Effect of Grip Width on Electromyographic Activity During the Upright Row

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Abstract

McAllister, MJ, Schilling, BK, Hammond, KG, Weiss, LW, and Farney, TM. Effect of grip width on electromyographic activity during the upright row. *J Strength Cond Res* 27(1): 181–187, 2013—The upright row (URR) is commonly used to develop the deltoid and upper back musculature. However, little information exists concerning muscle recruitment during variations of this exercise. Sixteen weight-trained men completed 2 repetitions each in the URR with 3 grip conditions: 50, 100, and 200% of the biacromial breadth (BAB). The load was the same for all grip conditions and was equal to 85% of the 1RM determined at 100% BAB. Repeated measures analyses of variance were used to compare the maximal activity of the anterior deltoid (AD), lateral deltoid (LD), posterior deltoid (PD), upper trapezius (UT), middle trapezius (MT), and biceps brachii (BB) during the 3 grip widths for eccentric and concentric actions. Significant differences ($p < 0.05$) were noted in concentric muscle activity for LD ($p < 0.001$) and PD ($p < 0.001$), and in eccentric muscle activity for AD ($p = 0.023$), LD ($p < 0.001$), UT ($p < 0.001$), MT ($p < 0.001$), and BB ($p = 0.003$). Bonferroni post hoc analysis revealed significant pairwise differences in the concentric actions from the LD (50% vs. 200% BAB and 100% vs. 200% BAB) and PD (50% vs. 200% BAB and 100% vs. 200% BAB), and eccentric actions of the LD (all comparisons), UT (all comparisons), MT (50% vs. 200% BAB and 100% vs. 200% BAB), and BB (50% vs. 200% BAB), with large-to-very-large effect sizes (ESs). Moderate-to-large ESs were noted for several nonsignificant comparisons. The main findings of this investigation are increased deltoid and trapezius activity with increasing grip width, and correspondingly less BB activity. Therefore, those who seek to maximize involvement of the deltoid and trapezius muscles during the URR should use a wide grip.

Key Words muscle activity, deltoid, trapezius

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Introduction

The upright row (URR) exercise is a commonly used resistance exercise to develop the deltoid and upper back musculature. However, outside lay media, little information exists concerning muscle recruitment during variations of the URR. Handa et al. (9) compared surface electromyographic (sEMG) activity during the URR with that occurring during the bent row, seated row, and anterior/posterior pull-down exercises. The results showed that both modes of the pull-down were effective for recruiting the latissimus dorsi. It was also noted that the URR exercise appeared to be most effective at targeting the biceps brachii (BB) and upper trapezius (UT) muscles, whereas the bent row was the most effective at targeting UT, middle trapezius (MT), and lower trapezius musculature. One limitation to this study (9) was that only the BB, latissimus dorsi, and trapezius muscles were evaluated via electromyography, whereas the deltoid group was not studied. Although the URR may be performed through a diagonal plane, if carried out through the lateral or coronal plane, the concentric phase typically involves the entire deltoid and supraspinatus muscles to control glenohumeral abduction. Concurrent scapular upward rotation that is controlled by the trapezius and serratus anterior muscles occurs. Because the lateral head of the deltoid is an abductor, and the posterior deltoid may act as an external rotator (7), these muscles should be evaluated as well.

Many studies have examined the effect of hand position on sEMG activity during the pull-down exercise (15,17,23,24). Some researchers suggest that the wide-grip pull-down will elicit greater activity of the latissimus dorsi in comparison with a narrow grip (23,24). Wills et al. (24) reported that wide-grip pull-downs are more effective at recruiting the latissimus dorsi in comparison with a narrow grip. These results have been confirmed by Signorile et al. (23) who compared activation of 5 different muscles, during 4 variations of the pull-down exercise (close grip, supinated grip, wide grip anterior, and wide grip posterior). These researchers reported that a wide-grip anterior pull-down elicited the greatest activity of the latissimus dorsi and triceps brachii long head during both eccentric and concentric phases (23). However, it has also been reported that grip width may not be responsible for eliciting significant changes

