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Technical Note

The Effects of Wearing a Portable Media Armband on Muscle Activation of the Biceps Brachii

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ABSTRACT

International Journal of Exercise Science 16(1): 1461-1470, 2023. Portable media armbands are commonly used among the physically active population. Their effect on muscle function has not been established. The purpose of this study was to determine if muscle activation of the biceps brachii is influenced by wearing a portable media armband during an elbow flexion exercise. Eighteen participants (11 males: age = 22.5 ± 2.1 years, height = 178.3 ± 5.2 cm, mass = 85.0 ± 6.5 kg; 7 females: age = 22.9 ± 2.5 years, height = 168.3 ± 5.7 cm, mass = 72.3 ± 12.2 kg) with no history of upper extremity injury volunteered for the study. Participants performed elbow flexion trials with a hand-held dumbbell with and without wearing a portable media armband. Dumbbell weight was determined by an 8-10 repetition maximum, and the condition was counterbalanced. The average concentric and eccentric phases for five trials for each condition were normalized to a maximum voluntary isometric contraction using electromyography. The independent variable was condition (with-PMAB and without-PMAB). The dependent variable was the muscle activation of the biceps brachii. Mean data for each condition were analyzed using separate paired-samples *t*-tests for the concentric and eccentric phases ($p < 0.05$). Statistical analysis revealed a significant difference for the concentric phase ($t_{17} = 2.905$; $p = 0.010$). The with-PMAB condition elicited greater muscle activation (72.57 ± 36.31%) compared to the without-PMAB (63.67 ± 26.2%), with a medium effect size ($d = 0.69$). There was no statistical difference for the eccentric phase ($t_{17} = 1.964$; $p = 0.066$), and a small effect size ($d = 0.46$). The increase in muscle activation during the concentric phase is likely due to a change in the muscle properties due to the compressive force applied to the muscle fibers by the portable media armband.

KEY WORDS: Electromyography, external apparatus, resistance, upper extremity

INTRODUCTION

The use of external supports, such as tape, braces, and support bands, are commonly used within the active population for injury prevention and rehabilitation. The benefits and disadvantages of wearing braces (5, 6, 22, 24), tape (4, 10), and bands (12) for injury prevention or assistance are well documented. Such external supports can provide protection and stabilization, particularly at articulations, while optimizing functional movements (4). There is, however, a long-standing belief from clinicians that wearing an external support at articulating surfaces can lead to the development of weakness in the surrounding muscles (5).

There are physiological considerations that should be taken into account with any external apparatus, as it may alter the mechanical properties of the muscle depending on the location and compressive nature of the apparatus. Muscle fiber length and conduction velocity are important neuromuscular components in the production of force (16, 17). Although alterations to the muscle through an external apparatus could change the electrical signals along the muscle fibers in an unfavorable manner, there are situations where they are advantageous. For example, the use of compression tights during running has been found to create mechanical efficiency by optimizing muscle fiber direction and decreasing muscle activation, resulting in the minimization of fatigue (1, 2, 21).

Portable media armbands are commonly used to keep people connected to electronic devices during physical activity. In particular, they provide access and control of personal music devices and cellular phones during exercise due to their convenient size and hands-free strap. Portable media armbands are typically worn with the elastic strap placed over the muscle belly of the biceps brachii. Unlike compression tights, braces, tape, and bands which are worn for a performance advantage or injury prevention, portable media armbands are used for convenience during activities such as running and resistance training.

A search of the literature yielded no previous research on the use of portable media armbands, nor their effects on muscle activation. Therefore, it is unknown if consumers are inadvertently altering their muscle function by wearing one. Research on external supports, such as portable media armbands, informs consumers and clinicians alike in the ability to weigh the potential benefits and disadvantages. The purpose of this study was to determine if muscle activation of the biceps brachii is influenced by wearing a portable media armband (Figure 1). Based on the lack of previous evidence in this area, the investigators proposed there would be no significant difference in the muscle activation of the biceps brachii while wearing a portable media armband and not wearing one during an elbow flexion exercise with an external weight. The results from this study can provide insight into muscle function of the biceps brachii while wearing a portable media armband so physically active individuals can make an informed decision on whether or not to use one.

