**Medicina Sportiva (2015), vol. XI, no 3, 2601-2608**
Journal of the Romanian Sports Medicine Society

# The effects of Versa Gripps® during pull-ups on surface electromyography in strength trained males

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**Abstract**. *Aim*. This study compared surface electromyographic (sEMG) signal amplitude during pull-ups with Versa Gripps® to those without grips on the dominant side wrist flexors (WF), wrist extensors (WE), latissimus dorsi (LAT), and infraspinatus (INF) muscles among strength-trained males. *Material and Method*. Thirty healthy males volunteered to participate in the study. All subjects reviewed, completed, and signed an informed consent form approved by Institutional Review Committees. Surface EMG was computed using the root-mean-square (RMS) of the EMG signal, integrated over 500 milliseconds, and normalized to the maximum voluntary contraction (MVC) for the muscles being investigated. EMG data from the four muscles were analyzed using paired two tailed t-tests for each individual muscle for Grip to No Grip conditions. *Results*. The comparisons revealed that the WE and WF sEMG were significantly less with the Versa Gripps® compared to No Grip. There were no significant differences between the Grip and No Grip conditions for the LAT and INF. *Conclusion*. These results suggest that the effort required by the WE and WF can be reduced with the use of Versa Gripps® in strength-trained males while performing a pull-up without inhibiting the recruitment of the LAT and/or the INF. This finding could be beneficial for strength-trained males suffering or recovering from lateral or medial epincondylitis because the decreased activation of the WE muscles during the pull-up exercise may help unload of the WE and WF which may aid in their recovery.

**Key words**: *epicondylitis, latissimus dorsi, infraspinatus, wrist straps.*

## Introduction

Strength training has evolved into an activity that is widely practiced for a variety of reasons. Evidence suggests that strength training has positive effects on the musculoskeletal system, such as prevention of osteoporosis, sarcopenia, lower back pain, and other disabilities (1). Other research has demonstrated that strength training may positively affect risk factors such as insulin resistance, glucose metabolism, diastolic blood pressure, LDL cholesterol, and body fat (2-4).

One aspect of strength training that is of importance is hand grip strength. The importance of handgrip strength during strength training should not be underestimated. Hand grip strength has been identified as a limiting factor for manual lifting and has been shown to be a required component of most strength-training exercises (5, 6). Since the hands must grasp the bar and withstand the force of the body weight during pull-ups, it is evident that handgrip strength and endurance are required to perform this exercise.

Although the authors of this investigation found no studies that examined the forearm forces involved during a pull-up, several studies investigated grip strength and arm sEMG activity among rock climbers while performing pull-ups or climbing related activities (7, 8).

These studies concluded that greater grip strength is found in those that can perform more pull-ups (7) and that the brachioradialis (BR) and flexor digitorum superficialis (FD) showed higher electrical activity than the other muscles during the fingertip pull-up (8). The pull-up is an exercise that requires strength in several muscle groups. A previous sEMG study of the pull-up revealed that the shoulder muscles involved in both the early and late stages of the pull-up include the latissimus dorsi, infraspinatus, and teres major (9). However, in this study the teres major was not selected as a muscle to investigate because there is not a good sEMG electrode placement for this muscle due to electrical cross talk. Other muscles involved in the activity include the biceps brachii, pectoralis major, wrist flexors, and wrist extensors.

In many sports, the use of specifically designed equipment (e.g. helmets, pads, bats, shoes, etc.) are used to help improve athletic performance and/or help reduce the risk of injury. Strength training is similar in that equipment such as weight belts, gloves, knee wraps, elbow wraps, and wrist straps have been developed as the activity has evolved. Previous research has investigated the effects and use of weight belts among weight lifters (10, 11); to our knowledge, however, no published studies have investigated the effects of weight lifting gloves or wrist straps. Similar to weight belts, wrist straps are commonly used among recreational and professional strength training participants because participants believe the wrist straps help them to improve grip capacity to make bigger gains in the larger muscles of the body such as the latissimus dorsi and the upper trapezius; to our knowledge, however, no research has been performed to examine this belief. The Versa Gripps® are a popular brand of wrist straps that are commonly used by strength training participants. According to the Versa Gripps® US Patent, the Versa Gripps® are "a grip assist apparatus to strengthen the weightlifter's grip and prevent a weight training injury by providing support to the wrist and hand while protecting the palm of the hand" (12).