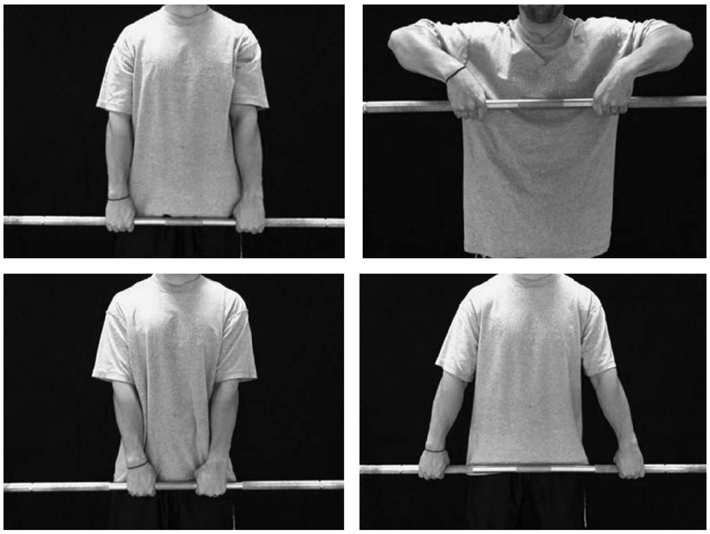

Figure 1. Images 1 and 2 show the initiation and completion of the concentric phase of the upright row at a 100% biacromial breadth. Images 3 and 4 show the grip positions for the narrow and wide conditions.

in EMG activity during this exercise, but pronation or supination of the forearm may cause such changes (17). These findings are contradicted by a previous investigation (15) that reported no significant change in EMG activity when comparing wide-grip pronated anterior pull-down (150% biacromial breadth [BAB]) with supinated-grip pull-down (100% BAB). However, subjects only lifted a load that represented approximately 30–40% maximum voluntary contraction (MVC), which may not be representative of normal training loads. In addition, each of these lifts was performed as 10-second isometric holds (15). As seen in previous research (1), dynamic lifting may cause a muscle to be contracted beyond 100% of its MVC.

A brief review conducted by Kolber et al. (13) suggests that the shoulder is one of the most common regions of injury during resistance training. It has been reported that up to 36% of injuries during resistance training can be attributed to the shoulder (8,12,14,19). A balance between agonist and antagonist muscles of the shoulder is necessary to maintain proper stability and shoulder functions. Weight training exercises that target large muscle groups may create an imbalance between deltoid and rotator cuff. It has been documented that such imbalances are linked to shoulder injury (3–5,16,18,20,22). Exercises that seek to strengthen the rotator cuff and scapular musculature should be incorporated into resistance training programs (13). Strengthening the rotator cuff musculature will provide stability and allow for normal shoulder functioning. In addition, rotator cuff strength improvements should decrease the likelihood of impingement with overhead exercises. An optimal ratio of strength between the internal and external rotators of the shoulder is imperative to maintain normal shoulder kinematics and decrease injury potential of the shoulder (13). It may be that varying grip widths during the URR exercise will elicit changes in activation musculature of the shoulder, but this concept has not been supported in the literature.

Methods

Experimental Approach to the Problem

Three grip widths for the URR exercise were investigated (100% BAB, 200% BAB, and 50% BAB): varying grips are suggested to isolate and strengthen different parts of the deltoid, back, and arm muscles. Grip conditions are shown in Figure 1, and this was done to standardize based on anatomical differences between subjects. We examined whether activity of muscles varies with grip width (anterior deltoid [AD], lateral deltoid [LD], posterior deltoid [PD], UT, MT, and BB [long head]) in a cross-sectional design. Each of the subjects performed the repetitions at the same load relative to their 1RM, and the grip widths were presented in random order. We hypothesized that there will be an increase in LD activity and a decrease in UT activity in response to increasing grip width.

Table 1. Subject descriptive data ($N = 16$, mean $\pm$ SD).*

Height (cm)	Weight (kg)	Age (yr)	BAB (cm)	Upright row 1RM (kg)
175.0 ± 7.3	80.7 ± 10.0	24.2 ± 3.1	34.34 ± 2.8	61.5 ± 12.3

*BAB = biacromial breadth; 1RM = 1-repetition maximum at 100% BAB.

