A comparison of two instructional methods of teaching the power clean weight training exercise to intercollegiate football players with novice power clean experience.

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(ABSTRACT)

There is conflict between recognized Strength and Conditioning professionals and organizations regarding the most effective methods of teaching the power clean weight training exercise. The area of greatest conflict is related to the effectiveness of whether to specifically introduce and segmentally practice the Double Knee Bend technique or not.

Sixty collegiate football players with novice power clean experience were randomly assigned to one of three groups: (1) a group in which the double knee bend technique was taught and practiced segmentally (DKB); (2) a group which was instructed in the same way as the DKB group except that the double knee bend was not specifically taught or practiced segmentally(NDKB), and (3) a control group (CG) which was exposed to an orientation session similar to the first two groups, but was not specifically instructed in the power clean technique.

Subjects in all three groups were video taped performing the power clean with a standardized weight both prior to and following a seven week training session. Each video taped trial was randomly assigned to an expert reviewer for qualitative analysis in a blind review. Reviewers rated the three upward movement phases as well as the total upward movement phase of the lift using a published check list and rated the performance from one to five with five being the best technique.

The result of the ANOVA and a Scheefe test showed that the two treatment groups both demonstrated significant improvement pre to post test in the power clean technique $p<0.01$. The control group did not significantly improve over the course of the same training period. In comparing the two treatment groups, the between groups analysis (DKB) and (NDKB) were not significantly different.

These results suggest that the double knee technique does not need to be specifically taught or segmentally practiced in order to improve power clean technique among college football players with novice power clean experience.

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Introduction and Review of Literature

Introduction

For the past twenty years, there has been an increased interest and participation in strength training and physical conditioning as it applies to intercollegiate athletes. In the 1970's, during the initial stages of collegiate strength and conditioning coaching, the majority of strength coaches had backgrounds in one of three areas: a) competitive power lifting, b) competitive olympic style weight lifting, or c) former football players with an interest or proficiency in strength training (Epley, 1997). Each coach's previous experience influenced the type of strength and conditioning program developed and implemented with his student athletes.

As the professional organization for collegiate and professional strength and conditioning coaches, the creation of the National Strength Coaches Association added credibility to the profession and led to increased acceptance from university athletic departments in 1978 (Epley, 1997). In 1981, the National Strength Coaches Association changed its name to the National Strength and Conditioning Association to reflect the application of strength and conditioning across a broader spectrum. Membership had grown from its initial eight members to 3,500. Members included strength coaches, sport coaches, exercise physiologists, physical rehabilitation specialists, and athletic trainers. Currently, the National Strength and Conditioning Association (NSCA) has over 10,000 members reflecting the growth in the entire fitness industry (Epley, 1997).

A national certification process was implemented in 1985. In terms of credibility and acceptance, this accredited certification (Certified Strength and Conditioning Specialist) has had a major impact on the status of the profession. The certification process is closely patterned after the National Athletic Trainers Association certification in both format and difficulty (Boyd Epley, personal communication, February, 15, 1997). It includes two sections of testing: a) a section on scientific principles which requires a knowledge of basic exercise physiology, kinesiology, and human anatomy; and b) a practical application of strength and conditioning techniques and strategies during which the applicant must demonstrate a functional understanding of appropriate training methods.

From its inception, one of the primary goals of the NSCA has been the dissemination of information to its members. Initially, this information was primarily provided via articles submitted by the members and published in the National Strength and Conditioning Journal. With the advent of certification, there became a need for standardized information to be distributed by the NSCA to its constituency. This information was gleaned from contemporaneous

experts both within and outside the organization. Exercise techniques and basic training strategies were marketed by the NSCA to its members in the form of various manuals and video tapes. In 1994, the National Strength and Conditioning Association commissioned Dr. Tom Baechle to develop a textbook to address exercise physiology relating to strength training, physical conditioning, training methodology, and proper exercise technique. This textbook, Essentials of Strength Training and Conditioning has become the primary resource for the Certified Strength and Conditioning Specialist examination (R. U. Newton, personal communication, July 3, 1997).

Specificity

One of the fundamental concepts of strength training endorsed by the National Strength and Conditioning Association is specificity (Baechle, 1994; Zatsiorisky, 1994). This concept applies to exercise selection, velocity of exercise, and intensity of exercise. The essence of specificity is described by the "SAID" principle (Specific Adaptations to Imposed Demands). This principle of exercise physiology refers to the direct relationship between the physical demands placed on the body by exercise and the accompanying bodily response and adaptation to such exercise stress (Baechle, 1994; Fleck & Kraemer, 1987).

Specificity of exercise encompasses several components: anatomical, mechanical, and velocity specificity. Anatomical specificity refers to the identification and training of muscle groups most important to the performance of the actual sports skills of the athlete. For example, a volleyball player is required to do many vertical jumps during a match. Primary muscles used are the gluteals, quadriceps, hamstrings, soleus, and gastrocneumius. Program design for a volleyball player must include exercises that develop and strengthen these muscle groups (Volleyball USA, 1995).

Mechanical specificity is a training theory that is a kinesiological approach. Simply stated, the greater the similarity of the training movement to the actual sports movement, the greater the carryover effect. The squat and power clean, for example, are biomechanically similar to the vertical jump and must be considered in program design for athletes performing variations of vertical jumping in their sport, such as volleyball or basketball (Baechle, 1994; Fleck & Kraemer, 1987; Hedrick & Anderson, 1996; Newton & Kraemer, 1994; Stone & O'Bryant, 1987).

Velocity specificity refers to the training theory which states that some resistance training should be performed at a similar velocity as required during the performance of the actual sport skills. This concept involves the fact that resistance training produces its greatest gains only in the velocity range of that

particular lift (Fleck & Kraemer, 1987; Baechle, 1994; Stone & O'Bryant, 1987; Zatsiorsky, 1994). Numerous studies support the role of high velocity strength training and its positive influence on certain power tests, such as the vertical jump and rate of force development as measured isokinetically (Hakkinen, K. 1989; Hakkinen, K. & Komi, P.V., 1985; Hedrick, A. & Anderson, J. C. 1996; Kaneko, M.T., Fuchimoro T., Toj., H., & Suei, K. 1983; Lesmes, G.R., Costill, D.L., Coyle, R.F., & Fink, W.J., 1978). Clearly, then, research infers that athletes benefit from velocity specific weight training as a part of their strength and power training program.

Choice of Resistance Training Modality

The strength training professional must decide what training tools or modalities to utilize in order to assist the athlete in achieving strength and power requirements for their sport. Practically, the strength and conditioning professional has two major training modalities available for resistance training: a) Free weights, (barbells and dumbbells) and b) exercise machines. Based on the theory of specificity, the use of free weights and free weight exercises remains more attractive. In Weight Training: A Scientific Approach, Doctors Stone and O'Bryant quote several studies which indicate that the use of free weight training programs produce superior results in strength development when compared to that of exercise machines (Stone, Johnson, & Carter, 1979; Wathen, 1980; Wathen & Shutes, 1982). Stone also provides evidence for superior gains in vertical jumps via the use of free weight exercises versus training exclusively with exercise machines (Stone, Johnson, & Carter, 1979; Sylvester, Stiggins, McGowen, & Bryan, 1981; Wathen, 1980).