Therefore, the overall purpose of this investigation was to investigate the effects of the use of Versa Gripps® on the sEMG signal amplitude during pull-ups on specifically involved muscle groups in strength trained males. Pull-ups, which are typically performed by strength training participants, require the use of several muscle groups, including but not limited to the wrist flexors (WF), wrist extensors (WE), latissimus dorsi (LAT), and the infraspinatus (INF). Pull-ups are often utilized as a physical fitness assessment tool to measure muscular strength and endurance of the shoulder musculature (13).

## Material and Method

*Experimental Approach to the Problem*. This study was conducted using a repeated measures, within-subjects design. The intervention to be evaluated in this study was the use of Versa Gripps®, specifically to determine the effects on the sEMG signal amplitude of the WF, WE, LAT, and INF muscles among one independent group of strength trained males. The subjects performed five pull-ups with and without the Versa Gripps®. The order of the Versa Gripps® condition was randomly assigned for each participant to control for any bias due to order.

*Subjects***.** Thirty healthy trained males (age = 32.4±8.4yrs, height = 1.75±0.090m, weight = 80.7±12.3kg, body fat = 10.6±4.7%) volunteered for this study. Before testing, all subjects reviewed, completed, and signed an informed consent form approved by Institutional Review Committees. In order to meet the inclusion criteria for this study the subjects had to be males between the ages of 18-49 years of age who actively participated in strength training two to three times per week (14, 15) with the self-reported ability to perform seven or more full range of motion pull-ups from a dead hang with a pronated grip as well as a self-reported strength training experience of at least 12 months.

Subjects were excluded from the study if they had a previous shoulder, wrist, or hand subluxation, dislocation, or fracture, joint instability, tendinitis, bursitis, impingement, adhesive capsulitis, neurovascular complications. Other exclusions included any condition that limited physical activity for greater than two days over the last six months, current complaints of neuromuscular pain, numbness, or tingling in the upper extremity, neck, or back during the pull-up testing (14), and/or a known allergy to tape. Subjects were asked in advance of their testing date to avoid performing any upper body physical activities for two days prior to participating in the study in order to avoid fatigue and soreness prior to the investigation.

*sEMG*. The sEMG data collection and processing was performed with the Noraxon Myosystem Software and Myosystem 1200 equipment (Noraxon USA, Inc, Scottsdale, AZ). The Myosystem 1200, a four channel sEMG unit, and the MyoResearch software were used to process the sEMG signal. The Noraxon signal detection and processing system utilized an eighth-order Butterworth low-pass filter of 500 Hz (±1%), first order high pass filter of 10 Hz (±10%), a sampling frequency of 1000 Hz, a common-mode rejection ratio of greater than 100dB, a gain of 1000, a baseline noise of less than 1 microvolt RMS, and an input impedance of greater than 100 MΩ. The MyoResearch software algorithm rectified and smoothed the signal by calculating the RMS using a 50-ms moving window. The mean RMS, integrated over 500 milliseconds for each muscle, was normalized to a maximum voluntary isometric contraction (MVIC). The peak sEMG for concentric contractions was then averaged over repetitions two to five with and without the grips. The software normalized the RMS of each muscle's signal for each repetition to its respective MVIC. Peak RMS values were calculated over 3 repetitions for each of the four muscles for each grip condition.

Specific electrode placement was based on the suggested electrode placements established by Noraxon USA, Inc. and cited by Konrad (16). Noraxon blue sensor dual (bipolar, single differential) electrodes were utilized for each muscle being evaluated. Each electrode in the Noraxon dual sensory electrode set was one centimeter in diameter with a one centimeter separation between the edges of the conducting surfaces, or two centimeters between the centers of each electrode. A dual electrode set was positioned directly over each of the four muscles and aligned parallel to the fiber direction. The electrodes for the WF were placed approximately eight centimeters below and four centimeters medial to the midpoint of the imaginary line bisecting the antecubital fossa. The electrode placements for the WE were placed approximately eight centimeters below and seven centimeters lateral to the midpoint of the imaginary line bisecting the distal portion of the olecranon process. The electrodes for the latissimus dorsi muscle were placed approximately 12 cm lateral to $T_{11}$. The electrodes for the infraspinatus were placed approximately four centimeters inferior to the spine of the scapula over the infraspinatus fossa on the lateral aspect of the muscle. All electrodes were placed superficially parallel to the direction of the muscle fibers on the subject's hand dominant side. A Noraxon single electrode was also placed over the spine of the scapula; this single electrode was used as the reference electrode (16).

