Exercises to Activate the Deeper Abdominal Wall Muscles: The Lewit: A Preliminary Study

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Abstract

Badiuk, BWN, Andersen, JT, and McGill, SM. Exercises to activate the deeper abdominal wall muscles: The Lewit: A preliminary study. *J Strength Cond Res* 28(3): 856–860, 2014—The abdominal wall is a prime target for therapeutic exercises aimed to prevent and rehabilitate low back pain and to enhance performance training. This study examined the "Lewit," a corrective exercise prescribed for several purposes, which is performed lying supine in a crook-lying position and involves forceful breathing. Muscle activation and lumbar posture were compared with bracing the abdominal wall (stiffening) with robust effort and "hollowing" (attempting to draw in the wall toward the naval) with robust effort. Eight healthy male volunteers with 6 channels of electromyography were collected by means of surface electrode pairs of the rectus abdominis, external oblique, and internal oblique (IO) together with lumbar motion. The Lewit exercise caused higher muscle activity in the deeper abdominal wall muscles, in particular the IO and by default the transverse abdominis were activated at 54% maximum voluntary contractions (MVCs) on average and 84% MVC peak with no change in spine posture to maintain the elastic equilibrium of the lumbar spine. The Lewit is a deep oblique muscle activation exercise, and the activation levels are of a sufficient magnitude for training muscle engrams. This information will assist strength and conditioning coaches with program design decisions where this corrective abdominal exercise may be considered for clients who elevate the ribcage during strength exertions, or for clients targeting the deep obliques.

Key Words spinal stabilization, rehabilitation, electromyography, lumbar spine

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Introduction

There has been substantial research focusing on decreasing the risk of developing low back disorders and enhancing performance through lumbar stabilization techniques and core-strengthening exercises. Core-strengthening exercises have traditionally focused on improving the activation patterns and strength of abdominal muscles. Further, corrective exercises are often directed at the abdominal mechanism to enhance performance and reduce the risk of developing pain or injury. This study assesses 1 such exercise.

The abdominal wall is a prime target for therapeutic exercises aimed to prevent and rehabilitate low back pain. Specifically, the deeper abdominal wall muscles (internal oblique [IO] and transverse abdominis [TrA]) have been the target of these exercises (14). Some have suggested a "hollowing" maneuver to activate these muscles (4), whereas others have advocated a "bracing" technique to simply activate the entire abdominal wall (3) with the activation level adjusted to match the demands of the task and minimize pain. The act of bracing, however, was to create torso stiffness and spine stability, facilitating the ability to bear load, rather than deliberately enhancing strength. Activation of the abdominal wall has also been implicated in performance training through creating proximal stiffness to enhance movement distal to the ball and socket hip and shoulder joints (8). The lateral abdominal muscles have also been identified in assisting the hip musculature to stabilize the pelvis during tasks involving walking while carrying great loads (12). Abdominal muscles have also been the target of training given their recognized role in challenged breathing to generate intraabdominal pressure (5,6) assist in childbirth (6), and for defecation (6,15). Understanding training techniques to enhance abdominal wall function is of interest to those involved in any of the activities listed above.

Given this rationale for selecting appropriate abdominal training exercises, this study examined the "Lewit," an exercise named after the Czechoslovakian neurologist Dr. Karol Lewit. Given the role of the obliques in torso flexion moment generation, together with its role in active ventilation (that being to force air out of the lungs) (5), he derived an exercise incorporating both mechanisms. The Lewit is performed with the subject lying supine in a crook-lying position (Figure 1) with the hips flexed to form a 90° angle between the thigh and trunk, while the knees are flexed to form a 90° angle between the thighs and legs. Initially, the individuals breathe normally (normal tidal breathing). They then focus on "teetering" the pelvis, using the sacrum as a fulcrum axis with the ground to allow the natural lordotic curve of the lumbar spine to be maintained by posturing the lumbar spine into elastic equilibrium (i.e., not flattened to the floor). This represents the least stressed and unloaded posture for the spine. At the end of each normal exhalation, the lips are pursed as if breathing through a straw to create resistance. Full effort is then directed to expelling all possible air with forceful abdominal effort. During this final phase, the abdomen appears to rise and Dr. Lewit's intent was also to pull the ribcage down, correcting the tendency in some to hinge the thoracic spine about the thoracolumbar junction during powerful exertions such as lifting. Overhinging in extension is associated with pain at the thoracolumbar junction.