Regarding mechanical specificity, using free weight exercises allows maximum variability of mechanical planes of motion. In contrast, each exercise machine is restricted to the particular movement for which it was designed. The ability to perform a variety of exercises with one piece of equipment (i. e. the barbell) makes the use of free weight exercises appealing to many strength and conditioning professionals (Fleck & Kraemer, 1997; Stone, 1982). Free weight exercises can be designed to mimic the mechanical requirements of many sports skills. In addition, the selection of free weight exercises allows the athlete to train on a "ground base," that is, standing on his own two feet. This is perhaps the most elementary aspect of mechanical specificity, as most sports skills are performed with the athlete initially standing on the ground (Arthur & Bailey, 1997).

In Complete Conditioning for Football, Mike Arthur and Bryon Bailey report that during a block or tackle in football, applying force via extension of the legs takes 2 to 3 tenths of a second. Also, by studying films of athletes

performing the ten yard sprint, they conclude that virtually all athletes needed similar time intervals to extend the legs and the same amount of time for the athlete's foot to contact the ground during the ten yard sprint. Moreover, both the faster and slower sprints had very similar times regarding leg extension rate and foot strike. The average time to extend the legs in a ten yard sprint was 3 tenths of a second on the first step and 2 tenths of a second on steps two and three (Arthur & Bailey, 1997). Similarly, they hypothesize that during the performance of a vertical jump, athletes extend their legs at a similar rate averaging 2 tenths of a second, but observed a difference in height jumped between individuals. They concluded that the difference in height jumped between individuals is not the speed of extension, but the amount of force that can be applied during the window of 2 to 3 tenths of a second.

Free weight exercises may be designed to allow the athlete to use acceleration during the performance of the exercise, which many exercise machines built with cans and pulley systems do not allow. (Arthur & Bailey, 1998; Baechle, 1992; Fleck & Kraemer, 1997; Starr, 1974; Stone & O'Bryant, 1982). Importantly, while a variety of free weight exercises can be employed using acceleration, problems regarding deceleration and the utilization of appropriate resistance levels exist. Some exercises, such as squat and press variations, become less attractive when selecting exercises for a high velocity resistance training format (Arthur & Bailey, 1988; Stone & O'Bryant, 1982). Lifts more closely associated with Olympic style weight training use acceleration more often in training. These lifts include snatches, cleans, pulls, and jerking variations (Stone & O'Bryant, 1982).

Olympic style exercises such as cleans, jerks, and snatch variations allow the athlete to accelerate the bar throughout the range of movement (Arthur & Bailey, 1998). In the text Complete Conditioning for Football, Arthur and Bailey (1998) refer to the triple extension that occurs when the ankle, knee, and hip extend simultaneously during the proper execution of the pulling movements in Olympic style weight training. They stated, "The greatest benefit of the Olympic lifts is that the triple extension matches the time frame of two tenths of a second" (p. 37). Clearly then, as the time frame of leg extensions found in blocking and tackling in football, vertical jump, and ten yard dash is the same, evidence indicates a need for olympic style weight training.

Practical Application of the Power Clean Exercise

Garhammer (1985) specifically identifies the benefits of performing the power clean exercise:

> The power clean is moderate to highly specific, and thus transfers well to a large number of physical demands and skills required during sports activities. Perhaps the most direct example is the explosive rotary leg and hip drive which occurs during the second pull of a properly executed power clean. This is very similar to the ways the legs and hips are used for blocking and tackling in football. If the power clean is performed properly with a "scoop" or second knee bend, between the first and second pull, then a stretch prior to the second pull will be imposed on the hip and knee extensiors, providing for storage and subsequent use of elastic energy as occurs with the counter movement in all jumping activities (p. 10).

In fact, Bruno Pauletto, former President of the National Strength and Conditioning Association, believes that, based on the principles of specific adaptation to imposed demands, the power clean positively transfers learning to athletic performance in developing explosive power and the biomechanical similarity between the power clean and athletic movement (Baker, Bieck, & Ethenbury, et.al 1985). Pauletto further states that a biomechanical analysis of the power clean shows the rotary action of the legs and hips, which is very similar to the jumping, running and pulling action common to many sports. In terms of muscle group specificity, the power clean is a multi-joint exercise that involves the ankle, hips, back, shoulders and wrist joints, as well as most of the muscles associated with these joints (Baker, Bieck, & Kraemer, et.al, 1985).

Description of the Power Clean

The power clean is a ground based, multi-joint weight lifting exercise commonly used by athletes participating in weight training. Garhammer (1985) suggests that

> More generally, the power clean requires an athlete to exert large multiple muscle group forces while standing on his own two feet rather than while supported by external structures, such as benches or seats. This develops balance and coordination during forceful exertions. The speed of movement during the second pull is also very valuable in conditioning the nervous system (p. 10).

The power clean is a variation of the clean and jerk, an exercise used in the sport of Olympic weight lifting. The clean and jerk is a two part exercise that requires great strength, technique and concentration (Popplewell, 1978). In concordance with the rules of the International Weightlifting Federation the clean and jerk has specific technical requirements. In the first phase, the clean,

> The bar shall be placed horizontally in front of the lifters legs. It shall be gripped, palms downward, and brought in a single movement from the ground to the shoulders, while either "splitting" or bending the legs. The bar must not touch the chest before the final position. It shall then rest on the clavicles or on the chest or on the arms fully bent. The feet shall be returned to the same line, legs straight before performing the jerk. The lifters may make his recovery in his own time (Popplewell, 1978, p. 95).

In the second phase, the jerk, an athlete must

> Bend the knees and extend them as well as the arms so as to bring the bar to the full stretch of the arms vertically extended. Return the feet to the same line, arms and legs extended and await the referee's signal to replace the bar on the platform. The referee's signal shall be made as soon as the lifter becomes absolutely motionless in all other parts of the body (Popplewell, 1978, p. 96).

The power clean varies the clean segment of the clean and jerk exercise. The major difference is observed during the "catch" or rack phase. During the Olympic style clean, athletes drop into a low squat position or split their feet (one forward and one backward) in a scissors style manner. This motion allows athletes to lower their body sufficiently as to allow them to rack or place the bar on the shoulders. When performing the power clean, athletes still rebend their knees in order to rack the bar on their shoulders, but not to the degree of flexion as normally practiced in the Olympic style clean. When the athlete performing a power clean stands upright with the bar successfully racked on the shoulders, the lift is considered complete. Importantly,

> "Because so many muscles are used during the execution of a power clean, it is a very economical exercise in terms of the muscle mass active per unit of time, similar to the requirements of most sports" (Garhammer, 1985, p. 10).

Segmental Components of the Power Clean

The power clean is commonly described in segmental components as follows: a) the start, b)the first pull, c) the transition, d) the second pull, and e) the catch phase.

The start - as the athlete approaches the barbell stationed on the ground, he assumes a shoulder width stance facing the barbell. The lifter's arms remain just outside his legs. The lifter squats down next to the bar and grasps it with a pronated grip, arms fully extended with the elbows rotated out. The bar, positioned over the balls of the lifters' feet, stays close to the lifter's shins. The lifter's lower back should be in an arched or flat position, not rounded, shoulders over the bar, not behind. The lifter's line of sight should be 90 degrees from his body line (Baechle, 1994; Beilik, 1985).

