

INFLUENCE OF ARM SUPPORT ON THE UPPER EXTREMITY OF CERVICAL SPINAL CORD INJURED SUBJECTS

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INTRODUCTION

- In rehabilitation after a cervical spinal cord injury (CSCI) improvement in upper extremity function has a high priority.
- Intensive rehabilitation is important to (re)learn motor functions.
- To facilitate goal directed arm movements during daily living or training the arm is often supported.
- Several therapeutic devices and robotics were developed to support the upper limb during exercise.
- Aim: specific effect of arm support on kinematics and muscle activity during reaching tasks in SCI patients.

	SUBJECT ID NUMBER								
	1	2	3	4	5	6	7	8	9
GENDER (MALE / FEMALE)	M	M	M	M	F	M	F	M	M
AGE (YEARS)	28	55	47	59	39	40	26	53	36
TIME SINCE INJURY (MONTHS)	58	29	282	209	66	221	161	170	198
MOTOR LEVEL OF THE LESION	C5	C6	C6	C6	C5	C5	C6	C6	C7
ASIA IMPAIRMENT SCALE	A	C	B	D	B	C	A	A	A
asia motor score of the measured arm (mrc-scale)									
C5 (ELBOW FLEXORS)	4	5	5	5	4	5	5	5	5
C6 (WRIST EXTENSORS)	0	4	4	4	5	2	5	5	5
C7 (ELBOW EXTENSORS)	0	2	0	5	4	4	0	0	3
C8 (FINGER EXTENSORS)	0	0	0	4	1	0	0	0	0
T1 (FINGER ABDUCTORS)	0	0	0	4	0	0	0	0	0

Abbreviations: ASIA = American Spinal cord Injury Association; MRC = medical research council.

Table 1

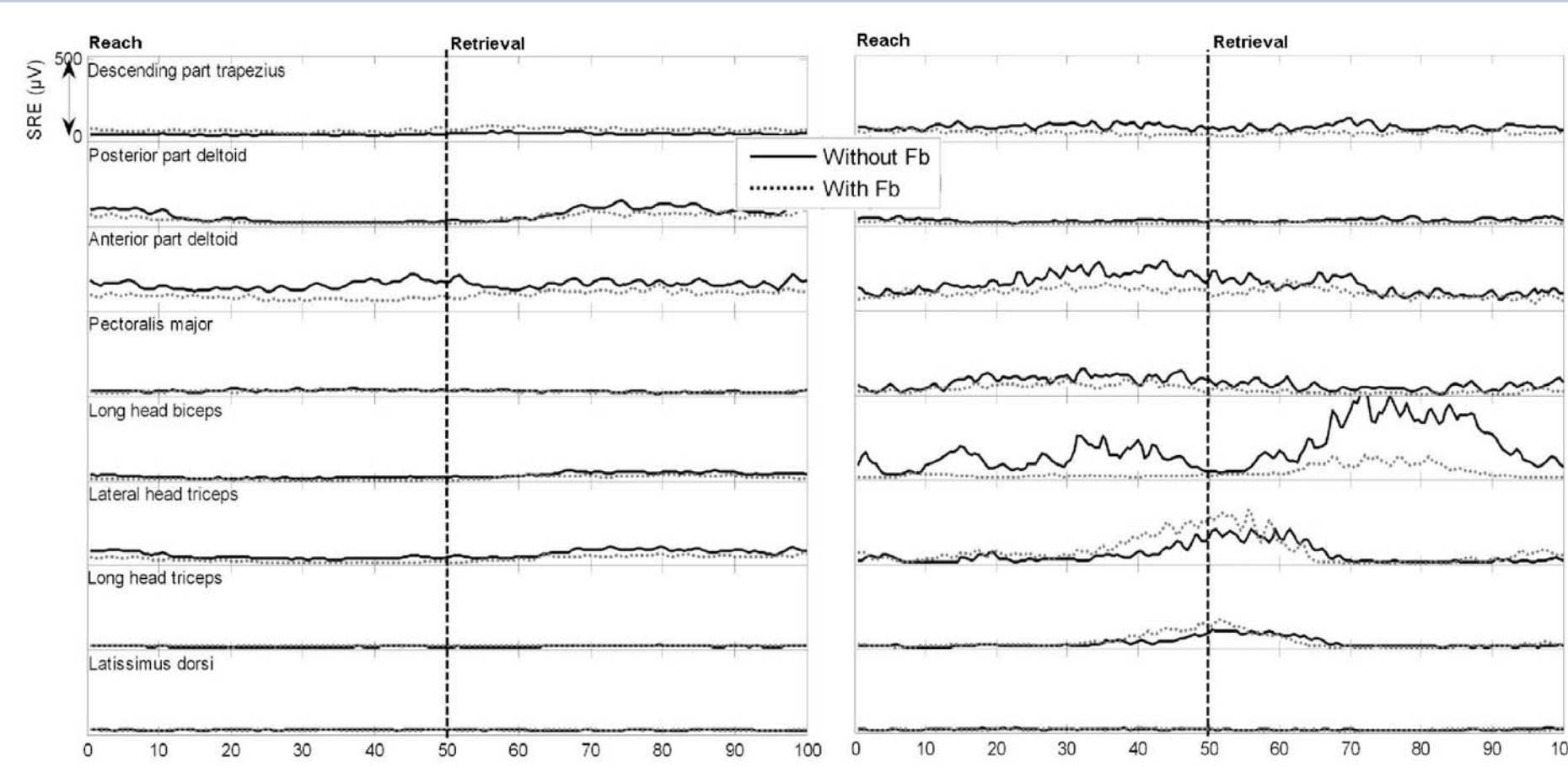


Figure 3 Mean muscle activation pattern of a reach and retrieval task with and without the Freebal(Fb). Left: Smooth rectified EMG (SRE) pattern of subject with ID number 9. Amplitude of the SRE in the anti-gravity muscles decreased with the use of gravity compensation, with the exception of the descending part of the trapezius. Right: SRE pattern of subject with ID number 2. Amplitude of the SRE in the anti-gravity muscles decreased and the amplitude of the SRE in the triceps increased with the use of gravity compensation.