Subjects

Sixteen healthy weight-trained men between the ages of 18 and 35 years were recruited via word of mouth from the university population. Subjects were required to have experience performing the barbell URR exercise and have engaged in heavy weight training for at least

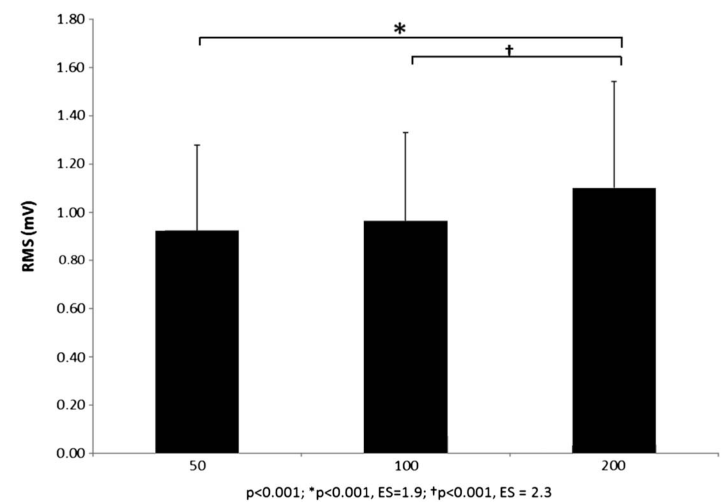

Figure 2. Concentric activity of the lateral deltoid; $p < 0.001$, $N = 16$. Bonferroni post hoc showed significant interactions between grips 50 and 200% ($p < 0.001$; ES = 1.9) and 100 and 200% ($p < 0.001$; ES = 2.3). ES = effect size; RMS = root mean square.

3 years before participation. Subjects participated in a total of 2 sessions including establishment of 1RM and sEMG testing.

Procedures

During the first session, subjects provided written informed consent and completed a medical history/physical activity questionnaire as approved by the local institutional review board. Also obtained during the first session were anthropometric data that included height, weight, and BAB. Acromion processes were palpated and BAB was measured using a broad-blade anthropometer (Lafayette Instruments, Lafayette, IN, USA); 1RM in the barbell URR exercise (100% BAB) was also assessed (6). Strict form was enforced to ensure minimum assistance was provided by nontested musculature. Sessions were separated by at least 48 hours, and each participant refrained from any upper-body resistance training 48 hours before each session.

In the second session, subsequent to standardized warm-up lifts and a preliminary repetition to ensure sEMG electrode integrity, subjects performed 2 sets of 2 repetitions in the barbell URR exercise at the 3 different grip widths. The various grip widths were completed in a randomized counterbalanced manner at 85% 1RM. The standardized warm-up incorporated the URR at the following loads with 2 minutes between sets: 10 repetitions with unloaded York Olympic barbell (20 kg), 10 repetitions at 55% 1RM, 5 repetitions at 65% 1RM, 2 repetitions at 75% 1RM, and 1 repetition at 85% 1RM.

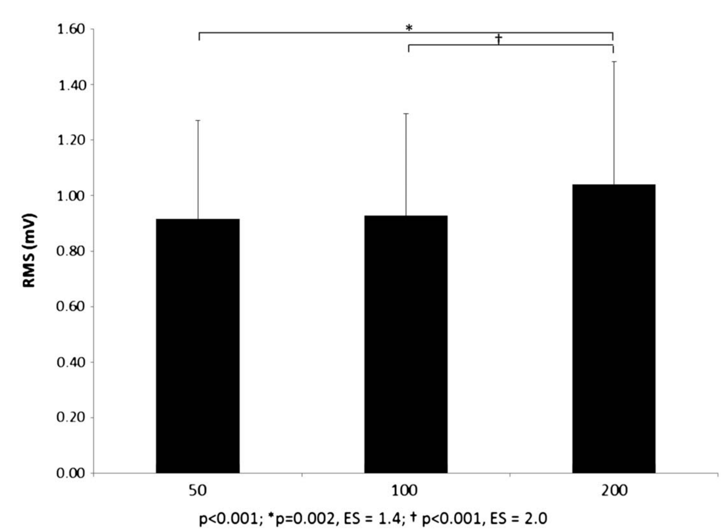

Figure 3. Concentric activity of the posterior deltoid; $p < 0.001$, $N = 16$. Bonferroni post hoc showed significant interactions between grips 50 and 200% ($p = 0.002$; ES = 1.4) and 100 and 200% ($p < 0.001$; ES = 2.0). ES = effect size; RMS = root mean square.

