal time. These movements typically form the cornerstone of sports training programmes designed to improve performance.
- For maximum training benefits to be taken transferred into performance, a stretch-shortening (plyometric) movement is incorporated into the lifting action. This is achieved using a double-knee bend lifting technique, which should be taught by all coaches.

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A Director of the British Strength & Conditioning Association and in charge of sportscotland's athlete development programme, Clive is registered as a British Olympic Association strength & Conditioning specialist & BASES (British Association of Sport & Exercise Sciences) sports scientist, and has worked with International performers from a diverse range of sports including rugby, tennis and bobsleigh. Clive is a widely published author, has presented at conferences worldwide and has just completed his first book on training methods for games players.

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With the popularity of CrossFit and its use of Olympic lifting in its routines, we are also seeing a rise in people interested in entering an official weightlifting event. In addition to CrossFit, many other sports are now using the Olympic lifts as training aids. All of this has led to the revitalization of weightlifting competitions. Whereas only a few years ago many of our events consisted of only one session of as few as fifteen lifters, today many event chairs are forced to cap their entries at fifty or sixty. This was unheard of until recently. While this is good news for those of us try Olympic lifts are brutally honest and provide excellent feedback every rep, and while there are arguments that the exercise is a sport itself, thatâ€™s a benefit rather than a distraction. Weight lifts do more than just improve athletic power; they also help improve discipline, says @spikesonly. Click To Tweet. Itâ€™s easy to scoff and move on to something else to read, but I promise this article will go against the grain to more than just passing fads. It will transcend beyond the science as well. Read on for eight hidden benefits of Olympic-style weightlifting. When Taught Properly, Athletes Enj Building dense, strong bones is another benefit of physical activity. Strengthens immune system. Exercising more = getting sick less. Improved sleep. We know just how important sleep is, and exercising can help you capitalize on these benefits. Mental health benefits. Exercise is good for your mental health too, as it can battle feelings of anxiety and depression, sharpen your focus, and improve self esteem. Prolonged life. When you add all of these benefits together, what do you get? A longer, healthier, more enjoyable life! Looking for more ways that physical activity can improve your overal