The first pull - the athlete lifts the barbell from the floor, just above the knees by simultaneous extension of the knee and hip and plantar flexion of the knee. "During the first pull the shoulder and hip joints should raise at the same rate, so that a line from the shoulder to the hip at the end of the first pull is paralleled to the same line drawn at lift off" (Garhammer, 1984, p. 46). The lower back should remain arched with the head facing straight forward. Keep the bar close to the body, with arms fully extended. Heels remain in contact with the floor (Baechle, 1994).

The transition (double knee bend or scoop) - at the completion of the first pull, a transition in body position occurs, often called the scoop or double knee bend. The hips move forward and slightly downward as the knees rebend under the bar, and the torso shifts to an almost vertical position. However, shoulders remain slightly in front of, or directly over the bar. This transition begins with a shift of balance on the feet from the heels toward the toes (Garhammer, 1984, p. 61). Garhammer (1984) suggests that

> The velocity of the barbell should gradually increase during the first pull, but may level or decrease slightly during the transition. This is caused by a temporary reduction of force applied to the barbell as the body interrupts its general extension or uncoiling in order to shift into a much stronger leverage position for the second pull. (Garhammer, 1984, p.61).

The second pull - as soon as the transition phase is complete the second pull phase begins. "This is a very explosive movement that closely resembles the vertical jump relative to knee and hip extension." (Garhammer, 1984, p. 62) The

athlete should keep the shoulders over the bar as long as possible with elbows out, the bar brushing against the middle or top of the thighs on its upward path. At the point of maximum hip and knee extension and plantar flexion of the ankle, shrug the shoulders. When the athlete reaches the maximum shoulder elevation at the completion of the shrug, he should flex and pull with the arms. Keep elbows high and in a position over the wrist during this upward pull. The athlete should pull the bar as high as possible (Baechle, 1994).

The catch - at the completion of the second pull, the bar begins to decelerate and the athlete must move under the bar quickly in order to catch or "rack" it on the shoulders. To accomplish this, the athlete bends both arms as the hip and knee flex and the ankles dorsi flex. The lifter continues upward force on the barbell with the arms as the body moves downward, and the upper body or torso must remain vertical with minimal forward lean. Garhammer states that "The elbows rotate very rapidly from their high outward position to under the bar and then upward in front of it as the bar meets the shoulders and clavicles" (Garhammer, 1984, p.62). Importantly, "The bar is caught or racked on the shoulders with the knees and hips flexed in order to absorb the weight of the bar." (Baechle, 1994; Beilik, 1985; Garhammer, 1984).

Importance of the Double Knee Bend or Scoop

Most importantly, the double knee bend or scoop phase of the power clean exercise remains critical to this study. The value of this phase is recognized by virtually all of the proponents of and recognized experts of the power clean. In order for the power clean to positively carry over or transfer value to other explosive power activities the double knee bend component of the exercise must be utilized (Garhammer , 1995; Newton, 1985). Applications to sport include the vertical jump, blocking or tackling in American football, and the start and turn propulsion in swimming, for example. In the 1970's, Garhammer conducted force plate studies on the power clean in which he concluded,

> If the power clean is performed properly with a "scoop" or second knee bend between the first and second pull, then a stretch prior to the second pull will be imposed on the knee and hip extensiors, providing for storage and subsequent use of elastic energy as occurs with the counter movement in all jumping activities (Garhammer, 1985, p. 10).

Significantly, Harvey Newton, former United States Olympic weight lifting coach also regards the double knee bend phase of the power clean as important, Mr. Newton states:

> Assuming an athlete properly learns to lower his hips as the bar is pulled between the knee and waist areas by bending the ankles and knees, the proper "stretch reflex" action of the quadriceps will result thus permitting an explosive jumping motion upward (Newton, 1985, p. 11).

Proper technique is important, as misperforming the exercise lessens potential benefits:

> If the power clean is not performed properly, e.g., rotational forces are combined with excessive use of the arms, no jumping action will result, and thus, the transfer to activities such as high jumping, shot put, a properly delivered punch in boxing, some judo throws and certain movements in team sports such as basketball and football would be inadequate (Newton, 1985, p.11).

Whaley, (1993) also recognizes the importance of the double knee bend segment of the power clean exercise. He states that the proper execution of the double knee bend allows the athlete to utilize the accumulation of elastic energy in the quadriceps muscle group. Moreover, he believes that Olympic style lifting exercises are generally added to athletic training programs in order to increase explosive power and that this element of specificity only occurs where optimal technique is utilized. Whaley further suggests that properly using the double knee bend reduces stress on the lumbar spine. Technically, without a properly executed double knee bend, athletes tend to raise their hips faster, making the pull phase a torso extension rather than the maximum summation of vertical force, thereby placing additional stress on the lumber spine. The proper execution of the double knee bend allows the athletes to lift heavier weights, which can have a positive effect on the motivation of the lifter (Whaley, 1993).

Regarding the benefit of the double knee bend technique when performing Olympic lifts the Executive Director of the Australian Weightlifting Federation, Bruce Walsh, made the following statement:

> Much has been made of the mechanical action in the second part of the pull, known as the scoop in the USA, and otherwise termed the double knee bend to the rest of the world. This action involves a slight but discernible rebending of the knees as the bar passes the knees to begin what is commonly referred to as the second pull. This

> rebending of the knees places the quadriceps in a more advantageous position to exert maximum power on the bar. Also, because of the rapid eccentric contraction involved, there is a utilization of stored elastic energy as well as invoking a stretch reflex facilitation around the knee joint - in a simpler sense, a plyometric action. Consequently, the summation of the effects of the scoop/double knee bend is the placing of the quadriceps in a more favorable position to apply force and the involvement of a plyometric action at a crucial part of the pull, two factors which have a most positive effect on the power output in snatching, cleaning, power clean, power snatch, etc. (Walsh, 1989, p.65).

Can The Double Knee Bend be Taught?

In regards to the power clean, the overwhelming consensus of Olympic weightlifting authorities is that the scoop or double knee bend phase is an important aspect of the exercise for maximum effectiveness. However, a great debate exists as to whether this segment of the exercise can be taught or is an "anatomical accident" that occurs naturally when other aspects of correct technique are employed by the lifter. Indeed, two former United State Olympic Weightlifting Team coaches, Harvey Newton and Carl Miller, are proponents of teaching the double knee bend to athletes. Lyn Jones, the current National Coaching Director of USA weightlifting, the sanctioning organization for the United States Olympic Weightlifting Team, says, "this action can not be taught. It occurs quite naturally. However, because of this anatomical accident the lifter is now able to utilize the body's major power source - the legs - a second time in the final part of the pull (Jones, 1991, p. 35).