To avoid any excessive stress on the shoulder, the subjects were instructed to raise the bar no higher than the height of the xiphoid process, in an attempt to keep the humerus from going above horizontal (21). Subjects were also instructed to avoid any excessive lumbar flexion/extension because this would elicit unnecessary assistance of the erector spinae muscles and allow for a greater mechanical advantage during the lift, with the same instructions as for the 1RM.

Muscle activity during each grip width was determined via surface electrodes placed on the AD, LD, PD, UT, MT, and BB (10). Electrodes were placed parallel to the fibers considering pennation angle so that the same fibers intersected both

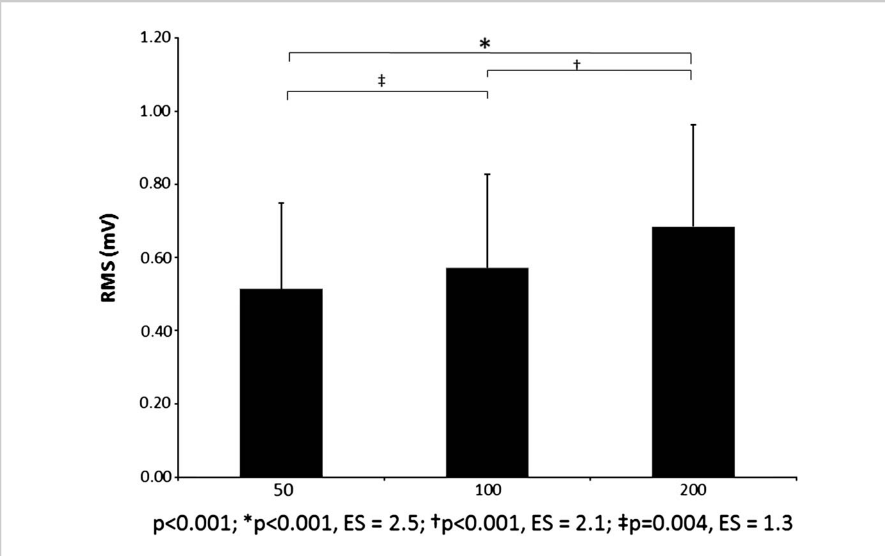

Figure 4. Eccentric activity of the lateral deltoid; $p < 0.001$, $N = 16$. Bonferroni post hoc showed significant interactions between grips 50 and 200% ($p < 0.001$; ES = 2.5), 100 and 200% ($p < 0.001$; ES = 2.1), and 50 and 100% ($p = 0.004$; ES = 1.3). ES = effect size; RMS = root mean square.

electrodes, distal to the motor point. Before electrode placement, the subject's skin was shaved, abraded with fine sandpaper, and cleaned with alcohol. Electrodes (Ambu, Inc., Glen Burnie, MD, USA) were 2 cm round Ag/AgCl with an interelectrode distance of 2 cm, and a ground electrode was placed on cervical vertebrae #7 for signal noise reduction. Signals were recorded and processed using a Myopac Jr. (Run Technologies, Mission Viejo, CA, USA) with 6 dual-lead channels. The electrodes used are passive and therefore preamplification was not necessary; and the system has a common mode rejection of 90 dB, a band-pass filter (10–450 Hz), and an input impedance of 10 MΩ. Gain was set at 1,000. A position transducer (P510; Unimeasure, Corvallis, OR, USA) was attached to the barbell to determine eccentric and concentric actions. Synchronized data were collected at 2 kHz (Datapac 5; Run Technologies) and channeled through a 12-bit analog-to-digital converter (DAS1200Jr; Measurement Computing, Middleboro, MA, USA). During offline analysis (Datapac 5), raw sEMG signals were band-pass filtered using a fourth-order Butterworth digital filter (10- to 450-Hz cutoff). Amplitude was quantified by computing a root mean square, 125-millisecond time constant of the raw signal, and averaged for both repetitions of each grip width.

Statistical Analyses

Data are expressed as mean ± *SD*. Repeated measures analyses of variance (one for each muscle and muscle action) were used to compare the maximal activity of each muscle during the 3 grip widths, and the a priori significance was set at $p < 0.05$. Bonferroni post hoc analysis was used for pairwise comparisons in the instance of significant main effects, and standardized effect sizes (ESs) for repeated measures were calculated. Statistical calculations were performed using SPSS 20.