The purpose of this study was to quantitatively measure core muscle activation and spine flexion during the Lewit exercise. Given that no previous research exists that quantified the demands of the Lewit, the first objective was to describe the mechanics of the exercise. The second objective was to compare the Lewit with other abdominal strategies, namely, bracing the abdominal wall (stiffening) with robust effort and "hollowing" (attempting to draw in the wall toward the naval) while in the crook-lying position. It was hypothesized that the Lewit exercise would not result in increased spine flexion, while activating the abdominal muscles more than the hollowing technique and equal to that of maximal effort abdominal bracing.

Methods

Experimental Approach to the Problem

The purpose of this study was to quantify core muscle activation and spine flexion during the Lewit exercise, a proposed new abdominal training and corrective exercise. The Lewit was compared with other abdominal strategies that have been previously characterized in the literature, namely, bracing the abdominal wall (stiffening) with robust effort and "hollowing" (attempting to draw in the wall toward the naval) while in the crook-lying position. Independent variables of exercise (abdominal hollowing, abdominal bracing, the Lewit) and dependent variables of spine posture and muscle activation values were tested for the influence of exercise type with a test-retest design.

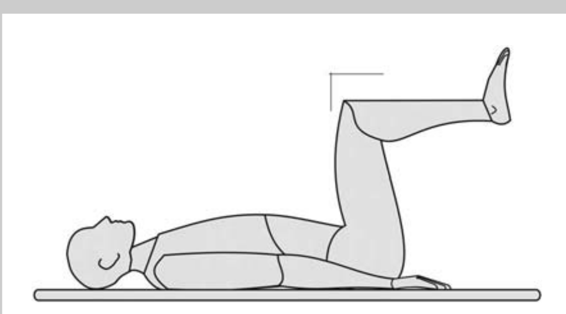

Figure 1. The Lewit is performed in a crook-lying position.

Subjects

Eight healthy male volunteers (age $\bar{x} = 22.5$ years, range: 19–28 years, $SD = 2.2$; height $\bar{x} = 1.79$ m, $SD = 0.06$) signed an information and consent form approved by the University Office of Research Ethics. All the participants were healthy and had no history of disabling low back pain.

Procedures

Muscle Activation. Six channels of electromyography (EMG) were collected via surface electrode pairs (Meditrace, Mansfield, MA, USA) placed 2.5 cm apart, center to center over the following muscles on each side of the body: rectus abdominis (RA)–2.5 cm lateral to the navel; external oblique (EO)–approximately 3 cm lateral to the linea semilunaris but on the same level of RA electrodes; and IO–caudal to the EO electrodes and the anterior superior iliac spine but still cranial to the inguinal ligament (11). Transverse abdominis was not recorded directly; however, its activity can be inferred from the IO activation during supine tasks (9). Electromyography data were sampled at 2,160 Hz, A/D converted with a 12-bit converter, bandpass filtered between 30 and 500 Hz, full-wave rectified, low pass filtered (Butterworth) at 2.5 Hz to mimic frequency response of the torso muscles (2). The subjects performed a series of maximum voluntary contractions (MVCs) for normalization of each muscle's EMG signal. To achieve maximal exertion of the abdominal muscles, the subjects adopted a sit-up position while they were restrained by a researcher. They then performed a maximal isometric flexion moment; together with simultaneous right and left lateral bend moments and right and left twist moments (11). For all conditions, the experimenter provided sufficient resistance for contractions to be isometric.

Spine Posture. The ribcage relative to the pelvis kinematics (i.e., lumbar motion) for the abdominal exercises was measured using a 3-SPACE ISOTRAK (Polhemus, Colchester, VT, USA) recording at a sample rate of 60 Hz. To accomplish this, the 3-Space electromagnetic field source was strapped in place over the anterior pelvis, and a receiver was strapped across the rib cage over the T12 spinous process. Spine posture was normalized to crook-lying posture in elastic equilibrium (i.e., this corresponded to 0° of flexion extension, lateral bend, and twist) (11).

Exercise Tasks. The subjects performed the 3 exercise variations with 3 trials of each in a random order. All 3 exercises were performed in the same supine posture.

