dead lifts, squats and muscle action

report: Tony Lycholat

Much of what has traditionally been said about the performance of 'big' exercises like the dead lift or squat has not necessarily been based on serious scientific investigation. For example, to what extent does stance width really matter? Does changing the foot position (that is, the amount of rotation at the hip) dramatically change muscle action and hence training effect?

In recent months, several papers published in mainstream research journals have investigated these questions. Most recently, two different types of dead lifts have been compared (Escamilla, R.F., et al, An electromyographic analysis of sumo and conventional style dead lifts, *Med. Sci. Sports Exerc.*, Vol. 34, No. 4, pp 682 - 688, 2002).

dead lift technique (as described by the authors):

"Athletes use the dead lift to enhance hip, thigh and back strength. The starting position is with the lifter in a squat position with the knees and hips flexed approximately 80 - 100 degrees, arms straight and pointing down and a alternating handgrip used to hold a barbell positioned in front of the lifter's feet. The barbell is then lifted upwards in a continuous motion by extending the knees and hips until the lifter is standing erect with knees locked and the shoulders thrust back. From this position, the barbell is slowly lowered back to the ground by flexing the knees and hips."

There are two main variations of this technique. One technique (referred to as conventional) maintains a relatively narrow stance (approximately hip to shoulder width) with the feet parallel and arms outside the knees. The sumo style has the feet further apart, turned out, with the arms inside the knees. It is widely believed that the two different techniques emphasise different muscle groups, yet the authors say few studies have compared biomechanical parameters between sumo and conventional dead lifts. It was the purpose of their study to compare muscle activity from leg, thigh, hip and trunk musculature between sumo and conventional dead lifts.In addition, the authors also investigated the effect of performing both techniques with and without a training belt.

method

Thirteen collegiate American football players acted as subjects. All were familiar with both lifting techniques and used them in their current training programme. Body segment movement was recorded using a six-camera, three-dimensional motion analysis system and electromyographic (EMG) data was recorded from the rectus femoris, vastus lateralis, vastus medialis, biceps femoris, semitendinosus / semiembranosus, lateral gastrocnemius, tibialis anterior, hip adductors, gluteus maximus, L3 paraspinals, T12 paraspinals, middle trapezius, upper trapezius, rectus abdominus and external obliques. This data was collected from each subject's left side only.

Four variations of each lift were performed by each subject in a randomised order: Sumo dead lift

with belt; sumo dead lift without belt; conventional dead lift with belt, and conventional dead lift without belt. The same weight was used for each lift, equivalent to their 12-repetition maximum (12RM).

results

The authors reported several small but significant EMG differences between sumo and conventional dead lifts. The sumo technique had greater EMG activity in the vastus lateralis, vastus medialis and tibialis anterior, but significantly less activity in the medial gastrocnemius. And when the belt conditions were compared, the no-belt condition involved significantly greater EMG activity in the rectus abdominis, but less EMG activity in the external obliques.

Based upon this study, the authors believe that the sumo style of dead lift may be more effective overall than the conventional dead lift in recruiting the vastus medialis, vastus lateralis and tibialis anterior. The conventional dead lift, they believe, may be more effective in recruiting medial gastrocnemius. Furthermore, wearing a belt during sub-maximal training does not appear to alter muscle activation patterns, with the exception of the abdominal musculature.

researching the squat and leg press

A similar approach to investigating squat techniques was taken by another team of researchers, again led by Escamilla (Escamilla, R.F. et al, Effects of technique variations on knee biomechanics during the squat and leg press, *Med. Sci. Sports Exerc.*, Vol. 33, No. 9, 2001, pp 1552 - 1566).

Ten experienced male lifters served as subjects. All performed the squat, a leg press (semi-recumbent machine) with a high foot placement (toes towards the top of the foot plate), and a leg press with a low foot placement (heels towards the base of the foot plate), using both a wide and narrow stance with feet straight or turned out 30 degrees, in a random order, using a 12RM load.

As in the previous study, body segment movement was recorded using a six-camera, three-dimensional motion analysis system and electromyographic (EMG) data was recorded from the rectus femoris, vastus lateralis, vastus medialis, biceps femoris, semimembranosus/semitendinosus and gastrocnemius. A force plate was also used to collect data to enable the estimation of forces acting at the knee joint.

results

In terms of muscle activity, the data suggest, say the authors, that the squat may be a more effective exercise for quadriceps and hamstring development compared with the leg press (whether high or low foot placement). Additionally, there were no significant EMG differences in any of the muscles tested in the two leg press versions, with the exception of gastrocnemius. Consequently, the authors believe that either version appears equally effective for the quadriceps and hamstrings, although the low foot position may enhance gastrocnemius development.

Of extra interest is the comment: "The hamstrings may actually be working nearly isometrically during both the knee flexion and knee extension phases (all exercises and variations) because they are concurrently shortening at the knee and lengthening at the hip during the knee flexion phase and lengthening at the knee and shortening at the hip during the knee extension phase. In any case, the hamstrings probably do not change length much throughout the squat, leg press (high) and leg press (low)."

In terms of foot placement, the authors conclude that 'because varying foot angles did not affect muscle activity or knee forces during the squat and leg press, it is recommended that athletes or rehabilitation patients employ a foot angle that is comfortable to them'.

NB: This is a study brimming with data and just a few of the main points of potential interest to the instructor are mentioned here. The interested reader is advised to consult the entire paper if they truly wish to begin to understand fully squat and leg press mechanics and muscle action. *fp*

other recent papers of related interest

1. Alkner, B.A., Tesch, P.A & Berg, H.E, quadriceps EMG/force relationship in knee extension and leg press, Med. Sci. Sports Exerc., 32: 459 - 463, 2000.

2. Escamilla, R.F. et al, A three-dimensional biomechanical analysis of the squat during various stance widths, Med. Sci. Sports Exerc., 33: 984 - 998, 2001.

3. McCaw, S.T & Melrose, D.R, Stance width and bar load effects on leg muscle activity during the parallel squat, Med. Sci. Sports Exerc., 31: 428 - 436, 1999.