Results

Subject descriptive information is shown in Table 1. With regard to the analysis of eccentric muscle actions, the AD, PD, UT, and MT did not meet the assumption of sphericity. During analysis of concentric actions, the AD and LD did not meet the assumption of sphericity. The Greenhouse-Geisser adjustment

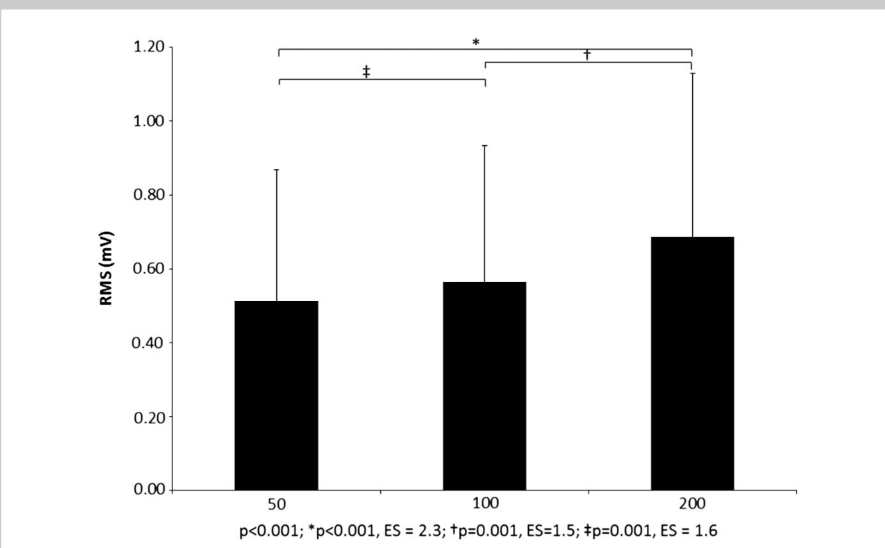

Figure 5. Eccentric activity of the upper trapezius; $p < 0.001$, $N = 16$. Bonferroni post hoc showed significant interactions between grips 50 and 200% ($p < 0.001$; ES = 2.3), 100 and 200% ($p = 0.001$; ES = 1.5), and 50 and 100% ($p = 0.001$; ES = 1.6). ES = effect size; RMS = root mean square.

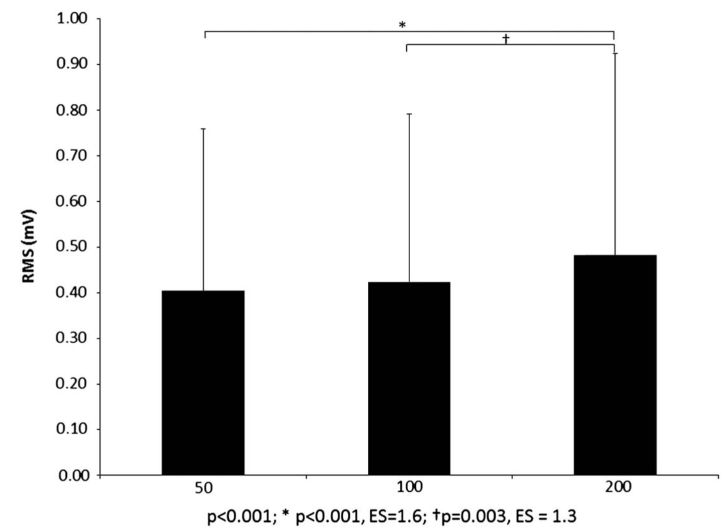

Figure 6. Eccentric activity of the middle trapezius; $p < 0.001$, $N = 16$. Bonferroni post hoc showed significant interactions between grips 50 and 200% ($p < 0.001$; ES = 1.6) and 100 and 200% ($p = 0.003$; ES = 1.3). ES = effect size; RMS = root mean square.

was used in situations where the assumption of sphericity was not met. Significant differences ($p < 0.05$) were noted in concentric muscle activity for LD ($p < 0.001$) and PD ($p < 0.001$), and in eccentric muscle activity for AD ($p = 0.023$), LD ($p < 0.001$), UT ($p < 0.001$), MT ($p < 0.001$), and BB ($p = 0.003$). No significant differences ($p > 0.05$) among grips were found in concentric muscle activity for AD ($p = 0.98$), UT ($p = 0.779$), MT ($p = 0.148$), and BB ($p = 0.221$), or in eccentric muscle activity for PD ($p = 0.074$).

