EFFECTS OF REACH DISTANCE UPON ELECTROMYOGRAPHICAL ACTIVITIES OF SELECTED UPPER BODY MUSCULATURE

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INTRODUCTION

In one-handed, submaximal pulling activities the forces required to move the load are not likely produced from trunk efforts alone, but with contributions from other parts of the body. The upper extremity plays an important role in exerting horizontal pulling forces [1] but more insight into the kinesiological strategies employed by an operator under varying pulling situations is still required.

The purpose of this study was to examine the effects of reach distance on the electromyographical activities (EMG) of eight selected muscles of the trunk and shoulder regions during submaximal horizontal pulling exertions located at elbow height.

METHODS

Eleven healthy male volunteer subjects were asked to execute a right-handed pull on an isoinertial load (12% of lean body mass) located at varying distances (10, 15, 20, 25, 30, 35 and 40% of subject stature) from the frontal plane containing the load handle. Controls were put in place to standardize foot placement, pull direction and tempo. A ME3000P (Mega Electronics Ltd, Kuopio, Finland) unit was employed to collect the EMG activity of the following muscles: left and right erector spinae (at the level of the fourth and fifth lumbar vertebrae), left and right external obliques and the trapezius, latissimus dorsi, deltoid and biceps brachii from the right side of the body. Each channel was sampled at 1000 Hz, band-pass filtered between 20 Hz and 500 Hz, amplified and stored on a personal computer for further analysis. The raw EMG signals were full-wave rectified and low-pass filtered at 4 Hz. The raw signal was then normalized to a maximal voluntary contraction (MVC).

RESULTS AND DISCUSSION

EMG data revealed increasing erector spinae activity as reach distance increased (Figure 1) and this muscle group was found to be co-active with external oblique muscles during the exertion. Shoulder complex muscles were found to be highly active in all conditions, but only the trapezius and deltoid muscles demonstrated significantly decreasing activities as pull reach increased (Figure 1). If any strategy could be identified based on the experimental data, it might be that for closer pull locations (*i.e.* 10-20% stature from frontal plane containing the load) a shoulder strategy is employed, not necessarily because of mechanical efficiency but because the muscles controlling the spine are not in a desirable posture to create an extensor moment and contribute to a pull force. At further pull locations (*i.e.* 30-40% stature from frontal plane containing the load) the subject seems to employ trunk extensor strategies to assist in the pull exertion.

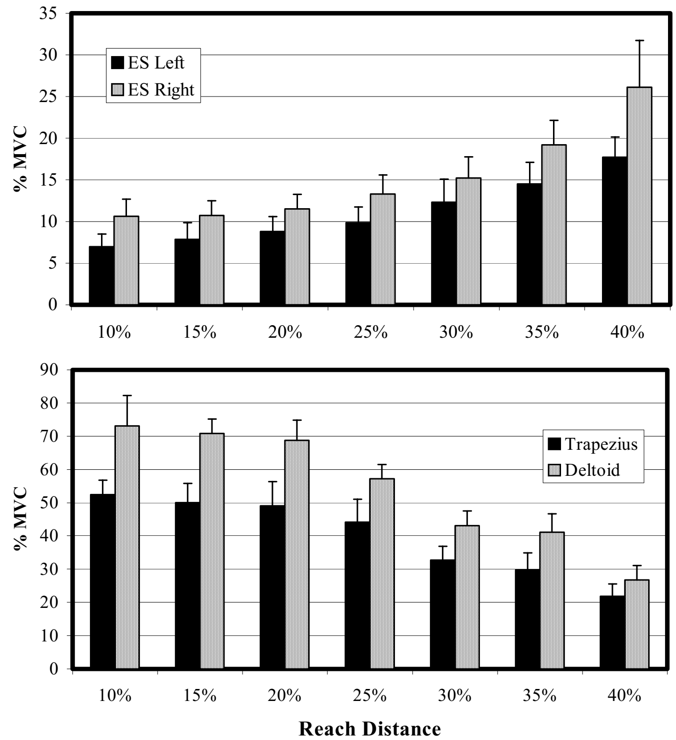

Figure 1: Mean (and standard error of the mean) EMG data. When performing *post hoc* comparisons with $\alpha = 0.05$, the following differences were found for the four muscles: (1) Left ES – 10%/15% different to 40%; (2) Right ES – 10%/15%/20% different to 40%; (3) Trapezius – 10%/15%/ 20% different to 40%; (4) Deltoid – 10%/15%/20% different to 30%/35%/40%; 25% different to 40%.

CONCLUSIONS

Much work must be done to understand better the strategies an operator will attempt to adopt a pull force under various postural conditions. It seems that executing a pull under conditions such as those simulated in this study could be optimized if the subject stood with the front toe at a distance of approximately 25% of stature from the frontal plane containing the load handle. These data provide some direction in positioning the operator within a workstation demanding pull force exertions.

REFERENCES

1. Hoozemans MJM, et al. *Ergonomics* **41**, 757-781, 1998.

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