Concordingly, Bruce Walsh, Executive Director of the Australian Weightlifting Federation agrees. While an avid proponent of Olympic style exercises such as the power clean for athletes, he emphatically states that "the performance of the double knee bend is a result of a good overall technique and is not a direct conscious act in itself (Walsh, 1989, p. 66). It is Walsh's belief that focusing on the double knee bend technique when teaching a novice to power clean results in premature weight transference to the balls of the feet as well as an unacceptable loss of upward momentum in the transition phase between the first and second pull. Indeed, Walsh believes the novice lifter can be "acquainted with this particular phenomena on the basis that if he performs other aspects of the movement correctly, then, in the process of time (i.e. sufficient practice and skill ability), the scoop will occur" (Walsh, 1989, p. 66). In fact the National Strength and Conditioning Association Journal has reflected the disparity of

opinion regarding the efficiency or method of teaching the double knee bend phase of the power clean.

Johnson (1982) detailed a specific segmental exercise designed to teach the beginner to perform the double knee bend, the clean deadlift to the knees plus a shift. This specific double knee bend exercise is one of a series of segmental lifts used in the progressive method of teaching the power clean exercise (Johnson, 1982). Bob Takano, former member of the United States Weightlifting Federation National coaching staff, also details a segmental exercise, the deadlift and shift to power position as part of the methodology of teaching the double knee bend to athletes learning the power clean (Takano, 1989).

In 1993 the National Strength and Conditioning Journal specifically addressed the double knee bend, in Teaching the Double Knee Bend Technique. Dedicated to educating the readers as to the importance of the double knee bend technique when performing the power clean, the article provides the mechanics of teaching this technique to the novice lifter. Whaley also suggests that segmentally teaching the scoop or double knee bend progressively when teaching the power clean exercise remains important to the success of positive transfer and ultimately, the athlete's success (Whaley, 1993).

Whaley, Takano, and Johnson all describe the same basic exercise to teach the double knee bend. Whaley (1993) states:

> The athlete is taught the proper starting position, bar over the balls of the feet, back flat, shoulders over the bar and head held as an extension of the spine. The pull from the floor is also of standard technique, emphasizing maintenance of back angle, hips low, arms straight and body weight toward the heels. This movement is very similar to other types of dead lifting used as Olympic style pulling assistance exercises, but there is one important difference, the finish of the movement is what makes the scoop dead lift unique and effective. Instead of standing erect and locking out the lift, the athlete pulls the bar to mid-thigh, rotating the hips toward the bar and the body weight toward the front of the foot; shoulders are over the bar with the arms straight and the legs still flexed. The athlete holds this position for one count, then returns the bar to the platform to reset and continue (Whaley, 1993, p.47).

Whaley suggests a program of twice a week for three to five sets of three to eight repetitions when implementing the clean deadlift plus shift exercise (Whaley, 1993).

Need for the Study

Because of the perceived benefits from performing Olympic style weight lifting exercises, many athletes perform these exercises worldwide. The most effective methodology of teaching and practicing these exercises should be sought for several reasons. The most efficient biomechanical execution of the exercise should also be the safest orthopedically for the athlete. Athletes have a limited amount of time for the performing weight training in their total training schedule; inefficient use of this time results in missed opportunities for productive sport practice. Additionally, better technical execution of the power clean exercise provides greater carry over for improving explosive power as measured by the vertical jump, due to closer adherence to the specificity of exercise principle (Armstrong, 1993; Baechle, 1994; Canavan, Garrett & Armstrong, 1996; Hedrick, 1993, 1996). Any areas of discrepancy in the teaching methodology of weight training exercises should be addressed and researched in an effort to provide the athlete the most productive program possible.

Research Question

There are fundamental differences among strength and conditioning professionals regarding the most effective methods of teaching the weight lifting exercise, the power clean. The most consistent difference seems to be regarding whether to include the introduction and active practice of the double knee bend segment of the lift (Jones, 1991a; 1991 b; Takano, 1992, 1993; Whaley, 1993, 1997). To resolve the issue of the efficacy of the double knee bend technique in instruction to experienced weight trainers with novice power clean experience, the following research question was asked: Do intercollegiate football players who are experienced weight trainers, but novices with regard to the power clean exercise, perform the technical execution of the power clean exercise with equal effectiveness after seven weeks of training regardless of whether the double knee bend segment of instruction is introduced and segmentally practiced or not?

Null Hypothesis

There will be no difference between the two experimental groups of intercollegiate players with limited power clean experience with regards to proper power clean technique, regardless of whether or not the double knee bend technique is introduced and practiced segmentally during a seven week training period.

Method

Participants

Sixty Division 1-A University varsity football players volunteered in this study. Prior to participating, all players signed an informed consent form according to standards set forth by the American College of Sports Medicine and the University Human Subjects Committee. Each athlete had at least one semester prior experience performing the above the knee hang clean in the University's strength and conditioning program. However, none of the participants had participated in any structured strength and conditioning program that utilized the power clean exercise prior to this study.

Design and Procedure

Each of the sixty athletes were randomly assigned to one of three training groups: a) the double knee bend group (DKB); b) the non-double knee bend group (NDKB); and c) the control group (CG). Each group had an equal number of athletes (n=20) and at no time were the different training groups allowed to be in the weight room simultaneously. All instructors were the same for each group, and all instructional cues were standardized among instructors. The training protocol was standardized for each training group, with the exception of the independent variables related to the power clean and certain related lifts (See Appendix 1).

Elieko bumper weightlifting plates and York iron weight plates were used on an Elieko 44 pound, standard olympic weightlifting bar. Athletes wore university supplied weight lifting belts to guard against potential back injury. Subjects were video taped as a means to compare pre and post testing.

On the first day of the training session, all three groups were provided with an initial orientation as to the correct performance of the power clean via demonstration. This was done to limit potential injury caused by improper lifting in the pre-test. Each demonstration was completed by a Certified Strength and Conditioning Specialist, as certified by the National Strength and Conditioning Association. At this time, standardized instruction as to the proper execution of the lift was articulated to each group. The protocol used for the instructions is presented in detail later. Importantly, the standardized, basic instructions included no direct mention of the scoop or double knee bend technique.

Orientation

During the first training session all athletes were introduced to the power clean. This introduction included a demonstration performed by a Certified Strength and Conditioning Specialist using a submaximal weight (160 pounds). The following instructional cues were given to all subjects during the demonstration.

1. Starting Position

    a. Back flat
    b. Arms extended
    c. Chest over bar
    d. Bar over the balls of the feet
    e. Eyes up looking straight ahead

2. Pull from floor

    a. Arms straight
    b. Shoulders over the bar
    c. Maintain arched or flat back position
    d. Slowly raise bar from floor, don't jerk the weight

3. Second pull
    a. After the bar crosses the knees, jump
    b. Let the bar brush the thighs on the upward path
    c. Be explosive
    d. Get full extension at the ankle, knee and hip
    f. Keep bar close to the body
    g. Keep elbows up over the wrist during the pull

4. The Rack

    a. As the bar reaches its maximum height, rebend the knees
    b. Forcefully "shoot" the elbows under the bar and through
    c. Let the bar rest on the shoulders
    d. When the bar is successfully "racked" on the shoulders, stand up with the weight.

Description of Groups

Group 1

The Scoop or Double Knee Bend Group (DKB). This group of athletes was taught the power clean exercise in a manner that thoroughly explained the technical execution of the double knee bend or scoop technique. Instruction included both verbal and visual cues regarding the double knee bend technique while they practiced the power clean. This technique refers to the rebending of the knees after the bar has passed the knee during the bar's upward assent. Rebending the knees results in the bar making slight contact with the lifter's thighs as the bar continues its upward movement.