Bonferroni post hoc analysis revealed several significant pairwise differences for the different grips during concentric actions of the LD (Figure 2) and PD (Figure 3). Post hoc analysis of eccentric actions also revealed significant pairwise differences in the grips for the LD (Figure 4), UT (Figure 5), MT (Figure 6), and BB (Figure 7). Effect sizes for these comparisons were large to very large. Moderate-to-large ESs (11) were noted for several nonsignificant pairwise comparisons. These ESs were noted during eccentric actions for AD (50% vs. 200% BAB, ES = 0.8; 100% vs. 200% BAB, ES = 0.7; 50% vs. 100% BAB, ES = 0.7), PD (50% vs. 200% BAB, ES = 0.9; 100% vs. 200% BAB, ES = 0.9), MT (50% vs. 100% BAB, ES = 1.0), and BB (100% vs. 200% BAB, ES = 0.8; 50% vs. 100% BAB, ES = 0.7). Moderate-to-large ESs (11) were also noted for concentric actions that did not reveal significance after post hoc from MT (100% vs. 200% BAB, ES = 0.7; 50% vs. 100% BAB, ES = 0.7) and BB (50% vs. 100% BAB, ES = 0.8).

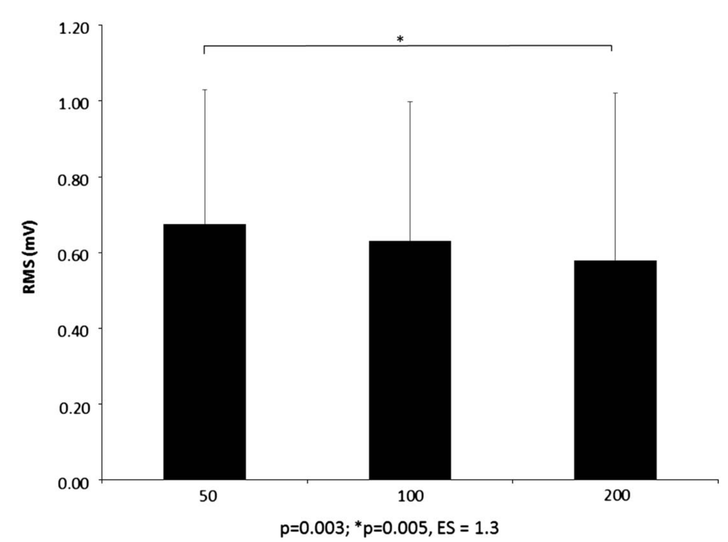

Figure 7. Eccentric activity of the biceps brachii; $p = 0.003$, $N = 16$. Bonferroni post hoc showed significant interactions between grips 50 and 200% ($p = 0.005$; ES = 1.3). ES = effect size; RMS = root mean square.

Discussion

The main findings of this investigation are increased deltoid and trapezius activity with increasing grip width in the URR, and correspondingly less BB activity. These results are in agreement with 3 previous investigations that have shown significant changes in relative EMG activation in response to hand position during upper-body pulling exercises such as wide-grip and narrow-grip pull-downs performed with pronation and supination (17,23,24). Our results showed that the relative changes were greatest in the LD and UT. The largest changes in LD activation were noted between 50 and 200% for the eccentric portion, and between grips 100 and 200% for the concentric portion of the lift. These findings are in accordance with our original hypothesis that increasing grip width will elicit significant increases in relative activation from the LD. One possible explanation could be that a greater degree of abduction is involved during a wide grip (200%) compared with a narrow grip (50%) because the humerus is further away from the midline of the body during the wide-grip condition.