Once the electrodes were properly placed, the outline of each electrode was traced with a permanent marker on the subject's skin and fastened by athletic tape to prevent them from falling off. No other external force, i.e. clothing, was permitted over the electrode to ensure the accuracy of the sEMG signal. These procedures were followed in order for the electrodes to be easily replaced in the same location as the original electrodes in the event that the original electrodes failed to remain adhered to the skin during the testing procedures. Since the reliability and validity of the sEMG would be compromised if the electrodes fell off, properly marking the original electrode placement helped ensure that the replacement electrodes were not placed over different motor units in the event that the original electrodes fell off the subject. However, no electrodes fell off of any subject during the course of this investigation.

*MVIC*. The MVIC for the WF and WE was performed utilizing a hydraulic hand dynamometer (JAMAR®, Clifton, NJ) as similarly described by Van Elk et al. (17); however, a few modifications were made: 1) the shoulder was positioned in 180° of flexion and the elbow at full extension because Su et al. (18) indicated that the highest mean grip strength was obtained in this position, and 2) the dynamometer was placed on setting II because Firrell et al. (19) revealed that maximal grip strength, regardless of hand size, was produced in this setting. A second MVIC for the WF and WE was performed using the hand held dynamometer with the shoulder positioned at 0° of shoulder flexion and the elbow bent to 90° (14) because it was noted that some of the subjects were able to obtain a higher grip strength in this position. The MVIC for the LAT and INF was performed as described by Konrad (16). According to Konrad (16), the simulation of a pull-up produces the highest LAT innervation, i.e., placing the shoulder in 90° of abduction, 90° of external rotation, and the elbow flexed to 90° before the subject applied a downward force by pulling down on an immobile weighted pulley to activate the LAT. The manual muscle test for the INF was performed with the subject in a seated position with the upper extremities held at 0° of shoulder flexion and abduction (at least two fingers away from the trunk so subjects did not press the arm against the trunk) and 90° of elbow flexion (16, 20).

*Pull-up Test*. The pull-ups were performed on the P-123B Eight Stack Total Body Gym (Promaxima, Houston, TX) pull-up bar station. For the purposes of this study, hand placement and orientation for the pull-ups were performed according to Lusk et al. (21) where it was concluded that an anterior lat pull-down with a pronated grip (irrespective of grip width) had the highest EMG activation. A *thumb over bar* hand position was also used for the pull-ups in this study based on the recommendations by Gabbard et al. (22) where they stated that the thumb over bar grip was better for flexed-arm hang performance. According to Konrad (12), standardizing tests for data collection is important for sEMG studies. Variables that were standardized were load, range of motion, and velocity. Load was controlled because the subjects pulled the same load, their body weight. Range of motion was controlled by ensuring that pull-ups were consistently performed utilizing a full range of motion as described below. Velocity was controlled by utilizing a metronome, also described below. In this study, a full range of motion pull-up began when the subject grabbed the horizontal bar (with a pronated, thumb-over bar, carrying width grip) with the elbows in full extension. Next, the subject flexed his/her knees to about 90 degrees so he or she was suspended from the pull-up apparatus by the upper extremities and the lower extremities were non-weight bearing. The subject began the concentric phase of the pull-up by lifting their torso until the lower ear-lobe was raised even with the horizontal pull-up bar; the end of the concentric portion of the pull-up was when the subject's upward movement of their head/body came to a stop at the top portion of the pull-up. The eccentric portion of the pull up began when the lower ear-lobe began to descend and was completed when the upper extremities returned to the starting position. Velocity of the pull-ups was controlled by utilizing a metronome (14) where the metronome was set at 50 beats per minute. Each beat of the metronome counted as one concentric repetition to the top. The second beat counted as one eccentric repetition to the bottom or start position.