The double knee bend component of the lift was also practiced segmentally as part of this group's training protocol. The exercise used to practice the scoop or double knee bend was the deadlift to mid thigh, which is performed in the following manner: a) the subject lifts the bar in a controlled manner past the knee, b) the knees rebend and actually go under the bar, at which point the bar rests on the lower to middle of the thigh for a one to two second count; c) at the end of this brief pause the bar is lowered back down to the ground in a controlled fashion. Note: the lifter's shoulders should stay over the bar and his lower back should maintain an arched position through-out the exercise. The deadlift to mid thigh has been taught in an effort to convey the double knee bend concept to individuals learning the power clean exercise by strength and conditioning professionals in the past (Johnson, 1982; Whaley, 1993).

Group 2

The Non- Scoop or Non-double Knee Bend Group (NDKB). The athletes were introduced to the power clean exercise in the same fashion as all of the subjects in the study. The training protocol for Group 2 (NDKB) was identical to group 1 with the following exceptions: a) never were the terms "scoop" or "double knee bend" used as coaching cue in the program, b)this group never practiced the double knee bend segmentally. Group 2 never performed the deadlift to mid thigh exercise. While no direct mention or directed practice of the scoop or double knee bend was made, no athlete was discouraged if and when this movement happened naturally during the performance of the lift. (See Appendix A for the entire training format for Group 2.)

Group 3

The Control Group. The control group (CG) received the same rudimentary instructions in the proper execution of the power clean as Group

1 (DKB) and Group 2 (NDKB). This instruction was designed to allow the subjects to be able to perform the power clean safely with submaximal weight for the purpose of the pre and post testing. The training protocol for these athletes included the above the knee hang clean and the above the knee hang clean\front squat combination. However, no other power clean related exercises were performed. All other strength and conditioning exercises were standardized to be the same as Group 1 and Group 2. The athletes from Group 3 were never in the training facility during the times that either Group 1 or 2 trained (See Appendix A for exact training protocol for the Control Group).

Instrumentation

A thorough search of existing literature shows that there is no established instrument for evaluating power clean lifting technique, a fact that necessitates the development of an instrument based on the most credible source available in the exercise science community. The Essentials of Strength and Conditioning, the official text book for the National Strength and Conditioning Association (NSCA) includes a checklist of the most important coaching points for various exercises. For the power clean lift, the checklist is broken down into seven phases:

1. The beginning position; 12 coaching points.
2. Upward movement phase: first pull; 9 coaching points.
3. Upper movement phase: transition (scoop); 5 coaching points.
4. Upper movement phase: second pull; 10 coaching points.
5. Catch; 6 coaching points.
6. Downward movement; 7 coaching points.
7. Breathing; 4 coaching points.

It was determined that the three upward movement phases (Phases 2-4) were the most critical aspects of the double knee bend technique (reference). Thus, the checklists for evaluating power clean were adapted, using only the upward movement phases and a Likert scale of 1 to 5. A score of 1 was considered poor technique, while a score of 5 was considered excellent technique.

The coaching points were broken down into three upward movement phases of the lift: a) the initial pull; b) the scoop or transition; and c) the second pull. Each phase of the lift received a sub-total score and was evaluated both pre- and post-test. The most relevant phase was the scoop or transition phase, since the double knee bend is actually performed. In addition, one item on the instrument within the scoop phase specifically addressed double knee bend. This item was evaluated and statistically compared in addition to the phase categories and the overall evaluation of technique (See Appendix B for statistical comparison and technical evaluation.

Testing

Following the demonstration and review of the above rudimentary coaching points, the following warm up routine was followed by all subjects in their respective groups. Importantly all players had previously been trained in the above knee hang clean and were therefore familiar with certain components of the lift, such as the rack phase:

Warm Up Routine

1) 120 pounds, 5 repetitions
2) 140 pounds, 3 repetitions
3) 160 pounds, 3 repetitions

The participants were then videotaped performing the power clean. The following weight was selected for use during the performance of both the pre and post test: a) 180 pounds for athletes of a body weight of 270 or less, b) 200 pounds for subjects with a body weight of 270 or more. These training weights represented a submaximal weight for all subjects, yet were considered a sufficient resistance level to require some degree of proper technical execution. Each participant performed 5 repetitions on both pre and post test videotaping. All athletes were videotaped from the same angle, at the side and slightly behind the subject with an unobstructed view of the knees, hip and torso.

The pre-test was performed on the first day of the seven week training session with each group. Post testing was performed during the last day of the seven week training session. All training groups performed the pre and post test out of view of the other groups.

Tape trials encoding format.

All players were assigned a four digit code, which was comprised of the last four digits of the subject's social security number. In addition to the four digit code, a letter code was devised specifically as to the pre or post test. This letter code was based on the first initial of the subject's last name and in regard to random assignment of a treatment group..

Formatting for these codes are listed in Table 1.

Table 1. Tape trials encoding format.

Pre Test Code Format

Last Name Initial	Code	Treatment Group
A-G	O	Control
H-M	L	Non Double Knee Bend
N-Z	B	Double Knee Bend

Example: Subject: J. Baker
SSN: 1234
Pre-Test: DKB Group

Subject Code: O 1234 B

Post Test Code Format

Last Name Initial	Code	Treatment Group
A-G	R	Control
H-M	C	NDKB
N-Z	P	DKB

Example: Subject: J. Hurley
SSN: 4321
Post-Test: DKB - Group

Subject Code: C 4321 P

Reviewers

Importantly, reviewers were deterred from ascertaining whether the trial he was reviewing was pre or post testing and which methodology was used to train the athlete. The following reviewers were asked to critique the technique of the subjects because of their expertise and experience in both coaching and conducting research in the sport of Olympic weightlifting:

1. Mr. Scott Bennett - Director of Strength and Conditioning - University of Wyoming.

2. Mr. Harvey Newton – Executive Director of the National Strength and Conditioning Association; former National coach of the United States Olympic Weightlifting team.

3. Dr. Kyle Pierce – Former editor of the National Strength and Conditioning Association Journal.

4. Mr. Leo Totten – Former National Coach for the United States Olympic Training Center, Colorado Springs, Co.

5. Dr. Michael Stone—Former President of the National Strength and Conditioning Association ; Author of Weightlifting: A Scientific Approach.

From this pool of five qualified reviewers, three were randomly selected as primary reviewers and two were selected as cross validators. Primary reviewers were Dr. Kyle Pierce, Mr. Harvey Newton, and Dr. Michael Stone. Cross validators were Mr. Scott Bennett and Mr. Leo Totten.

Each primary reviewer received a tape containing 40 randomly selected pre and post test trials from 20 subjects. They received both the pre and post test (arranged in random order) for each subject in order to minimize reviewer to reviewer variation. Pre and post test trials did not appear in any particular order on the tape.

The purpose of having cross validators was to test the consistency of the evaluations of the primary reviewers. These experts in the field of strength and conditioning were given a randomized sample of 42 pre and post test trials equal drawn from each of the three primary reviewers. The pre and post trials of seven subjects drawn randomly from each of the primary reviewers pool of trials. Both cross validators received the same taped trials in order to compare their rating consistency as well as the primary reviewers to cross

validators comparison. These correlation were made using a Pearson correlation analysis.