METHODS

Participants

This study utilized a counterbalanced, crossover design conducted in a controlled laboratory setting. Prior to participant recruitment, this study received approval from the University's Institutional Review Board. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (18). A power analysis was run using the means and standard deviations from data collected during a pilot study. It was determined a sample size of 14 with a medium effect size (0.5) would result in a power of 0.80 (8). Eighteen physically active males and females (11 males: age = 22.5 ± 2.1 years, height = 178.3 ± 5.2 cm, mass = 85.0 ± 6.5 kg; 7 females: age = 22.9 ± 2.5 years, height = 168.3 ± 5.7 cm, mass = 72.3 ± 12.2 kg) volunteered to participate in this study. Physically active was defined as participating in upper extremity resistance training for a minimum of three times per week for 30 minutes over a 6-week period. Prior to data collection, all participants completed informed consent and health history forms. The self-reported health history form was used to determine activity level, injury health status, and any other conditions that may affect participation. Exclusion criteria for this study included current or past history of heart, lung, or blood conditions, or shoulder or elbow injuries including dislocation, subluxation, fracture, surgery, thoracic outlet syndrome, decreased sensation in the upper extremities, or upper extremity pain at rest or during daily activities. Participants reported to the Human Performance Lab for one testing session.

Figure 1. Portable media armband (Sportline, Elmsford, NY).

Protocol

The skin over the biceps brachii on the dominant throwing side was cleansed with a 70% isopropyl alcohol pad prior to placement of a disposable 9-mm pre-gelled bipolar silver-silver chloride electrode (Noraxon USA, Inc., Scottsdale, Arizona) over the belly of the muscle. A single reference electrode was placed over the radial styloid.

Next, participants were seated on the side of a treatment table with the dominant throwing shoulder at neutral, the elbow flexed to 90°, and the forearm supinated. In this position, maximum voluntary isometric contractions (MVIC) were performed by having the investigator stabilize the elbow with one hand while the other hand resisted elbow flexion at the distal forearm (11). Participants performed three trials of a 5-second MVIC against manual resistance and there was a 60-second rest period between each trial.

Following the MVIC calibration trials, participants were given a 2-minute rest period. After which, participants were seated with their dominant throwing shoulder resting at 45° of glenohumeral flexion on a padded table. In this position, participants performed 10 warm-up bicep curl exercises at 50% of their self-estimated one repetition maximum (RM) (Figure 2). This was followed by a 2-minute rest period. Next, while in the same position, participants performed one set of 8-10 RM of a bicep curl. Participants self-selected a dumbbell weight they estimated to be their potential 8-10 RM. Participants performed as many continuous bicep curls as possible until fatigue or 11 repetitions, whichever came first, at a rate of 2-seconds per repetition. Velocity of the repetitions was controlled with a metronome set to 60 bpm. When a participant performed more than 10 or less than 8 repetitions, they were given a 5-minute rest period prior to selecting another dumbbell weight and repeated the 8-10 RM protocol. Once an accurate 8-10 RM was determined, participants were given a 5-minute rest period to avoid muscle fatigue.

Figure 2. Position for warm-up, 8-10 repetition maximum and testing trials.

Participants performed five separate bicep curl repetitions with a portable media armband and five separate bicep curl repetitions without a portable media armband. The repetitions were performed in the same position as the warm-up and 8-10 RM trials, and were performed using the weight determined by the 8-10 RM. There was a 1-minute rest period between each set of five repetitions. For one of the sets of five repetitions, the investigator secured a portable media armband (Sportline, Elmsford, NY) at the level of the deltoid tuberosity with a tightness that allowed two fingers between the armband and the skin. The order of condition (with portable media armband and without portable media armband) was counterbalanced.

Electromyography (EMG) signals were collected during the MVIC and testing trials at 1000 Hz with using the Noraxon Telemyo 2400TG2 EMG system (Noraxon USA, Inc., Scottsdale, Arizona). Calibration of the EMG signal was performed prior to recording data with participants in a relaxed state. MyoResearch XP version 1.07 (Noraxon USA, Inc., Scottsdale, Arizona) was used to process the raw EMG data, which consisted of full-wave rectification and smoothing using a moving window (50 ms) with a linear algorithm. This smoothing technique was selected due to the speed at which the biceps curl was performed and to avoid a phase shift in the EMG signal. A Panasonic PV GS300 camcorder (Panasonic Corporation of North America, Secaucus, NJ) was interfaced with the MyoResearch XP software to record each trial to allow for synchronization of the EMG data and the movement of the elbow. Event markers were placed within the EMG data to separate the concentric and eccentric phases for each trial. For each participant, the average of the five trials for each condition were normalized to the average of the middle 3-seconds of the three MVIC trials.

Statistical Analysis

The independent variable was the condition (with portable media armband and without portable media armband). The dependent variable was the muscle activation of the biceps brachii. Statistical analysis was performed with SPSS version 20 for Windows (SPSS, Inc., Chicago, IL, USA). The mean data for each condition was analyzed using separate paired-samples *t*-tests for the concentric and eccentric phases with an adjusted *p*-value ($p < 0.025$). The data met the assumptions for paired-samples *t*-test with regard to independent observation, normal distribution, and no outliers. Effect sizes were measured by Cohen's *d*, and reported as very small (0.00-0.19), small (0.20-0.49), medium (0.50-0.79), and large (0.80+) (27).