A Logitech webcam was used to film the subjects while they performed the pull-ups. The location of the camera relative to the subject was the same for all subjects during the completion of the pull-ups with the two grip conditions. Myovideo software was used to process the video signal. The video signal was used to identify the concentric and eccentric portions of the pull-ups to assist in defining the time period used to derive the RMS for each portion of the pull-ups performed.

*Testing Session*. All data was collected in one testing session. The beginning of the testing day consisted of obtaining an informed consent, health history questionnaire, a demographic/anthropometric data (age, sex, height, weight, body composition, and carrying width) from each subject. Body composition was obtained using Lange Skinfold Calipers (Beta Technology, Santa Cruz, CA) with the gender-specific three site Jackson-Pollock skinfold equations utilized by Johnson et al. (23).

Subjects watched a pre-recorded instructional 13-minute video that explained all essential information to the subjects. The video contained pertinent information such as hand placement, grip width, thumb position, definition/demonstration of a full range of motion pull-up using a metronome set at 50 beats per minute (14), proper use of the Versa Gripps® Pro, rest periods between testing conditions, and a brief five minute warm-up consisting of low intensity aerobic exercise (16) performed before testing was conducted. The appropriate size Versa Gripps® Pro, according to the manufacturer's guidelines, was also determined at this time.

After reviewing the instructional video, the subjects performed the five minute warm-up described in the video. Following the warm-up, the subject's skin was prepared for electrode application, which included: shaving, if necessary to remove any visible hair, and abraded with an alcohol wipe until erythema was attained. Electrodes were then placed at each muscle site.

After a brief three minute period, to allow for the electrode to skin contact to reach a stable electrical condition (16), a validity check was verified by performing an informal manual muscle break test for two to three seconds for each muscle being investigated. An inspection of the raw sEMG signal was performed by having the subject sit completely relaxed on a bench to allow the amplifier to pick up a raw sEMG signal no greater than 15 microvolts, but ideally less than 3.5 microvolts.

Next, a formal MVIC for the WF, WE, LAT, and INF was conducted. Following the normalization phase a five-minute rest period to minimize fatigue, the subject stood in the anatomical position where a 10-second static trial was recorded to establish baseline muscle activity as described by Konrad (16) and Youdas et al. (10). Each subject then performed the pull-ups with and without the grips. The order in which the pull-ups were performed (Grips vs. No Grips) was randomly assigned.

Since all of the testing for each subject took place on the same day, the rest time between the conditions (Grips vs. No Grips) was 10 minutes. Rest time between the MVIC and the initial testing condition and between each testing condition was based upon Weir et al. (24) who reported that there was no significant difference in one repetition maximum (RM) bench press between rest intervals of one minute, three minutes, five minutes, or 10 minutes.

*Statistical Analysis*. All statistical procedures were conducted using SPSS software v19 (SPSS Inc., Chicago IL). An a-priori power analysis was performed utilizing a small effect size ($f = 0.20$). The power analysis revealed that a sample size of 25 male subjects was required to detect a mean difference in sEMG recruitment of 10% MVIC (effect size = 0.20) between conditions with a statistical power ($1 - \beta$) equal to 0.80 at $\alpha = 0.05$ and a correlation coefficient among repetitions of $r = 0.66$. Paired two-tailed t-tests were conducted to compare each of the four muscles (WF, WE, LAT, and INF) individually with and without grips during the concentric phase of the movement.

The data were evaluated for outliers, homogeneity of variance, and normality. Since one data point for the WF concentric no grip and another data point for the WE concentric grip were more than 3.29 standard deviations above the mean, these specific data points were identified as outliers (23). These two specific data points were Winsorized to correct the outliers by changing the outlier data point value from its actual value to the next highest data point value that was within 3.29 standard deviations away from the mean (25). In order to finish correcting the data for outliers, it was necessary to change the lowest data point value in the WF concentric no grip data and the WE concentric grip data up to the next lowest data point value (25).