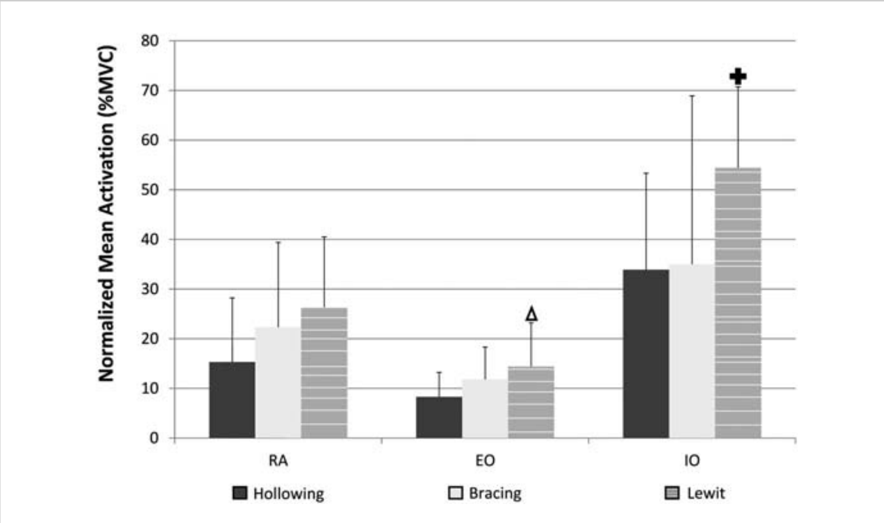

Figure 2. Normalized mean (bars) muscle activation and *SD* for rectus abdominis, external oblique, and internal oblique muscles across all experimental conditions.+ More internal oblique in Lewit than in bracing and hollowing ($p = 0.006$); Δ more external oblique in Lewit than in hollowing ($p = 0.025$).

Exercise technique was thoroughly explained and practiced. The subjects received sufficient rest (at least 30 seconds) between trials to prevent fatigue from affecting their performance. Approximately 5 minutes of rest was given between tasks. The hollowing and bracing trials began with the subject taking 2 regular breaths, followed by the initiation of the appropriate abdominal task. The prescribed abdominal effort was then maintained while the subject took 2 additional breaths. For the hollowing task, the subjects were instructed to robustly draw in the abdominal muscles toward their spine. For the bracing task, the subjects were instructed to robustly contract the abdominal muscles and take 2 breaths while maintaining the contraction.

Statistical Analyses

The EMG signals were normalized to the MVC of each muscle and downsampled to 60 Hz using custom designed LabView (National Instruments, Austin, TX, USA) software. Muscle activation was averaged over a 2-second window during the period the exercise was performed, creating an averaged sample score. Normalized peak EMG values were also identified for analysis. Spine flexion was averaged over a 1-second window while the exercise was performed, creating an averaged sample score.

Two separate 3-way repeated measure analyses of variance (ANOVAs) were used to assess the differences in average and peak muscle activation, respectively, between exercise, side and muscle. A 1-way repeated measure ANOVA was used to assess differences in spine posture.

The 3-way repeated measure ANOVAs ($\alpha = 0.05$) revealed no significant effect of side on muscle activation; therefore, the left and right EMG values were averaged for each muscle. Post hoc *t*-tests with Bonferroni corrections were used to investigate the differences in muscle activation during abdominal hollowing and bracing techniques compared with the Lewit (both mean and peak). Additional Bonferroni *t*-tests were used to determine the difference in the RA, EO, and IO activation during abdominal hollowing and bracing compared with the Lewit for both mean and peak values. The 1-way repeated measure ANOVA ($\alpha = 0.05$) revealed no significant effect of exercise on spine posture; therefore, no further analyses were performed.

Results

Mean Muscle Activation

Three-way repeated measure ANOVA showed a significant effect of muscle ($F[2,14] = 10.65$, $p = 0.014$) and exercise ($F[2,14] = 13.15$, $p = 0.008$) on EMG activity with no significant interaction effects. There was also no significant effect of side on muscle activation ($F[1,7] = 2.72$, $p = 0.143$); therefore, for the remaining analyses of mean muscle activity, left and right EMG values were averaged for each muscle. Bonferroni *t*-tests ($\alpha = 0.025$) revealed that the Lewit elicited significantly greater average abdominal muscle activation compared with the bracing ($t[23] = 2.57$, $p = 0.017$) and hollowing ($t[23] = 3.04$, $p = 0.006$) techniques. Specifically, the average IO activity during the Lewit was 19.4% greater than during abdominal bracing ($t[15] = 3.17$, $p = 0.006$) and 20.5% greater than during the hollowing technique ($t[15] = 2.50$, $p = 0.024$). Mean IO activation increased from approximately 33.9% (hollowing) and 35.0% (bracing) MVC to 54.4% MVC during the forceful exhalation phase of the Lewit (Figure 2). Similarly, EO activation increased from 8.3% MVC during the abdominal hollowing technique to the 14.4% MVC during the Lewit ($t[15] = 3.28$, $p = 0.005$), but only 2.6% greater activation than bracing. Although not statistically significant, EO activation also increased from 11.8% MVC during abdominal bracing to the previously mentioned 14.4% MVC during the Lewit. Although not statistically significant, the mean RA also increased from 15.3% and 22.3% MVC in hollowing and bracing to 26.3% MVC during the Lewit. The Lewit is a deep oblique muscle activation exercise tool.