One limitation to the current study is that 1 standard load was used for all grip widths. It is possible that the relative load is greater as grip width increases, thus requiring more deltoid and trapezius activity. This investigation was also limited to the use of sEMG, which does not allow for complete analysis of kinematics about the shoulder girdle and some of the functional musculature. Despite these limitations, our findings are similar to 2 previous investigations on grip and muscle activation (23,24) that reported increased activity from the latissimus dorsi during a wide-grip pull-down, compared with close-grip and supinated-grip pull-downs. Signorile et al. (23) attributed these findings to the fact that a wide-grip pull-down involves a greater degree of horizontal abduction in comparison with a supinated-grip and close-grip pull-down; therefore, increased demands are placed on the latissimus dorsi. Although there was no significant change in activity from the UT in response to grip width during the concentric portion of the lift, significant changes were noted during the eccentric portion of the lift. The largest change in activity was noted during the eccentric portion of the lift for 50 and 200%. These results suggest that increasing grip width may also elicit greater activation from the UT as well, but it also appears that in this multijoint movement, different recruitment strategies are used in the eccentric versus concentric portions. These results compliment the findings of Handa et al. (9) who reported that the URR is more effective at targeting the UT in comparison with the seated row, bent-over row, and anterior/posterior pull-downs. Significant changes in relative activation from the MT were noted during the eccentric portion of the lift (between grips 50 and 200%, and 100 and 200%), but no significant change in MT activity was noted during the concentric portion. However, moderate-to-large ESs (11) were noted between 50 and 100% and 100 and 200% conditions (ES = 0.7). The largest change in relative activity was seen between narrow and wide grips during the eccentric action for the MT. It is possible that there is increased scapular motion at a wide grip compared with a narrow grip, thus contributing to increased activity of the MT at a wide grip. It also appears that the EMG activity of the AD is relatively unaffected by varying grip widths during the concentric action. However, again it seems that recruitment patterns are different during the eccentric portion because we showed an increase in activity concurrent with increasing grip width. Significant changes in relative activation were seen during the concentric action from the PD but not during the eccentric action. Although there were no significant changes in activation in response to grip width during the eccentric action, moderate-to-large ESs (11) were noted between grips 50 and 200%, and 100 and 200%. The increases in PD activity concurrent with increasing grip width could be related to the possibility that the humerus is slightly more externally rotated during the wide-grip compared with the narrow-grip condition.

General increases in relative activity concurrent with increasing grip width were noted for all muscles with the exception of concentric actions of UT, AD, MT, and BB. These findings are similar to those reported by Clemons and Aaron (1) who reported increases in activity among the prime movers of the bench press when comparing wide grip to a narrow grip. These researchers (1) attribute their findings to the possibility that there is increased torque on the shoulder during a wide grip compared with a narrow grip. The results of our investigation again complement this claim. The eccentric portion of the lift showed a general decrease in relative activity from the BB, in response to increasing grip width. The largest decrease in BB activity was observed between 200 and 50% grip conditions. This could be related to the fact that there is less elbow flexion during the wide-grip condition (200%) compared with the narrow-grip condition (50%). Linear trends in EMG activity in response to grip width were also reported by Cogley et al. (2) who analyzed EMG activity during 3 hand positions during the push-up. These researchers (2) reported general increases in EMG activity from the pectoralis major and triceps brachii when moving from a wide grip to a narrow grip during the push-up. It was also reported that the wide-grip push-up places the humerus in more of a horizontally abducted position in comparison with a narrow grip. Because the narrow grip involves a lower degree of horizontal abduction, the pectoralis major is at a shortened position throughout the exercise. According to the length-tension relationship, muscles generate less tension at shorter lengths. To accommodate for this loss of tension, the muscle is forced to recruit additional motor units. This could possibly explain why the pectoralis major displa a narrow-grip push-up (2). These results relate to the current investigation because the LD is at a shorter length during a wide-grip URR compared with a narrow-grip URR. This concept could provide additional support to the finding that the LD has higher relative EMG activity (increased unit recruitment) at a wide grip compared with a narrow grip.

Practical Applications

With the exception of the BB, the results of our investigation suggest that there is a general increase in relative activity from the deltoid and trapezius muscles during a wide-grip URR. Therefore, those who seek to increase involvement of the deltoid and trapezius muscles should practice a wide grip during this exercise. Because there are differing mechanical properties when comparing a wide with a narrow grip, future investigations should test the effect of grip width on strength during the URR. Furthermore, performing an URR with dumbbells as opposed to a barbell would allow the limbs to travel in an arc, and because potential differing abduction properties exist when comparing these 2 modes of exercise, future investigations should examine dumbbell URR.

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