Journal of Strength and Conditioning Research, 1999, 13(4), 384–388

The Use of Lumbar-Supporting Weight Belts While Performing Squats: Erector Spinae Electromyographic Activity

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ABSTRACT

This study sought to analyze the effects of subjects' wearing weightlifting lumbar support belts on surface electromyographic recordings of the erector spinae muscle group while the subject executed parallel squats. Ten healthy college-age men with weightlifting experience participated in this study. Participants completed a total of 6 repetitions of high-bar parallel back-squats at loads equaling 60% of their 1 repetition maximum. Experimental conditions required subjects to perform 6 squats, 3 while wearing a belt and 3 without. Electromyographic electrodes recorded muscle activity at 800 Hz on both the right and left erector spinae at the lumbar (L3–L5) and thoracic (T5–T7) regions during all lifts. The results indicate that subjects' mean erector spinae activity was greater ($p < 0.0125$) in the lumbar region of the spine when wearing weight belts (±258 *SD*; 69.0 analog-to-digital units) during squatting exercises than the mean activity in subjects who were not wearing weight belts (±235 *SD*; 71.3 analog-to-digital units).

Key Words: low back, injury, stability, electromyography

Reference Data: Bauer, J.A., A. Fry, and C. Carter. The use of lumbar-supporting weight belts while performing squats: Erector spinae electromyographic activity. *J. Strength Cond. Res. 13(4):384–388. 1999.*

Introduction

The popularity of cross-training has increased the focus on the importance of weightlifting and proper exercise techniques for a broad range of competitive and recreational athletes. Whether or not an athlete's focus is weightlifting, the functional benefits derived from lifting weights have direct applications in nearly every sport. Functional benefits of resistive exercise range from performance enhancement to injury rehabilitation and prevention. However, all the benefits gained through weight training are lost if the individual becomes injured. Athletes may believe that injury risk is significantly reduced when wearing weightlifting belts during workouts. There is still controversy over whether weight belts provide any measurable improvement in back support that would in turn make lifting weights safer for the wearer (3, 7, 8, 10, 11, 18–20). This study sought to analyze the effects of weightlifting lumbar support belts on surface electromyographic (EMG) recordings of the erector spinae muscle group while the wearer executed parallel squats. The intent of the study was to determine if significant differences in EMG activity would be seen between athletes who wore a weightlifting belt and those that did not.

Although it is the goal of most exercises to encourage muscle activity, thereby leading to increases in the functional capabilities of specific muscles, the squat exercise does not target the activation or strengthening the erector spinae muscles. High levels of erector spinae activity during a squat indicate that those muscles were being asked to provide more than simple stabilization during the exercise. A significant decrease in the measured activity of the erector spinae would support the theory that the belts were providing the anticipated support and stabilization of the spine, thereby decreasing the need for the erector spinae muscles to play an active role during the squat.

Parallel squatting is often considered a fundamental exercise in weightlifting (16); when performed correctly, it offers maximum strength gains while posing minimum strain on the joints and soft tissues involved in the squatting movement (14). The entire power zone of the lower body has been identified as a target of the exercise, including the quadriceps, hip flexors and extensors, and musculature of the lower back (9). As a closed-chain exercise, the transferability of the benefits of the squat exercise are frequently discussed (2, 9, 12, 14). Furthermore, the safety of closed-chain exercises over open-chain exercises is also touted, based upon research published by authors who report decreased anterior tibial translation with closed-chain exercises

Table 1. Participant characteristics of 10 college-age, male subjects.

	Age (y)	Height (cm)	Weight (kg)	Maximum squat (kg)	60% Max (kg)	Experience (y)
Mean	26.30	181.50	84.91	165.91	98.86	9.75
SD	± 6.43	± 5.48	± 12.08	± 74.18	± 44.55	± 7.00

(4, 5, 13, 15, 17). Since squatting engages the large muscle groups of the lower body, often under extremely heavy loads, there exists a potential for overexertion and overuse injuries to all musculature and segments involved. Although proper technique is stressed repeatedly as the athlete's best method for reducing the chance of injury (2, 6, 12), lumbar support belts are often worn while performing squat exercises, presumably to reduce the risk of back injury.