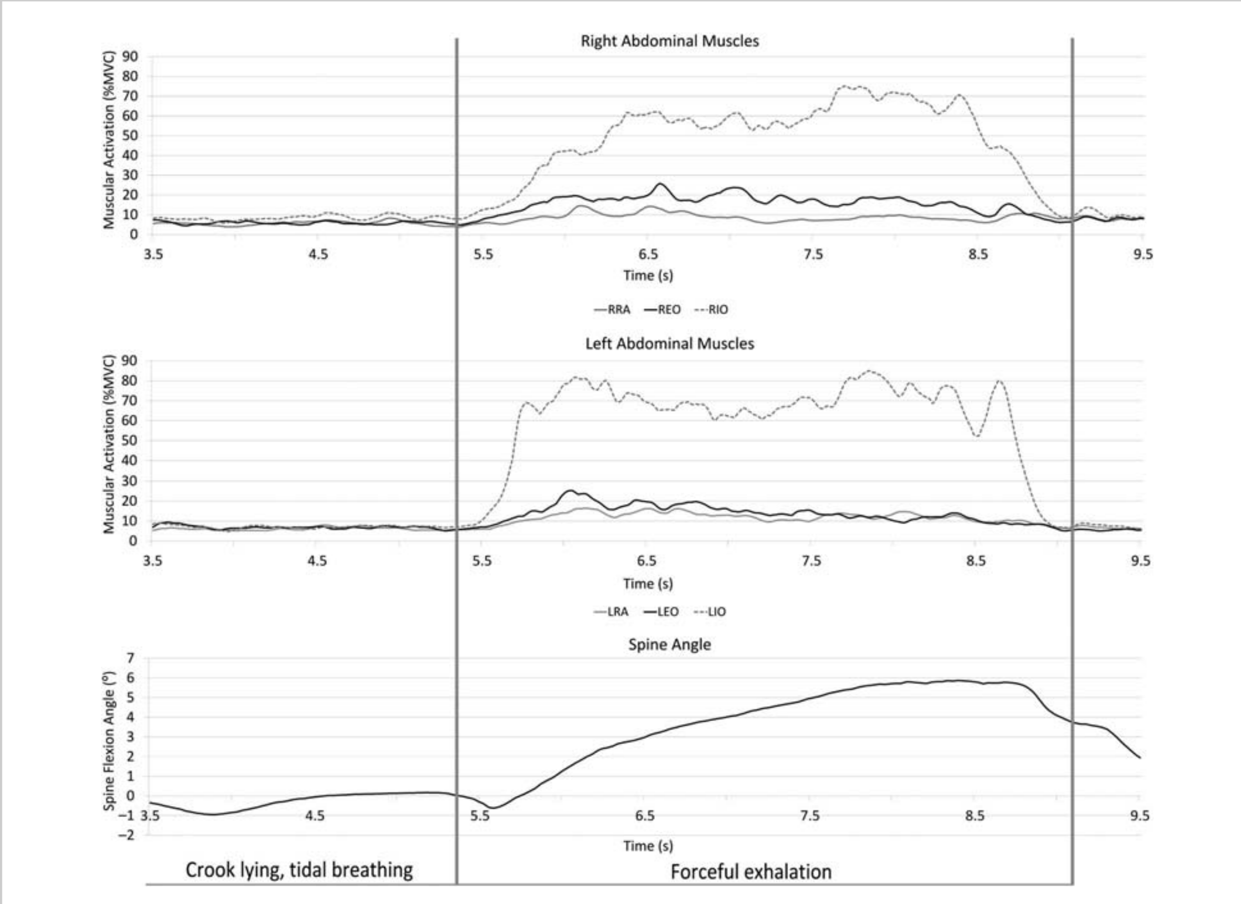

Figure 3. Time history of normalized right and left side rectus abdominis, external oblique, and internal oblique muscle activity along with spine angle during the Lewit exercise. Upon actively forcing air out of a restricted orifice, there is a sharp increase in the internal oblique activity (to ~80% maximum voluntary contractions), a slight increase in external oblique (to ~20% maximum voluntary contraction) and a lesser increase in the rectus abdominis activity (to ~13% maximum voluntary contraction) until the end of vital lung capacity (~3.5 seconds) with no statistically significant change in spine flexion angle. At the end of the vital lung capacity, abdominal muscle activity returns to normal resting levels.

