THE EFFECT OF GENERATING ANTI-GRAVITY SHOULDER TORQUES ON UPPER LIMB DISCOORDINATION FOLLOWING HEMIPARETIC STROKE

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INTRODUCTION

Despite the variability of lesion location and spontaneous recovery experienced by individuals following hemiparetic stroke, the commonality among subjects is the presence of abnormal muscle synergy patterns and resulting stereotypical movement behaviors. These synergies and associated pathological coupling of joint torques were first observed in the clinic [1,2] and later verified quantitatively by Dewald et al [3,4] under static conditions. The synergies are expressed in strong coupling of shoulder abduction with elbow flexion (the flexion synergy) and shoulder adduction with elbow extension (the extension synergy). In this study we will compare the expression of the flexion synergy induced by generating isometric shoulder abduction (SABD) as opposed to elbow flexion (EF) torques at a maximal and a sub-maximal effort level. The goal of this study is to understand whether generation of anti-gravity torques at the shoulder has a more profound effect on the expression of the flexion synergy as opposed to torques generated at the elbow.

METHODS

Hemiparetic stroke (n=7) and control (n=6) subjects were casted at the wrist and secured to a six degree of freedom (DOF) load cell with shoulder at 70° abduction and 40° flexion and the elbow at a 90° angle. In order to minimize the effect of trunk muscle activation, subjects were seated in a Biodex chair with the trunk secured and the shoulders strapped to the back of the chair. A computer monitor was placed in front of the subject to provide visual feedback in the form of a horizontal and vertical movement of a circular cursor on the screen representing elbow flexion-extension and shoulder abduction-adduction, respectively. Subjects were generating maximum voluntary torques (MVTs) and 25% of MVTs in the shoulder abduction and elbow flexion directions. Forces and moments measured with the load cell were converted online to torques at the elbow (flexion/extension) and shoulder (flexion/extension, abduction/adduction, and external/internal rotation) using a Jacobian transformation. Subjects generated 3-5 trials in either direction. An analysis of variance (ANOVA) was performed at the 0.05 level of significance to test for the presence differences in secondary torques between stroke and control subjects.

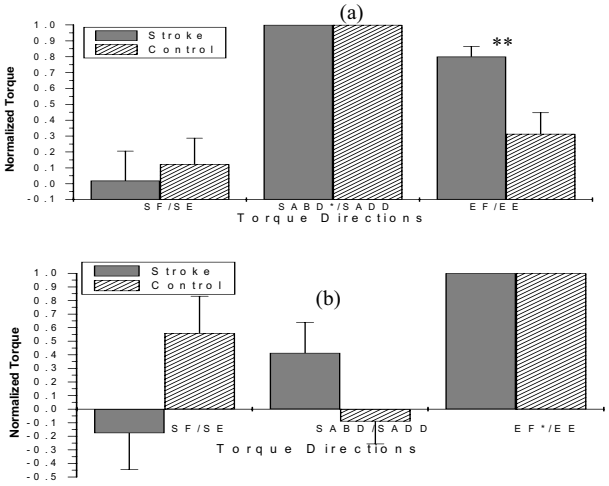

Figure 1. The group mean and standard errors of torque in each direction during the generation of (a) SABD and (b) EF torques at the **maximum** level. * P<0.05, **P<0.01.

RESULTS AND DISCUSSION

Figure 1 shows a significant increase in elbow flexion torques in stroke compared to control subjects during the generation of maximum SABD torques. Conversely, during the generation of maximum EF no significant increases in SABD were observed. The dominance of shoulder antigravity torques on the expression of the flexion synergy persists even at the 25% of MVT level as shown in figure 2 although the significance level was reduced from p<0.01 to p<0.05.

These results indicate that the generation of shoulder abduction torques following stroke results in a strong expression of the flexion synergy whereas generating EF does not have the same effect. Apparently, the activation of postural anti-gravity muscles at the shoulder uniquely impacts arm discoordination following stroke both in static as well as during dynamic arm reaching tasks as demonstrated in our laboratory in an earlier study [5].

REFERENCES

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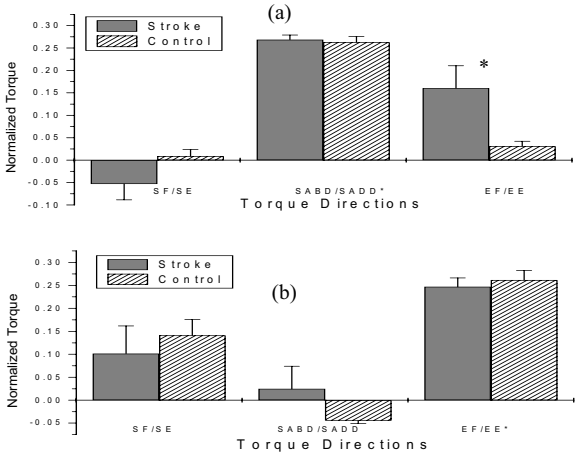

Figure 2. The group mean and standard errors of torque in each direction during the generation of (a) SABD and (b) EF torques at **25%** of MVT level. * P<0.05, **P<0.01.