It must be stressed that weightlifting is a very safe sport when proper protocols are followed; however, as with any sport, there are risks involved, and those risks are magnified when participants consider themselves protected by their sport equipment. Even today, when most athletes realize that weight belts may not significantly protect the wearer against lower-back injury in weightlifting, it is still common to see recreational and competitive athletes wearing weight belts during lifting activities. In addition, many industries that require employees to lift heavy objects at work have adopted policies requiring those employees to wear weight belts while performing their tasks, in hopes of reducing work-related lifting injuries.

A specific concern arises for the mechanical loading of the spine and the vulnerability of the mid- to lower-back musculature to injury while performing squats. Many researchers dispute whether wearing weight belts during lifting is actually an effective method of reducing the risk of back injury (3, 7, 8, 10, 11, 18–20). It is hypothesized that wearing lifting belts will induce an increase in intra-abdominal pressure, concomitantly reducing loads on the lower back, specifically at locations L5–S1. However, one recent report revealed no significant differences in intra-abdominal pressure between subjects wearing belts and subjects without belts (20). However, belts do appear to be effective in reducing asymmetric movements while performing many types of lifting, including lateral bending and twisting (7). Although the use of lifting belts is widespread throughout competitive, recreational, and industrial lifting situations, research does not support the general belief that belts increase functional performance (isometric lumbar muscle strength, isokinetic muscle endurance or fatigue, or dynamic lifting capacity) and prevent injury (3, 8, 11, 18, 19).

This study was designed to determine whether there were measurable differences in thoracic and lumbar erector spinae EMG activity between submaximal lifting tasks for experienced weightlifters with and without weight belts. Submaximal loads were selected to approximate lifting requirements experienced by athletes during warm-up and cool-down and experienced by high-repetition training and industrial settings, where high-repetition lifting is common but where individuals are rarely required to perform lifts of greater than 60% of 1 repetition maximum.

Methods

Scientific studies reporting the physiological effects of wearing weight belts are limited. Therefore, a greater understanding of the electrophysiological effects of using weight belts was sought by evaluating mean and integrated surface EMG signals of the thoracic and lumbar regions of the erector spinae for lifting conditions in which some subjects wore belts and others did not. The goal of this study was to determine if weight belts effectively stabilize the back, reducing the need for erector spinae muscle activity that would otherwise be required to stabilize the spine while performing parallel squats without wearing a weight belt.

Subjects

Ten healthy college-age men with weightlifting experience agreed to participate in the study and signed informed consent forms, as approved by both the University of Florida and the University of Memphis. For the purpose of this study, individuals who had a history of supervised weightlifting of more than twice per week for a minimum of 2.5 years were selected as subjects. All participants were familiar with and routinely wore weight belts during moderate to heavy lifting workouts. A summary of participant demographics is provided in Table 1.

Lifting Protocol

Each participant completed 2 trials, each consisting of 3 repetitions of high-bar parallel back-squats. One trial condition required subjects to perform 3 squats while wearing weight belts. All conditions were held constant for the second set of 3 squats, but in this set, no weight belt was worn. Lifting loads equaled 60% of each individual's self-reported 1 repetition maximum (1RM). The 60% load was considered safe for repeated lifts and simulated the weight often used during the warm-up or cool-down phases of a workout. The 60% 1RM load adequately represents a level of lifting required in many industrial settings, where workers are