A typical time history (Figure 3) shows the added muscle activation, particularly of the IO and TrA, during the forceful exertion phase of the Lewit.

Peak Muscle Activation

There were no statistically significant differences in peak muscle activity.

Spine Flexion Angle

There was no significant effect of exercise ($F[2,14] = 2.73$, $p = 0.10$) on spine flexion. Spine flexion angles remained essentially neutral (0.76° of spinal extension in bracing and 0.15° of spinal flexion during abdominal hollowing to 1.76° of spinal flexion during the Lewit).

Discussion

Muscle activation of the Lewit exercise was quantified based on abdominal EMG profiles. The Lewit exercise was hypothesized to activate the abdominal muscles significantly more than the abdominal hollowing technique and equal to abdominal bracing with no increase in spine flexion. For the deep obliques the hypothesis was supported, at least in terms of mean muscle activation. Clearly, the Lewit targets the deep oblique muscles. However, this was not observed in the RA. This is not surprising given the association of IO and TrA with the acts of sneezing, defecation, and childbirth (6) in addition to the role of TrA in challenged breathing (7).

Qualitatively, expelling all possible air with forceful abdominal effort during the final phase of the Lewit caused the abdomen to rise, pulling the ribcage down and not distorting the spine, at least not the lumbar portion measured in this study. These characteristics give merit to the Lewit being used as a corrective exercise for those who elevate the ribcage during strength exertions, because this exercise did not allow trunk flexion to occur.

The obliques are regionally activated, with several neuromuscular compartments; therefore, several exercises are required to fully challenge all components of the abdominal wall (10). However, for those wishing to train the deep abdominal wall muscles, the Lewit appears to be effective. These muscles appear to be important for several essential tasks of daily living. The notion exists that "forceful" activation levels during muscle training are better than lower levels for ingraining specific muscles into motor control patterns. An excellent overview by Monfils et al (13) documented the role of skilled movement practiced and performed with intensity to enhance synaptic strength of the engram representing the motor engram in the motor cortex. Further, simultaneous changes in the engram map reorganization occur with dendritic hypertrophy and synaptic potentiation; thus, both anatomical and neurophysiological enhancement of the motor pattern and engram occurs. From this perspective, the Lewit appears to incorporate the element of intensity to potentiate this abdominal motor pattern and engram. Note that the instruction to the participant was to robustly activate the abdominal wall during bracing and hollowing. This was to compare these techniques in a training context. These exercises would require lesser activation levels when used in a rehabilitation or pain control context.

The limitations of this study include the number of comparison exercises with the Lewit. Other exercises exist that have been shown to activate abdominal musculature (i.e. the curl-up, dead bug, and side bridge [1,11]); however, these types of exercises were not tested because they are not performed in the crook-lying position. This study did not examine the compressive load nor did it quantify the stability of the lumbar spine when performing the Lewit, leaving the challenge-to-compression ratio of the exercise in question. The floor is stabilizing to the spine, and it also applies forces to the torso prohibiting calculation of spine loads without the detailed pressure mapping of the torso–floor interface; thus, no comparison of spinal load or stability to previously reported values can be made.

Activation of the abdominal wall is of great importance for rehabilitation and training purposes. The breathing pattern of actively forcing air out against resistance, which is an essential feature with the Lewit, resulted in augmented mean abdominal muscle activity, particularly of the deep abdominal wall muscles. This increase in the muscle activity can be used in training motor patterns and mechanics where the objective may be to enhance stability, and do it at a level sufficiently robust as to more strongly construct movement engrams or motor patterns.

Practical Applications

Training muscles of the abdominal wall is often the objective of those attempting to enhance torso and spine stiffness and stability, in addressing musculoskeletal disorders such as low back pain and for enhancing performance in many activities. It seems the Lewit challenges the deep abdominal wall musculature in a posture that maintains the elastic equilibrium of the lumbar spine. This information will assist strength and conditioning coaches with program design where this corrective abdominal exercise may be considered for clients who elevate the ribcage during strength exertions, or for clients targeting the deep obliques.

Acknowledgments

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