The Effect of Postural Support on a Reaching Task in Children with Neuromuscular Disabilities

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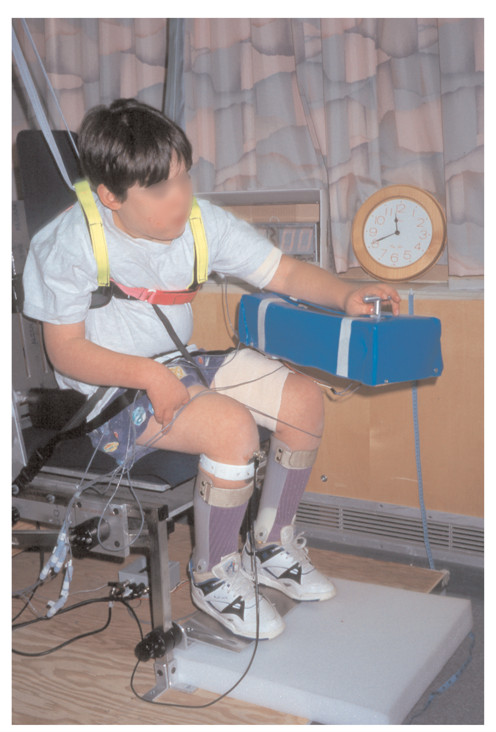
Introduction

A common therapeutic goal of supported seating is to improve upper extremity function[1-3]. This is based on the premise that stabilization of the proximal structures reduces excessive muscle activation at the shoulder and/or elbow which, in turn, leads to more accurate and quicker upper extremity function. However, the effects of postural support have not been well documented in the literature[1-3].

Objectives

The objective of this study was to determine whether seated postural support improves the ability of children with neuromuscular disabilities to perform a reaching task.

Methods



Subjects

Ten children were recruited, aged 7 to 19.2 years, with mild-moderate cerebral palsy or other neuromotor disability, who used wheelchair postural control systems. Ten age-matched children without physical disability (controls) were also recruited.

Procedure

Reaching Task

The seated reaching task consisted of moving a 'T'-shaped handle along a horizontal linear track from a starting position close to the body to the target position midline & 25 cm. in front of the body. Successful performance required maintaining the handle at the target position for 2 seconds.

Experimental Conditions

Subjects sat on a horizontal plate, covered with a foam cushion. A force/torque transducer was bolted underneath the plate and onto a chair fixed to a movable platform. The platform was translated anteriorly by means of a servomotor. For the perturbed trials, the platform was translated anteriorly shortly after the initiation of reach.

Each child performed a total of 48 reaching trials during the following conditions:

1) without seating support
2) with seating support
3) without seating support with anterior perturbations
4) with seating support with anterior perturbations

A total of four blocks of trials were performed in a randomized order, two blocks of 12 trials for each seating support factor. Within each block, 4 randomized trials were perturbed. The same order of the blocks was used for both groups.

Under conditions 2 and 4, support was provided by a foam covered back rest at the upper sacral to mid-thoracic regions of the back, and anterior and lateral supports at the upper trunk and pelvis.

Instrumentation & Data Collection

The 'T'-shaped handle was bolted onto an aluminum plate which slid on linear bearings between two parallel steel rods. The base of the handle was instrumented with strain gauges which measured perpendicular forces. A potentiometer attached to the handle determined handle position.
The seat was instrumented with a transducer that measured the x, y, and z forces and torques exerted on the seat.
A multi-channel EMG system recorded surface EMG of: biceps brachii, triceps brachii, rectus abdominus, L3 erector spinae, rectus femoris, and medial hamstrings on the same side as the task-performing arm.

Data Analysis

The effect of support on a total of 19 dependent variables was assessed.

Dependent Variables

ARM MOVEMENT (5 VARIABLES):	SEAT FORCES (5 VARIABLES)	MUSCLE ACTIVITY (9 VARIABLES)
- time to complete task	- centre of pressure (COP) location on AP & ML axes	- mean EMG each of the 6 muscle groups
- smoothness of movement (2 measures)	- COP movement along AP & ML axes	- co-contraction indices for the 3 flexor/extensor arm, trunk, & hip muscle pairs
- lateral handle force		
- variation of handle force	- vertical force	

Repeated measures of analysis of variance (ANOVA) were tested for group effects of support.
A statistically significant difference was set at $p<0.05$ (two-tailed test).

Results

Support had a significant effect on:

1. Movement time ($F(1,17)=6.927$, $p=0.0175$).
Movement times were longer when support was absent.

Movement time (sec) - means & 95% confidence limits (CL).

SUPPORT	PERTURB	SUBJECTS Mean	SUBJECTS CL	CONTROLS Mean	CONTROLS CL
No	No	1.7	1.2-2.4	1.1	0.9-1.3
No	Yes	1.8	1.2-2.7	1.0	0.8-1.2
Yes	No	1.7	1.3-2.4	1.0	0.8-1.3
Yes	Yes	1.6	1.1-2.3	1.0	0.7-1.2

2. COP location ($F(1,17)=17.630$, $p=0.0006$) and movement ($F(1,17)=49.061$, $p=0.0001$), A-P axis; ($F(1,17)=56.355$, $p=0.0001$), M-L axis.
The COP was displaced anteriorly when support was absent. Support reduced COP movement along both axes.

3. Vertical force on seat ($F(1,17)=7.642$, $p=0.0133$).
Support reduced the vertical force on the seat.

4. Elbow extension ($F(1,17)=7.970$, $p=0.0117$).
Mean EMG activity was lower when support was absent.

Triceps brachii EMG (microvolts) - means & 95% confidence limits (CL)

SUPPORT	PERTURB	SUBJECTS Mean	SUBJECTS CL	CONTROLS Mean	CONTROLS CL
No	No	20.7	14.5-29.5	8.2	6.5-10.4
No	Yes	24.4	17.4-34.3	8.4	6.7-10.5
Yes	No	25.0	17.9-34.9	10.9	8.4-14.1
Yes	Yes	25.1	17.0-36.9	10.9	8.5-14.0

5. Biceps/Triceps Co-contraction ($F(1,17)=7.970$, $p=0.0117$).
Arm co-contraction was lower when support was absent.

Biceps/Triceps Co-contraction (cross correlation coefficient) - means, standard deviations (sd) & coefficient of variation (cv)

SUPPORT	PERTURB	SUBJECTS Mean (sd)	SUBJECTS cv	CONTROLS Mean (sd)	CONTROLS cv
No	No	0.415 (0.146)	0.35	0.117 (0.240)	2.06
No	Yes	0.500 (0.176)	0.35	0.158 (0.277)	1.76
Yes	No	0.503 (0.189)	0.38	0.318 (0.219)	0.69
Yes	Yes	0.504 (0.185)	0.37	0.324 (0.217)	0.67

Discussion & Conclusions

The results give some support for the proposed positive effects of seated support, i.e., faster and smoother arm movement occurred during perturbation trials with support present. However, the results do not support the premise that support may improve performance by reducing co-contraction of opposing arm muscles, i.e., elbow extensor means & triceps-biceps co-contraction both increased with support present.

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