RESULTS

Statistical analysis revealed a significant difference for the concentric phase ($t_{17} = 2.905$; $p = 0.010$), in that the with-portable media armband condition elicited greater muscle activation (72.57 ± 36.31%) compared to the without-portable media armband (63.67 ± 26.2%). The effect size was $d = 0.69$, indicating a medium effect. Figure 3 illustrates the findings of the concentric phase. There was no statistical difference for the eccentric phase ($t_{17} = 1.964$; $p = 0.066$), in which the muscle activation during the with-portable media armband condition (40.01 ± 17.59%) compared to the without-portable media armband (37.40 ± 15.70%). The effect size was $d = 0.46$, indicating a small effect. Figure 4 illustrates the findings of the eccentric phase.

DISCUSSION

This study investigated the effects of wearing a portable media armband on the muscle activation of the biceps brachii during a bicep curl exercise. This is the first known study to examine the muscle properties while wearing a portable media armband during exercise. The results indicated a significant increase in muscle activation on the biceps brachii during the concentric phase while wearing the portable media armband, and no significant difference in the muscle activation during the eccentric phase. This is likely due to increased tension on the muscle fibers from the portable media armband as a result of an increase in arm circumference during the concentric contraction. Since there is a smaller circumference of the arm during the eccentric contraction phase, less external tension on the muscle fibers would be expected.

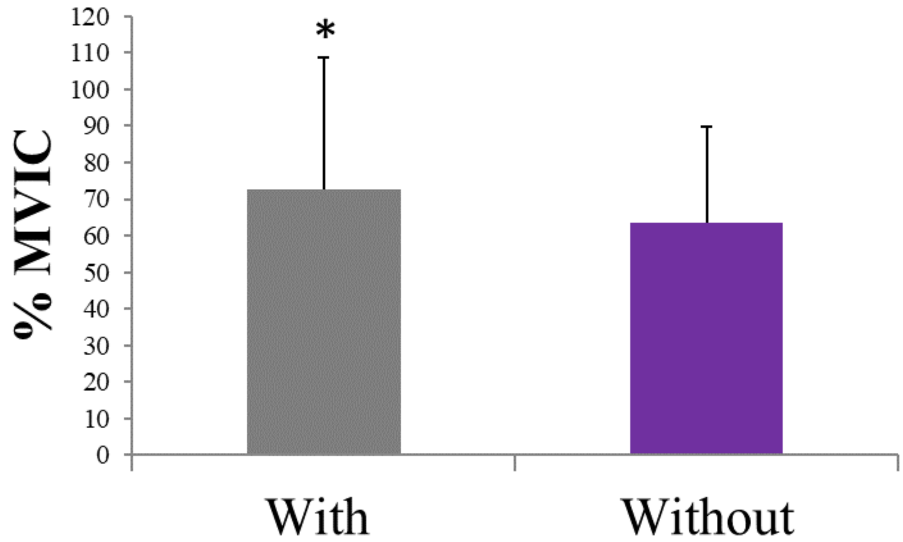

Figure 3. The muscle activation means and standard deviations (only positive illustrated) of the biceps brachii during the concentric phase of a biceps curl with and without wearing a portable media armband. %MVIC = % maximum voluntary isometric contraction. *Significant difference ($t_{17} = 2.905$; $p = 0.010$) such that with-portable media armband was greater compared to without-portable media armband

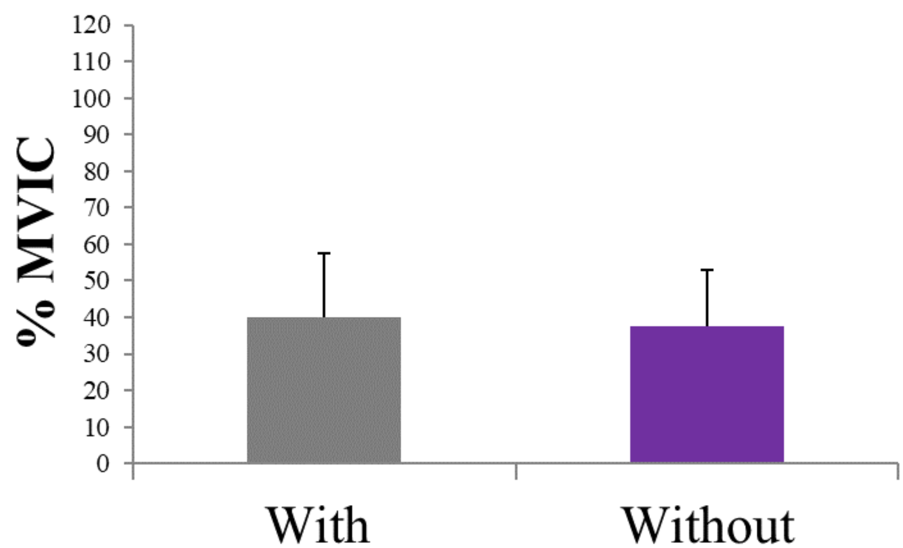

Figure 4. The muscle activation means and standard deviations (only positive illustrated) of the biceps brachii during the eccentric phase of a biceps curl with and without wearing a portable media armband. %MVIC = % maximum voluntary isometric contraction. No significant difference ($t_{17} = 1.964$; $p = 0.066$)

