AN ELECTROMYOGRAPHIC COMPARISON OF PARALLEL AND TRAP BAR SQUATS

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INTRODUCTION

The squat exercise is often referred to as the "king" of all weight-lifting exercises (O'Shea, 1985) and is considered the best exercise for the muscular development of the legs, hips and back (Weider, 1983). A squat is typically performed with an Olympic bar placed behind the neck with the load distributed across the upper back and shoulders and the bar parallel with the ground (parallel squat).

A trap bar is a diamond-shaped steel frame with sleeves extending from opposite corners and handles approximately 15 cm from the sleeves (Fig. 1). Its weight and sleeve size are identical to that of an Olympic bar. Performing free-weight squat exercises using a trap bar is thought to place a lesser load on the lumbar region because the center of gravity of the resistance is in closer alignment with the center of gravity of the lifter than the parallel squat using an Olympic bar (Gentry et al., 1987). This reduces the force placed on the lifter's stabilizing muscles while still providing sufficient resistance on the legs to provide an effective work-out.

Figure 1. Trap bar squat.

The purpose of this study was to compare the electromyographic (EMG) activity of the muscles of the thighs and lower back during a squat performed using an Olympic bar and a trap bar. It was hypothesized that reduced EMG levels in lower back muscles would be observed in the trap bar while no differences in thigh muscle activity would be found between bar types.

PROCEDURES

Twelve males and 4 females (age 25.4±6.1 yrs, height 177±13 cm, weight 751±190 N) with mixed strength training experience were asked to perform two trials of three repetitions using each of the two bars with a load approximately equal to 75% of their body weight. Subjects were asked to warm up by light jogging performed on a motorized treadmill at a self-selected pace.

Muscle activity was detected using a MESPEC 4000 radio telemetry EMG unit sampling at 900 Hz. Six pairs of surface electrodes were attached to the right side of the body over the following muscles: (1) rectus femoris (RF) – center of anterior surface of the thigh, approximately half the distance between the knee and iliac spine, (2) vastus lateralis (VL) – 3-5 cm above the patella, on an oblique angle just lateral to the midline, (3) vastus medialis (VM) – 2 cm superior to the rim of the patella at an oblique angle (≈55°) directed medially, (4) biceps femoris (BF) – lateral hamstring, 2/3 distance between the greater trochanter and the back of the knee, (5) semitendinosis (ST) – medial hamstring, half the distance between the gluteal fold and the back of the knee, and (6) erector spinae (ES) – approximately 2 cm lateral to the L3 level vertebrae oriented vertically. Electrode pairs were placed approximately 2 cm apart and parallel to the line of action of the muscle.

Maximum voluntary isometric contractions (MVIC) were performed for each of the muscle monitored for normalization purposes. To determine the descending and ascending phases of a repetition, a video-based Peak Motus® system was used to determine the vertical location of the right hip. For each subject, the middle repetition of each trial was analyzed and the average of the 2 repetitions for each bar type was used in subsequent statistical analysis. For the average normalized EMG levels during each phase for each muscle, a 2 (phases) x 2 (bar types) MANOVA with repeated measures was performed and Geisser-Greenhouse adjustments were used when the covariance matrix circularity was violated (using an a-priori alpha level of 0.05). Because the primary focus of this study was on the differences between bar types, results of the phase main effect are not reported here.

RESULTS AND DISCUSSION

No significant difference between bar types was found in the EMG levels of the muscles of the thigh (RF, VL, VM, BF, and ST) in the descending or ascending phase of the squat. However, significantly lower EMG activity was found in the ES during the descending phase ($p=0.019$). These results support our hypotheses.

Because muscle activity is a major contributor to forces acting on the spine (Schultz, 1990), the significantly lower ES activity during the descending phase of the squat indicates that a lesser load was placed on the anatomical structures of lumbar region. On the other hand, non-significant differences between bar types in the activity of thigh muscles confirm that thigh muscles received the same amount of stress with the Olympic and trap bars.

SUMMARY

Trap bar squats seem to be a good variation of squats for beginners because they will still receive the same workout for their legs with less risk of injury to the lumbar region. Also, they do not need to pick the bar up as high as in the parallel squat which makes it easier for someone with less experience working with free-weights to perform squat exercises. Furthermore, it is safe to perform trap bar squats without a spotter.

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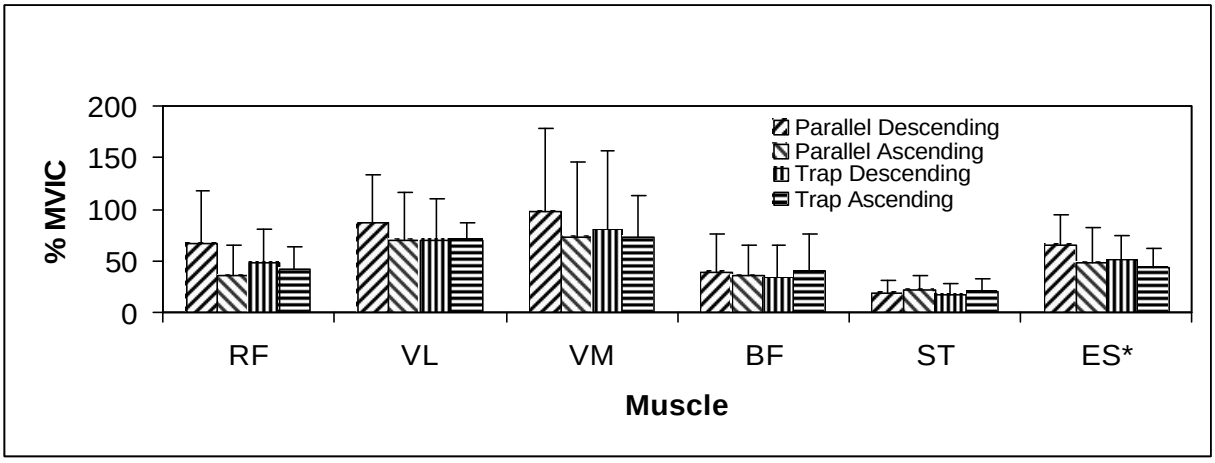

Figure 2. Average normalized EMG values during both phases of the parallel and trap bar squats. *Significant differences ($p<0.05$) exist between bar types in the descending phase.