

GRIP FORCE RESPONSES TO CHANGES IN THE PROVISION OF SUPPORT

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INTRODUCTION

Grip strength is an important prerequisite to good hand performance. Muscle weakness and impaired motor control are important factors in generating grip force. The impairment is often manifested in decreased ability to perform simple daily tasks such as pouring a drink or feeding. The procedures for testing grip forces are well documented and used in clinical practice to monitor progress during occupational and physical therapy, to assess potential for rehabilitation, or to monitor the likelihood of postoperative complications (Fess and Moran, 1981, Griffith et al, 1989). The usefulness of grip force assessments decreases when a patient cannot perform a simple task such as lifting an object with one hand and using the other arm for help. It is reasonable to assume that grip force is changed when assistance is provided. For example, a series of experiments with fingertip contact of surrounding objects provided a body of evidence that light touch contact is important in reducing postural sway while standing (Jeka, 1994). However, the effects of light touch and additional support on grip force while manipulating an object were not investigated. The purpose of the study is to determine whether there are adjustments in grip force as a result of additional support provided to the arm.

METHODS

Eight healthy subjects participated in the experiment while comfortably seated at an adjustable table. The total task involved grasping the cup located in the initial position, then lifting and transporting it to the final position. The cup was instrumented with two strain gauges; one was located on the side, and the second was set in the base of the cup (Scholtz, Latash, 1998). A cylindrical grasp involving an opposition of the thumb and the rest of the fingers was used. The subjects were required to lift the cup with the dominant arm, and transfer it without additional support, and then with additional support provided by the contra lateral arm. Provision of the contra lateral arm support included light touch of the index finger, and maximal or 50-percent support of the palm. In addition, an upper extremity skateboard was used as a movable support. Two different cup weights were used in the study: $\frac{3}{4}$ lb and 2lb. The following parameters were measured: peak grip force, time required to reach peak force, and movement time. A PC computer with customized software based on the LabView-4 package was used to control the experiment, collect the data, and perform most of the analyses.

RESULTS

With no additional support, the subjects applied more than 50% of their maximal isometric grip force to lift and transfer the 2-lb cup. The grip force decreased when any of the studied supports were provided. The smallest grip force was recorded when 50-percent of the maximal force provided by the contra lateral arm was used. Similar grip forces were measured when maximal support by the contra lateral hand was provided and when a skateboard support was used. Light touch substantially decreased grip force when compared to conditions without additional support. Similar but smaller changes in grip force were seen with the lesser weight.

DISCUSSION

Lifting and transporting an object required the subjects to apply grip force higher than it was required to prevent the object from slipping. Any additional support decreased the force needed to securely hold the object. This suggests that the brain adjusts grip forces while performing the same task involving different provisions of support. The ability of the CNS to reduce grip force in conditions of light touch (in which the forces provided with the finger are too small to unload the arm), is the most intriguing. It is quite possible that light touch used as an additional reference point in stabilizing the extremity may result in eliminating muscle fatigue while performing different tasks. One of the potential applications of light touch while lifting objects is in rehabilitation of individuals with weakness of muscles of one extremity.

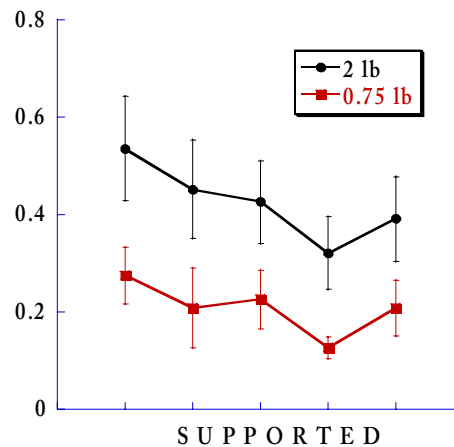


Figure 1. Grip force (normalized by the maximal isometric force) measured without additional support and with different provisions of support. Averaged data for 10 subjects are presented.

REFERENCES

- Fess, I, Moran, C. (1981). *Clinical Assessment Recommendations*. Am. Society of Hand Therapists.
- Griffith, J. et al. (1989) *British J of Surgery*, 76, 704-705
- Jeka, J, Lackner, J. (1994) *Exp Brain Res*, 100, 495-502
- Scholz, J., Latash, M. (1998) *Human Movement Science* 17, 753-779

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