Training

Each group lifted weights three days per week (Monday, Wednesday, and Friday) for seven weeks during the study (See Appendix A for specific training regimen for each group). Each workout session lasted approximately eighty minutes. Prior to each training session, subjects in all groups warmed up for 10 minutes, and performed stretching of the lower back and hamstring muscle groups. In all the groups, all power clean related lifts were performed before any other scheduled weight training exercises during each workout session. This insured that the power clean was practiced when the athletes were not too fatigued to utilize proper form.

Data Analysis and Statistical Treatment

In order to test the hypotheses and provide evidence to answer the research questions posed earlier in this paper, the data reduction and statistical analysis was divided into three separate components:

1) Analysis of the between group and within group main effects using a combined total score, including all three upward movement phases of the power clean.
2) Analysis of the between group and within group main effects of each upward movement phase separately.
3) Analysis of the correlation between primary reviewers and cross-validaters in grading the power clean lifting technique of all subjects.

A one-way ANOVA with a Scheffe test was used to determine mean differences between groups for components 1 and 2. The Scheffe test, which determines the difference between means was chosen because it is one of the most conservative of all follow-up tests (Howell, 1992). A Bivariate Correlation analysis was employed to determine the correlation between the primary and cross-validator reviewers in grading the subjects.

Results

In order to answer the research questions posed in Chapter One the following results were recorded. These results reflect the format of the instrument used by the evaluations of the power clean technique (see Appendix B). The technique of the power clean was evaluated both segmentally and in complete movement fashion. Thus the results were broken down into three segmental phases which were analyzed separately as well as the total sum of scores of the three phases which indicated an overall rating of the subjects technical execution of the power clean.

The three segmental phases of the power clean analyzed separately were: 1. The upward movement phases: first pull; 2. Upward movement phase: transition (scoop); and 3. Upward movement phase: second pull.

The scores are the mean subjective rating of various experts in the field of strength and conditioning and weightlifting. The scores reflect the quality of the technique of the lifts on a scale of one to five, with five being the highest attainment of proper form.

Table 2 shows the comparison of mean scores of the first pull phase of the lift. The entire list of technical points evaluated in all segmental phases of the lift are found in Appendix 2.

The results of the ANOVA and the Scheefe test of the first pull of pre-test mean scores indicate no significant difference between any of the three groups. Group 1 - Double Knee Bend (DKB), group 2 - No Double Knee Bend (NDKB), and Group 3 - Control Group (CG).

The results of the post-test scores of this same phase indicate a significant difference between the two experimental groups (NDKB and DKB) and the control group. There was no significant difference found between the two experimental groups, NDKB and DKB, $p<0.01$.

This same pattern was reflected in the results of the statistical analysis of the transition or scoop phase of the lift and the final segment of the lift evaluated, the second pull. The results are reported in Tables Two and Three respectively.

The results of the statistical analysis and post hoc test of the total of the three scores also reflected no significant difference between the three groups

during the pre-test. The post test results of the total score indicated a significant difference between the two instructed groups (NDKB and DKB) and the control group. However, no significant difference was found during the post test of the total scores of NDKB and DKB, $p<0.01$.

Cross Validation

In an effort to determine the consistency of scoring, a cross validation procedure was implemented by having two independent, qualified evaluators rate a random sample of the subject's techniques that were previously evaluated by the primary reviewers.

In Table 6, a bivariate correlation analysis of total test scores revealed a significant correlation of .561 and .590 between scoring of the primary evaluators and the cross validators ($p<0.01$).

Table 2. Pre and post mean test scores of upward movement phase: first pull

	Group One DKB	Group Two NDKB	Group Three Control
Pre	29.05 ± 7.53	29.10 ± 5.54	25.15 ± 5.83
Post	34.45 ± 7.19*	35.20 ± 6.93*	25.90 ± 5.52

* ($p<0.01$)

Table 3. Pre and post mean test scores of upward movement phase: transition (scoop)

	Group One DKB	Group Two NDKB	Group Three Control
Pre	11.85 ± 2.16	11.55 ± 3.03	10.05 ± 2.06
Post	16.80 ± 3.17*	16.35 ± 3.89*	10.50 ± 2.54

* $p < 0.01$

Table 4. Pre and post mean test scores of upward movement phase: second pull

	Group One DKB	Group Two NDKB	Group Three Control
Pre	24.85 ± 7.49	22.10 ± 3.93	21.60 ± 5.11
Post	31.75 ± 6.33*	31.45 ± 5.61*	20.70 ± 3.34

* $p < 0.01$

Table 5. Pre and post mean test scores of total scores of power clean technique

	Group One DKB	Group Two NDKB	Group Three Control
Pre	66.00 ± 15.60	67.75 ± 9.95	56.80 ± 10.61
Post	83.00 ± 13.02*	83.00 ± 14.39*	59.15 ± 11.63

* $p < 0.01$

Table 6.

Bivariate Correlation results of total test scores between cross validators and primary reviewers as well as Pearson correlation coefficient.

	Mean Scores	Cross Validator 1	Primary Evaluator	Cross Validator 2
Cross Validator 1	73.38 ± 16.19	1.00	.590*	.665*
Primary Evaluators	69.08 ± 18.58	.590*	1.000	.561*
Cross Validator 2	79.36 ± 13.79	.665*	.561*	1.000

* $p < 0.01$

Discussion

Introduction

The literature has fairly well established the power clean weight training exercise as an important exercise for the development of sports specific muscular power (Baker, Bielek, Etherberry, et al. 1985; Caravan, Garret & Armstrong, 1996; Fleck & Kraemer, 1997). The power clean exercise incorporates three components of specificity: anatomical, mechanical and velocity (Garhammer, 1985; Pauletto, 1991). Many collegiate football strength and conditioning programs employ the power clean as a major component of their strength and power training regimens (Baechle, 1992).

Given the importance of this lift as established by the literature and the salience of the exercise within college football strength and conditioning programs, the importance of teaching the technical aspects of the lift correctly becomes paramount. Critical to the technical execution of the lift is the scoop or double knee bend technique which should occur during the transition phase of the lift. If the double knee bend technique is not executed properly the lift will fail to provide the potential benefits of mechanical specificity (Newton, 1994). Improper execution of power clean technique could lead to a wide range of maladies including a greater risk of orthopedic injury and loss of transfer specificity (Baechle, 1992; Garhammer, 1985; Newton, 1994; Pauletto, 1991).

Thus, the purpose of this study was to determine whether or not the double knee bend technique, which should occur during the transition phase of the lift, required singular emphasis and segmental practice by athletes learning the power clean. In doing so, this study is designed to compare two popular approaches of instructional method of teaching the power clean and answer the following research question (Johnson, 1982; Jones, 1991, 1991b).

Do intercollegiate football players who are experienced weight trainers, but novices with regard to the power clean exercise, perform the technical execution of the power clean exercise with equal effectiveness after seven weeks of training regardless of whether the double knee bend segment of instruction is introduced and segmentally practiced or not?