## Results

The paired t-tests for each individual muscle tested with the Grip compared to the No Grip conditions revealed the following: a) The WF had a significantly lower activation (p = 0.040) when comparing the Grip condition with the No Grip condition (Table I); b) The WE had a significantly lower activation (p = 0.001) when comparing the Grip condition with the No Grip condition (Table I); c) there were no significant differences (p > 0.05) in activation between the Grip and No Grip conditions in the LAT and the INF (Table I and Table II).

Table I also displays the values of peak activation for the Grip and No Grip conditions for the subjects averaged over repetitions 2-4. Table II displays the results of the paired t-tests for the subjects. Figure 1 displays the values of the peak activation (percentage) data averaged over repetitions 2-4 for the Grip and No Grip conditions for the subjects.

**Table** I. Mean Normalized EMG Activity (Mean +/- SD) of the WF, WE, LAT, & INF

| Muscle | No Grip | Grip | Difference | Significance ψ |
|---|---|---|---|---|
| WF | 72.9 +/- 22.2 | 65.7 +/- 23.4 | 7.2 | 0.040* |
| WE | 69.6 +/- 32.9 | 55.7 +/- 26.2 | 13.9 | 0.001* |
| LAT | 107.0 +/- 50.3 | 102.2 +/- 46.3 | 4.8 | 0.133 |
| INF | 88.8 +/- 37.8 | 83.8 +/- 32.0 | 5.0 | 0.067 |

*Ψ p value is based on paired t-test with Bonferroni corrections (α = 0.0125);* denotes a significant difference; EMG = Electromyographic; WF = Wrist Flexors; WE = Wrist Extensors; LAT = Latissimus Dorsi; INF = Infraspinatus*

**Table** II. Paired Samples Test

| | | Paired Differences | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | | | | |
| | | Mean | Std. Dev. | Std. Error Mean | Lower | Upper | t | df | Sig. (2-tailed) |
| Pair 1 | LATCNG – LATCG | 4.826 | 17.081 | 3.1187 | -1.5518 | 11.2051 | 1.548 | 29 | .133 |
| Pair 2 | INFCNG – INFCG | 4.983 | 14.340 | 2.6182 | -.3715 | 10.3382 | 1.903 | 29 | .067 |
| Pair 3 | WFCNG – WFCG | 7.133 | 18.131 | 3.3103 | .3631 | 13.9036 | 2.155 | 29 | .040* |
| Pair 4 | WECNG – WECG | 13.937 | 15.390 | 2.8100 | 8.1896 | 19.6837 | 4.960 | 29 | .001* |

*α = 0.0125 with Bonferroni correction; * denotes a significant difference; LATCNG = Latissimus dorsi concentric no grip; LATCG = Latissimus dorsi concentric grip; INFCNG = Infraspinatus concentric no grip; INFCG = Infraspinatus concentric grip; WFCNG = Wrist flexors concentric no grip; WFCG = Wrist flexors concentric grip; WECNG = Wrist extensors concentric no grip; WECG = Wrist extensors concentric grip*

