THE EFFECTS OF WRIST SPLINTING ON MUSCLE ACTIVITY DURING A HAND GRIP TASK

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INTRODUCTION

Wrist splints are commonly used in the rehabilitation of carpal tunnel syndrome and other wrist disorders. While they are usually prescribed for night use, they have become common for both day and workplace use. Theoretically, splinting of the wrist should lower muscle activity by stabilizing the wrist and reducing the need for co-contraction. However, the effectiveness of decreasing muscle activity through wrist restraint is inconclusive [1, 2]. The purpose of the study was to examine the relationship between forearm muscle activity and splinting during grip force production.

METHODS

Ten healthy volunteers (5 male, 5 female) participated. Forearm muscle activity was examined during four grip force exertion levels (12.5, 25, 50 and 100%Grip $_{max}$) in three wrist postures, with and without a wrist splint. EMG was recorded from flexors carpi radialis (FCR) and ulnaris (FCU), flexor digitorum superficialis (FDS), extensors carpi radialis (ECR) and ulnaris (ECU) and extensor digitorum communis (EDC). Plexiglass splints were affixed to the dorsal aspect of the right forearm and hand with tape for each posture (0°, 30°flexion, 30°extension). Experimental set up and procedures followed a previous study [3]. A grip dynamometer (MIE Medical Research Ltd., Leeds, UK) was used with a 5 cm grip span and was not supported, while the forearm rested on a platform. An oscilloscope provided visual feedback with the instantaneous grip force overlaid on the target grip force. Differential raw EMG and grip force data were collected at 1000 Hz, with EMG digitally linear enveloped at 3 Hz. Each trial lasted 10 s and was initiated with a "pre -exertion"(zero force) phase lasting a minimum of 1.5 s, followed by an increase to the desired target force, which was maintained for a minimum of three seconds. Average EMG (AEMG) was calculated for "pre -exertion"and target force phases.

RESULTS AND DISCUSSION

No significant differences in activity were observed between splinted and non-splinted conditions for any muscle during low to moderate target forces (12.5, 25, 50% However, the use of a splint significantly increased muscle activity for ECR, ECU, EDC, FCR and FCU during maximal efforts (100% Grip$_{max}$) at postures specific to each muscle (all F <13.6, all p <0.044). These increases ranged from 7.3%MVE for FDS to 28.2%MVE for FCU. The largest difference was observed for FDS (39.1%MVE), but it was not statistically significant. During pre-exertion (0%Grip $_{max}$), wrist splinting appeared to support the wrist, as evidenced by lower AEMG for ECR and FDS (all F >6.1, p <0.036). ECU, EDC and FCR also exhibited lower activity, but did not attain significance. However, this finding may be explained by lower grip forces required to hold the dynamometer in the pre-exertion phase when splinted (approx. 0.6 N less). Figure 1 illustrates the general result that AEMG was generally lower at zero grip force, similar from low to moderate target forces (12.5, 25, 50%, and higher at maximal (or near maximal) grip exertions. True maximal grip force was not attained by most participants, especially in the flexed wrist posture; however, there was no difference with or without splinting. While the splints created for this study are not representative of most commercially available products, these data indicate that the effectiveness of splinting may be governed by force level and wrist posture. These data also suggest that industrial wrist bracing to reduce operator effort with power hand tool use, such as with power screwdrivers [4], may require further assessment using EMG.

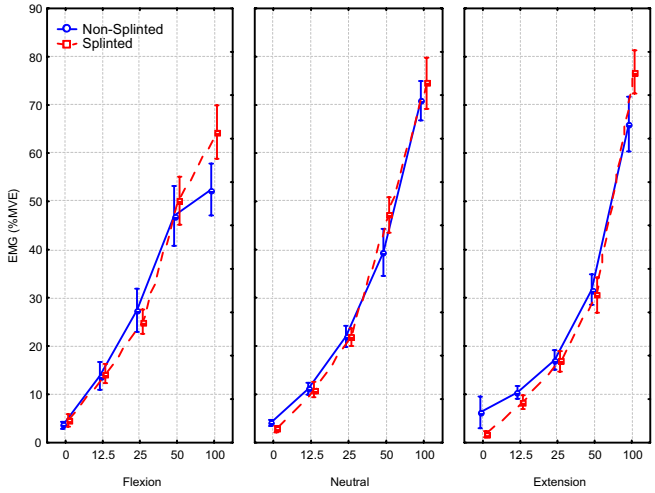

Figure 1. Mean ECU muscle activity (%MVE) versus grip force (%Grip $_{max}$) for the three wrist postures in splinted (dashed line) and non-splinted (solid line) conditions.

CONCLUSIONS

At low to moderate grip effort levels, muscle activity was not altered by using a wrist splint, however, at maximal effort, AEMG increased with the splint. It would appear that a dorsal wrist splint does not reduce muscular effort in what might be considered "active"use. In ad dition, under the conditions tested, dorsal wrist splints did not reduce co-contraction. Thus, the increasingly common use of wrist splints during daily activities should be reconsidered, if the intent is to reduce wrist loading by decreased muscle activity.

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