With regard to external apparatuses that wrap around extremities, previous studies have focused on the acute effects of taping (4, 10, 20) and bracing, (5, 12, 19) to determine their effects on muscle and nerve function. Wearing a band to support the forearm has been found to increase the rate of muscle fatigue (12), while a forearm brace was determined to negatively affect joint proprioception (19). Likewise, for the lower extremity, a patellar taping technique was found to inhibit the activation of the vastus medialis obliquus (20). While it was concluded those external apparatuses are detrimental to muscle and nerve function, (12, 19, 20) the results of the current study showed it to be beneficial to muscle activation. With appropriate duration and frequency of repetitions, muscle activation of 66% or greater is associated with strength gains (15). Based on the muscle activation levels found in the current study, future research is necessary to determine if the 8.9% increase during the concentric phase with the portable media armband would result in unilateral strength gains.

It is likely the increased muscle activation in our study resulted from an increase in compressive forces placed on the muscle belly causing deformation of the muscle fibers. Unlike a portable media armband, elastic therapeutic tape, also known as kinesiology tape, is an external apparatus that can be placed over an articulation or muscle belly thru minimal tension with the intention of relieving a patient's pain or swelling without hindering motion. It has been reported that the use of elastic therapeutic tape on the trapezius does not significantly affect muscle activation despite participants reporting a sense of increased relaxation while wearing the tape (26). In patients diagnosed with lateral epicondylitis, the use of elastic therapeutic tape with tension has been found to improved functional disability (25) and decrease pain (3) compared to no tension applied in the placebo group. Although the current study consisted of healthy individuals, it is evident that minimal tension from an external apparatus can influence muscle and nerve function.

Previous research did not find positive or negative effects as a result of long term prophylactic ankle brace use (5). It should be noted that prophylactic braces and portable media armbands differ in their purpose and location, and therefore have varying effects on the surrounding tissues. Prophylactic braces are worn at articulating surfaces and function to limit range of motion and increase joint stability. The tension from prophylactics braces is distributed over the ligaments and tendons, which possess minimal contractile properties. Due to the location and purpose of prophylactic braces, they are not apt to disrupt normal muscle contractile function. On the contrary, portable media armbands are placed away from joints as to not limit joint range of motion, with the most commonly observed location being over the muscle bellies of the biceps brachii and triceps brachii. Since they are placed over the muscle fibers, the length-tension relationship of the contractile tissue can be altered.

While focusing on neuromuscular function is important, the changes in vascular flow from external apparatuses should also be considered. Changes in biceps brachii size, strength, and function have been observed following exercise protocols with blood flow restriction (7, 9, 23, 29, 30, 32, 33). The current study did not account for the potential effects of restricted blood flow to the upper extremity as a result of the portable media armband. Previous research has found that blood flow restriction increases electromyography activity during low intensity resistance exercise compared to the same exercise without blood flow restriction (29, 31). There is even evidence that positive muscle adaptions result from blood flow restriction even without exercise (13, 14, 28). Although it appears likely that minimal vascular occlusion occurs with the use of a portable media armband, future research will need to assess the amount of blood flow restriction, if any, that results from wearing a portable media armband.

In addition to not investigating blood flow, limitations to this study include examining the muscle activation of only the biceps brachii. The authors recognize other muscles of the upper arm may be affected by the use of a portable media armband. Additionally, all participants in the current study were healthy and physically active. Portable media armbands are likely used regularly by individuals with musculoskeletal injuries and systematic conditions such as cardiovascular disease and neurological disorders. It in unknown if wearing a portable media armband may impact individuals with these conditions to a greater or lesser extent.

This study showed an increase in muscle activation during the bicep curl exercise in healthy, physically active individuals while wearing a portable media armband. Although muscle activation was found to be different during this study, unilateral differences in strength from wearing a portable media armband are not conclusive. Further research is necessary to determine the long-term consequences or benefits of wearing these devices. Until additional research is conducted, in order to alleviate the potential risk of unilateral strength gains, individuals using portable media armbands during upper extremity resistance exercises should consider alternating the side of use.

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