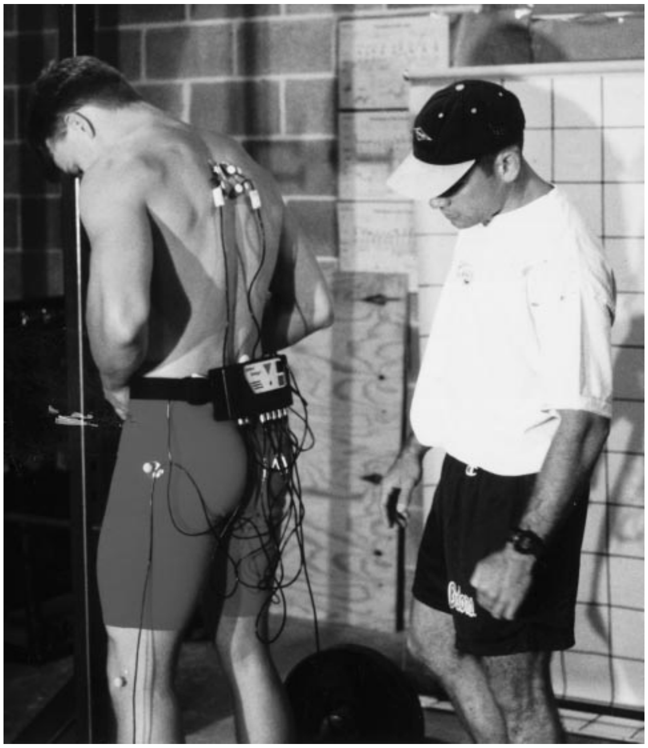

Figure 1. A researcher inspects the data logger and electrode placement as a subject secures the data logger waist strap before testing. Note the surface electrodes on the thoracic spinal region; the lumbar electrodes are obscured by the data logger in this view.

required to wear lifting belts while performing their duties (1).

Electrode Placement

Surface electrodes recorded electrical activity bilaterally on both the right and left erector spinae at the lumbar (L3–L5) and thoracic (T5–T7) regions. These sites were chosen because of the large muscle size at these regions, relative to the rest of the muscle group, which ensured that electrodes could be placed over the muscle belly regardless of the size of the individual tested. The electrodes were placed 3 cm laterally to the right and left of the spinous processes of the L3–L5 and T5–T7 vertebrae. The weight belts were made of rigid leather, were approximately 1 cm thick, and were 12 cm wide in the area which, when worn, extended from the anterior aspect of the pelvis across the lower back. The same brand and style of belt were used for all testing. Participants were fitted with the size of belt most appropriate for their body size and structure.

Data Collection

EMG data were recorded at 800 Hz using the Paromed Datalogger unit (Paromed Gmbh; Neubeuern, Germany). Signals were time sequenced with standard 30-Hz video to determine the beginning and ending points of each lifting movement. Figure 1 shows a researcher inspecting the EMG electrode placement on a

Table 2. Percentage of baseline electromyographic signals.

	No weight belt		Weight belt	
	Mean	*SD*	Mean	*SD*
Lumbar integral (A/D·s)*	215	±77.0	265	±162
Lumbar mean (A/D)	235	±71.3	258	±69.0
Thoracic integral (A/D·s)	235	±153	235	±162
Thoracic mean (A/D)	156	±45.2	158	±49.3

* A/D = analog-to-digital units.

subject as he straps on the data logger controller unit before starting a set of lifts without a weight belt.

Before testing, baseline EMG recordings were acquired as each participant completed 1 to 3 lift sets of 3 squatting repetitions in an unloaded condition. For this portion of the data collection, the subjects performed sets of lifts using a 2-kg wooden pole in place of the straight weight bar used during the experimental tests. Use of the pole encouraged the participants to maintain correct form during unloaded baseline data collection. To ensure the accuracy of the EMG data, each participant's data were collected during a single test session. If any of the surface electrodes were dislodged during the test session, the test would be aborted and the subject rescheduled to be tested at another time; however, there were no difficulties with the electrodes and such actions were never required.

Data Analysis

Each participant's test data were normalized by calculating the average percentage of baseline EMG data converted into analog-to-digital units. The normalized measures were statistically evaluated using *t*-test comparisons between conditions with and without the weight belt for the data collected at both the lumbar and thoracic regions. Four *t*-tests were performed on integrated and mean EMG data to detect significant differences ($\alpha = 0.05$) between wearing and not wearing a weight belt during the squatting exercise. To account for the multiple *t*-tests, we employed the Bonferroni method of maintaining experiment-wise type I error, which required comparisons versus a testwise α value of 0.0125.