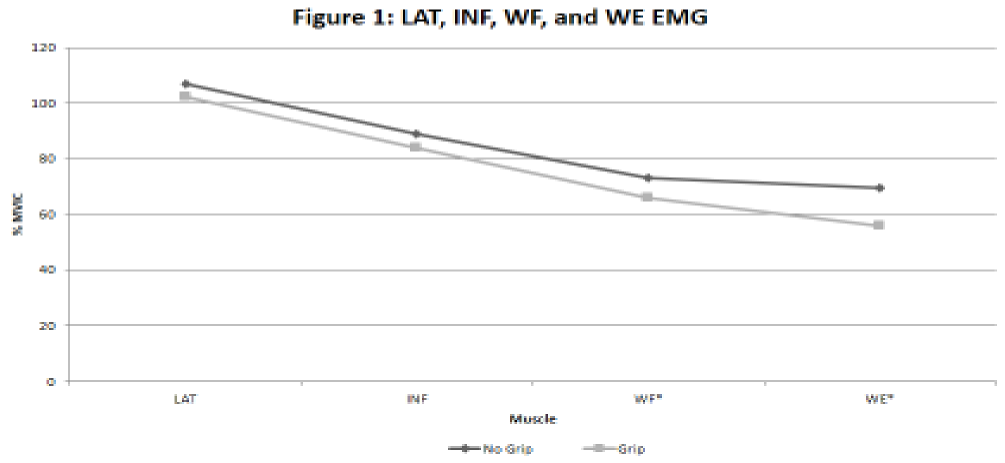

**Figure 1.** Mean normalized electromyographic (EMG) activation of the latissimus dorsi (LAT), infraspinatus (INF), wrist flexors (WF), and wrist extensors (WE) expressed as a percentage of maximum voluntary isometric contraction (MVIC) during pull-ups without Grips and with Grips. The WF* and WE* demonstrated a significant difference between the two grip conditions.

## Discussion

The use of weight lifting equipment such as weight lifting belts, gloves, knee wraps, elbow wraps, and wrist straps is common practice among strength training participants. Unfortunately, with the exception of weight lifting belts, no literature to the author's knowledge has investigated the effectiveness of the use of wrist straps or other similar type of weight lifting equipment. At the time that this study was conducted, the authors were unable to discover any evidence to support the claims made by the Versa Gripps® manufacturer.

The results of the data revealed that the WE and WF showed a significant decrease in sEMG signal amplitude between the No Grip and Grip conditions. The data from this study suggest that the use of Versa Gripps among strength-trained males helps to decrease the effort required of the WE and WF during pull-ups without inhibiting or assisting the LAT and INF. This could potentially lead to better performance in maximum number of pull-ups performed if hand grip strength is the limiting factor.

Although it has been reported that finger flexor muscle strength can be increased by placing the wrist in a position of ulnar flexion and wrist extension, additional strain on the structures around the wrist also increases (26). Since the effort required by the WE and WF were significantly decreased during the performance of pull-ups with the use of the grips, it was possible that the wrists of the subjects were placed in a position of extension during the performance of the pull-ups. An evaluation of the videos of the subjects demonstrated that the subjects initially placed their wrists in some extension in order to wrap the Versa Gripps® around the bar. However, it was noted that once the subjects bent their knees and hung down toward the starting position of the pull-up with the elbows in full extension the wrists fell into a neutral position. It has been reported that the neutral position of the wrist is the safest position because it reduces the strain on the wrist structures (26). Despite the wrist being placed in a neutral position, the WE and WF were co-contracting in order for subjects to maintain their wrists in neutral position. Further research on the exact position of the wrists during the performance of pull-ups with wrist straps could potentially quantify these observations.

One limitation in the study was the experience of the subjects with using the Versa Gripps® or a similar type of wrist strap. Although the subjects were instructed in the proper use of the grips before performing any pull-ups, some subjects appeared to have difficulty in getting accustomed to the grips during the activity. Coincidentally, some subjects appeared to not use the grips to their advantage. On some occasions, subjects reported feeling a better grip with the Versa Gripps® and as a result appeared to squeeze the pull-up bar harder during the activity instead of letting the grips take some of the workload from the WF and WE.

Hence, there may be a learning curve for some subjects with using the Versa Gripps® and this may have had an influence on the results.

Future research could also include novice users and experienced users of wrist straps to determine any potential differences between the two groups. Furthermore, more research on the effects of the use of Versa Gripps® on maximum pull-up performance for males is needed in order to determine if the use of Versa Gripps® could help to improve maximum pull-up performance in strength trained males. Other future research on the effects of the use of Versa Gripps® on other exercises such as deadlifts, shrugs, and rows could prove to be beneficial to determine if the effects of the use of Versa Gripps® is effective in other exercises that require a pulling type of motion. Lastly, patients cleared to return to their prior level of function but who were previously diagnosed with lateral ore medial epicondylitis might be studied to determine if the use of Versa Gripps® among this population experience the same decreased activation of the WE and WF as measured in healthy male subjects.

*Acknowledgements*. The authors would like to acknowledge California State University-San Bernardino undergraduate students Jesus Gutierrez and Elizabeth Montes for their assistance in formatting this document.

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Received: June 18, 2015
Accepted: August 25, 2015