Power Clean Segmental Score Evaluation

The power clean technique was evaluated segmentally by each upward movement phase of the lift as well as in total. This was done to determine if any one phase of the lift might skew the total lift evaluation by being irrelevant or an

outlyer. In other words, one experimental group could have out performed the other in a different segment of the lift yet the overall or total evaluation might show no significant difference between groups. The mean test results of the total of three segments of power clean technique evaluation (first pull, transition or scoop, and second pull) are reflective of the individual segmental results.

In analyzing each of the three upward phases of the power clean segmentally, a consistent pattern is evident throughout the analysis. In all three segments the difference among the pre-test scores across the three groups (Control, DKB and NDKB) were not statistically significant. Similarly this was true for the total analysis of the power clean with all three phases combined. This finding is relevant because it suggests that the three randomly assigned experimental groups were similar, in terms of their lifting skills, prior to their respective treatments.

In comparing the pre to post test results among groups some significant differences do arise. First, the control group experienced no significant change in any of the three segments nor the total power clean rating score from pre to post test. This suggests that six weeks of practicing a similar weight training program with no power clean instruction, other than that received during the orientation session, was not sufficient in causing a significant improvement in any component of the lift.

With the two experimental groups who were instructed (DKB and NDKB) both groups did achieve significant improvement from pre to post test in both the individual phases and the total power clean ratings. The improvements were consistent from phase to phase which showed that the total score improvements were not due to the contaminating effect of one group out performing the other in one phase only, thus skewing the total score. There was, however, no statistical difference between the two instructed groups (DKB and NDKB) with regard to post test scores. This finding suggests that the teaching of the double knee bend has no significant effect of the quality of the performance of the power clean and is therefor unnecessary.

Conclusion

On the basis of the results observed in this study the null hypothesis was accepted. There appears to be no significant difference between the technical execution of the power clean with sub-maxial weight whether the double knee bend technique was verbalized and practiced segmentally or not by subjects learning the power clean during a seven week training period. While this finding is relevant to this specific group, it would seem to support the teaching

philosophy of the Weightlifting USA organization with regards to the double knee bend technique. The position of this organization is that the double knee bend can not be taught and need not be practiced segmentally when learning the power clean exercise (Jones, 1991).

The results of this study can only be generalized to a similar population of subjects. Fortunately, in the environment of collegiate football strength and conditioning programs, populations similar to the population of subjects involved in this study are typical.

This was a short duration study (seven weeks of training) involving relative novice performers with regard to power clean technique. The reviewers of the tape were aware of the length of the study so may have rated these subjects within this context versus rating the technical execution of national level olympic weightlifters. Perhaps the segmental practice of the double knee bend across a longer period of time would produce a greater discernible difference in the technical performance of the double knee bend technique while performing the power clean.

It is recognized that the highly subjective nature of qualitative analysis lends itself to a potential bias which could affect the results. Although this is an unavoidable factor in a study of this type, many efforts were made to minimize any potential bias. First, those chosen to review the tape were considered to be from among the most experienced and respected professionals in the area of strength training and lifting techniques. All trials were analyzed in a "blind" review with trials and groups randomized. A separate group of cross validators were enlisted to review a random sample of subjects previously rated by the primary reviewers. The scores of the primary reviewers were compared to the scores of the cross validators via a Pearson Correlation Analysis. The results of that analysis showed a modest correlation between the primary reviewers and the cross validators.

One possible study might be one involving individuals who have difficulty performing the double knee bend after initial instruction and practice of the power clean. In other words, what is the efficiency of teaching the double knee bend to a remedial group of lifters that were deficient in that particular area of the lift?

Implications for the Collegiate Strength and Conditioning Coach

As previously stated, the population studied is somewhat typical of the entire population of collegiate football players in this country. Many players have some experience with weight training in high school, most have no experience being formally coached in the power clean or other olympic style weightlifting exercises. The current environment for collegiate athletes is one that demands time efficiency and expediency of training methods. This is due to the tremendous overall time demands and actual time restrictions placed on strength and conditioning activities as mandated by the National Collegiate Athletic Associations, the governing body of the majority of college programs. Efforts should be made to study the efficiency of training methods in order to best instruct the athlete.

Based on this study the strength and conditioning professional, introducing the power clean exercise, might best spend his time teaching other aspects of the power clean rather than spending training and teaching time emphasizing the double knee bend aspect of the lift.

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Training Protocol Appendix A

Group #1 Scoop Double Knee Bend (DKB)
Power Clean or Related Exercises

All percentages based on previously established above the knee hang clean max.

Week 1

Monday

Deadlift to knee:	1 set, 5 reps
Deadlift to mid thigh:	2 sets, 5 reps
Below knee hang clean:	Warm up, 5 reps
	61% - 5 reps
	64% - 5 reps
	67% - 5 reps

Wednesday

Deadlift to knee:	1 set, 5 reps
Deadlift to mid thigh:	2 sets, 5 reps
Clean pulls from floor:	70% - 5 reps
	73% - 5 reps
	79% - 5 reps

Week 2

Monday

Deadlift to knee	1 set, 5 reps
Deadlift to mid thigh:	2 sets, 5 reps
Below knee hang clean:	Warm up, 5 reps
	64% - 5 reps
	67% - 5 reps
	70% - 5 reps

Wednesday

Deadlift to knee:	1 set, 5 reps
Deadlift to mid thigh:	2 sets, 5 reps
Clean pulls from floor:	67% - 5 reps
	76% - 5 reps
	82% - 5 reps

Week 3

Monday

Deadlift to knee:	1 set, 3 reps
Deadlift to mid thigh:	2 sets, 3 reps
Below knee hang clean:	Warm up, 3 reps
	64% - 3 reps
	67% - 3 reps
	70% - 3 reps
	76% - 3 reps

Wednesday

Deadlift to knee:	1 set, 3 reps
Deadlift to mid thigh:	2 sets, 3 reps
Clean pulls from floor:	70% - 3 reps
	76% - 3 reps
	82% - 3 reps
	88% - 3 reps

Week 4

Monday

Deadlift to mid thigh:	2 sets, 3 reps
Power clean:	Warm up, 3 reps
	62% - 3 reps (2 sets)
	64% - 3 reps (2 sets)

Wednesday

Power clean:	Warm up, 3 reps
	64% - 3 reps
	67% - 3 reps
	70% - 3 reps
	73% - 3 reps (2 sets)
Clean pulls from floor:	2 sets, 3 reps
	last set - 91%

Week 5

Monday

Deadlift to mid thigh:	2 sets, 3 reps
Power clean:	Warm up, 3 reps
	61% - 3 reps
	64% - 3 reps
	67% - 3 reps (2 sets)

Wednesday

Power clean:	Warm up, 3 reps
	64% - 3 reps
	70% - 3 reps
	73% - 3 reps
	76% - 3 reps (2 sets)
Clean pulls from floor:	2 sets, 3 reps
	last set 94%

Week 6

Monday

Deadlift to mid thigh:	2 sets, 3 reps
Power clean:	Warm up, 3 reps
	61% - 3 reps
	64% - 3 reps
	67% - 3 reps
	70% - 3 reps

Wednesday

Power clean:	Warm up, 3 reps
	64% - 3 reps
	70% - 3 reps
	73% - 3 reps
	79% - 3 reps (2 sets)

Week 7

Monday

Deadlift to mid thigh:	2 sets, 3 reps
Power clean:	Warm up, 3 reps
	64% - 3 reps
	67% - 3 reps
	70% - 3 reps
	73% - 3 reps

Wednesday

Power clean:	Warm up, 3 reps
	64% - 3 reps
	70% - 3 reps
	79% - 3 reps
	82% - 3 reps
Clean pulls from floor:	2 sets, 3 reps
	last set 97%

Training Protocol

Group #2: The No Scoop or No Double Knee Bend Group (NDKB)

Power Clean or Related Exercises

All percentages based on previously established above the knee hang clean max.