Results

The averages and standard deviations of electrical signals are given as a percentage of baseline activity in Table 2. EMG responses for both lumbar and thoracic erector spinae locations for exercises performed with a weight belt were either greater than or virtually equal to the measures taken when the subject did not wear a weight belt. Statistically, however, significant differences in EMG activity existed only in the lumbar region of the erector spinae. Analysis of the data indicated a significant change in the mean lumbar EMG signal ($p = 0.01$), which increased by 23% from the non-weight-belt-wearing to weight-belt-wearing condition. The results of the analysis of the integrated lumbar EMG signal also proved significant ($p = 0.003$), representing a 10% increase in that response variable between the condition of not wearing a weight belt and wearing a weight belt.

Discussion

These results were contrary to what was expected, since it is believed that the use of weight belts provides additional support to the spine and therefore should result in a decrease in the activity of the back musculature used to stabilize the spine during lifting tasks. The results of our study indicate that the erector spinae is statistically more active in the lumbar region of the spine when wearing a belt during squatting exercises.

A possible explanation for the increase in muscle activity may be found in considering the physical application of the belt. Generally, it was be observed that when applying a lifting belt, the lifter pulls the belt extremely tightly around the waist, presumably to increase support. Although this act may or may not actually increase intra-abdominal pressure, and although such a practice may or may not actually provide greater stability of the spine, it is certainly possible that buckling a belt so tightly around the waist may create a degree of preload on the spinal extensors. Essentially, by pulling the belt tightly, an amount of tension may already be placed on the erector spinae before any flexion of the spine or contraction of the spinal extensors ever occurs.

It is to be expected that the activity of the erector spinae group will increase once flexion of the spine begins during the squatting repetitions; but the added tension created by a preload may actually increase the risk of muscle overexertion and strain rather than decrease the reliance on these muscles to stabilize back during lifting. However, it is yet to be determined if the increases shown in this study are physiologically relevant and indicate a state of activity of the muscles that might lead to increased fatigue.

Although this study supports the previously suggested contention that there is actually a potential for an increased degree of lower-back injury while wearing lumbar support belts during lifting (11), the limited number of subjects, trials, and loads lifted, coupled with the selection of a single lifting exercise for evaluation of data, makes it inappropriate to state that wearing lifting belts will increase the likelihood of injury. Certainly, more research is necessary to fully understand the benefits, detriments, and associated tradeoffs of wearing a back support belt while performing squats. However, athletes who practice performing squats while wearing weight belts must be aware of the data that raises doubts as to whether wearing such belts decreases or increases their likelihood of being injured during their lifting workouts.

Practical Applications

When an athlete or coach uses or recommends particular equipment, it is crucial that the equipment performs as expected. Weight belts are commonly used in recreational, competitive, and industrial lifting situations. Although the benefits of wearing belts remains in dispute, until evidence is presented to the contrary, many lifters will continue to believe that wearing a weight belt increases the stability of the spine and decreases the likelihood of injuring the lower back. The general opinion of those who use the back support lifting belts is that the increased external support offered by the belt should decrease the need for muscular stabilization and should elicit a decrease in erector spinae activity during lifting.

This study was designed to determine if a decrease in erector spinae activity is observed while performing high-bar squats when wearing a weight support belt when compared to equivalent lifts while not wearing a belt. A noticeable decrease would indicate that the belt is relieving some of the need for the erectors to provide as much muscular stabilization of the lumbar spine as would be necessary in performing the same lifts without the belts. Findings that would indicate an increase or no difference in erector spinae activity between the 2 conditions of wearing a weight belt and not wearing a weight belt would tend to refute the theory that wearing a weight belt helps maintain proper lower-back mechanics and would likely decrease the chance of injury to that region during lifting.

In short, if anything less than a decrease in erector spinae activity is observed in someone who performs a squat while wearing a belt, the belt does not provide the biomechanical change people expect to help minimize the risk of lower-back injury. Our findings do not support wearing weight belts during submaximal lifting as a method of reducing erector spinae muscle activity. Athletes, coaches, and industry in general must be made aware that weight belts do not elicit the biomechanical benefits in trunk stabilization and support that they are commonly thought to provide.

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Acknowledgments

The authors would like to thank the United States Weightlifting Federation for its financial support of this project.

Data were collected in the Elma Neal Roane Fieldhouse, University of Memphis, Memphis, TN, and analyzed in the Biomechanics Laboratory, part of the Department of Exercise and Sport Sciences, at the University of Florida, Gainesville, FL.