Week 1 Phase 1

Week 2

Monday

Olympic deadlift to knee:	3 sets, 5 reps
Hang clean, below knee:	Warm up, 5 reps
	64% - 5 reps
	67% - 5 reps
	70% - 5 reps

Wednesday

Olympic deadlift to knee:	3 sets, 5 reps
Clean pulls from floor :	67% - 5 reps
	76% - 5 reps
	82% - 5 reps

Week 3

Monday

Olympic deadlift to knee:	3 sets, 5 reps
Hang clean below knee:	Warm up, 5 reps
	64% - 3 reps
	67% - 3 reps
	70% - 3 reps
	73% - 3 reps

Wednesday

Olympic deadlift to knee:	3 sets, 3 reps
Clean pulls from floor:	70% - 3 reps
	76% - 3 reps
	82% - 3 reps
	88% - 3 reps

Week 4

Monday

Olympic deadlift to knee:	2 sets, 3 reps
Power clean - technique emphasis:	Warm up, 3 reps
	61% - 3 reps (2 sets)
	64% - 3 reps (2 sets)

Wednesday

Power clean:	Warm up, 3 reps
	64% - 3 reps
	67% - 3 reps
	70% - 3 reps
	73% - 3 reps, 2 sets
Clean pulls from floor:	2 sets, 3 reps
	last set 91%

Week 5

Monday

Deadlift to knee:	2 sets, 3 reps
Power clean:	Warm up, 3 reps
	61% - 3 reps
	64% - 3 reps
	67% - 3 reps (2 sets)

Wednesday

Power clean:	Warm up, 3 reps
	64% - 3 reps
	70% - 3 reps
	73% - 3 reps
	76% - 3 reps (2 sets)
Clean pulls from floor:	2 sets, 3 reps
	last set 91%

Week 6

Monday

Deadlift to knee:	2 sets, 3 reps
Power clean:	Warm up, 3 reps
	61% - 3 reps
	64% - 3 reps
	67% - 3 reps (2 sets)

Wednesday

Power clean:	Warm up, 3 reps
	64% - 3 reps
	70% - 3 reps
	73% - 3 reps
	79% - 3 reps (2 sets)
Clean pulls from floor:	2 sets, 3 reps
	last set 91-94%

Week 7

Monday

Deadlift to knee:	2 sets, 3 reps
Power clean:	Warm ups, 3 reps
	64% - 3 reps
	67% - 3 reps
	70% - 3 reps
	73% - 3 reps

Wednesday

Power clean:	Warm up, 3 reps
	64% - 3 reps
	70% - 3 reps
	79% - 3 reps
	82% - 3 reps (2 sets)
Clean pulls from floor:	2 sets, 3 reps
	last set 94-97%

Training Protocol

Group 3: Control Group
Power Clean or Related Exercises

All percentages based on previously established above the knee hang clean max.

Week 1

Wednesday

Hang clean/Front squat combo:	Warm up, 5 reps
	61% - 5 reps
	64% - 5 reps (2 sets)

Friday

Hang snatch	4 sets, 5 reps

Week 2

Wednesday

Hang clean/Front squat combo:	Warm up, 5 reps
	61% - 5 reps
	64% - 5 reps
	67% - 5 reps

Friday

Hang snatch:	4 sets, 5 reps

Week 3

Wednesday

Hang clean/Front squat combo:	Warm up, 5 reps
	61% - 4 reps
	64% - 4 reps
	67% - 4 reps
	70% - 4 reps

Friday

Hang snatch:	4 sets, 5 reps

Week 4

Wednesday

Hang clean:	Warm up, 5 reps
	64% - 3 reps
	70% - 3 reps
	76% - 3 reps (2 sets)

Friday

Hang snatch:	4 sets, 4 reps

Week 5

Wednesday

Hang clean:	Warm up, 5 reps
	64% - 3 reps
	70% - 3 reps
	76% - 3 reps
	79% - 3 reps

Week 6

Wednesday

Hang clean:	Warm up, 5 reps
	64% - 3 reps
	70% - 3 reps
	76% - 3 reps
	82% - 3 reps
	88% - 3 reps

Week 7

Hang clean:	Warm up, 5 reps
	64% - 3 reps
	70% - 3 reps
	76% - 3 reps
	82% - 2 reps
	88% - 2 reps

Appendix B

Please evaluate the numbered, taped trials of the power clean using the statements provided in the check list below. Rate the execution of each statement on a scale of one to five with one being very poor technique and five being excellent technique. It is not necessary to compile the scores. Simply circle each rating.

UPWARD MOVEMENT PHASE: FIRST PULL

1. Begin pull by extending the knees.
   1 2 3 4 5

2. Move the hips forward and raise the shoulders at the same rate.
   1 2 3 4 5

3. Keep the angle of the back constant.
   1 2 3 4 5

4. Lift the bar straight up.
   1 2 3 4 5

5. Keep the bar close to the body, heels on the floor.
   1 2 3 4 5

6. Keep elbows fully extended.
   1 2 3 4 5

7. Keep shoulders back and above or slightly in front of the bar.
   1 2 3 4 5

8. Keep head facing straight forward.
   1 2 3 4 5

9. Maintain torso position.
   1 2 3 4 5

UPWARD MOVEMENT PHASE: TRANSITION (SCOOP)

1. Thrust hips forward and continue pulling until knees are under the bar.
   1 2 3 4 5

2. Keep feet flat.
   1 2 3 4 5

3. Torso should be nearly vertical and erect.
   1 2 3 4 5

4. Keep shoulders positioned directly over the bar.
   1 2 3 4 5

5. Keep elbow fully extended.
   1 2 3 4 5

UPWARD MOVEMENT PHASE: SECOND PULL

1. Brush the bar against the middle or top of the thigh.
   1 2 3 4 5

2. Keep torso erect and head facing straight or slightly up.
   1 2 3 4 5

3. Keep elbows straight.
   1 2 3 4 5

4. Move the bar explosively by extending the hip, knee, and ankle joints in a “jumping action”.
   1 2 3 4 5

5. Keep the shoulders over the bar as long as possible and elbows out.
   1 2 3 4 5

6. Keep the bar close to body.
   1 2 3 4 5

7. At maximum plantar flexion, shrug the shoulders.
   1 2 3 4 5

8. At maximum shoulder elevation, flex and pull with the arms.
   1 2 3 4 5

9. Keep the elbows high during the pull, over the wrist.
   1 2 3 4 5

10. Pull the bar as high as possible.
    1 2 3 4 5

Curriculum Vitae

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