METHODS

- Nine CSCI subject participated in this cross-sectional study (Table 1).
- They performed a maximal reaching task, which consisted of three maximum reaches in front of the subjects and above the table top. And a reach and retrieval task in which subjects were instructed to move at their own comfortable speed between a starting and target dot on the table (35 centimeters) for thirty seconds.
- Both task were executed with and without arm support delivered by the Freebal (Figure 1). The experimental setting is presented in Figure 2.
- Study parameters: Angles at shoulder and elbow, surface EMG of eight superficial muscles of the upper extremity and trunk (Figure 3).



Figure 2 Arm support provided by two slings connected to two, independently adjustable, springs via cables and pulleys overhead. This system compensate for gravity throughout the 3D workspace

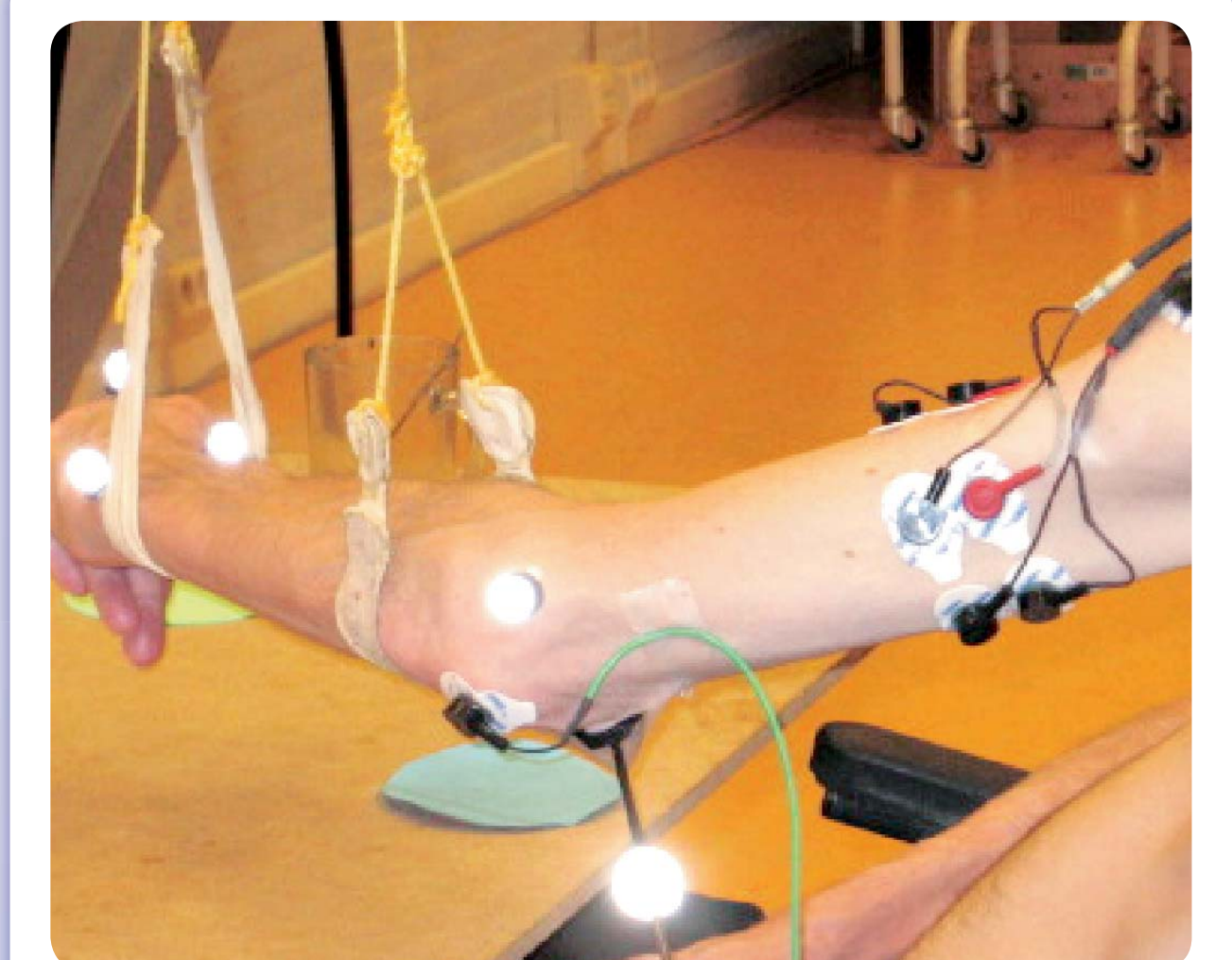
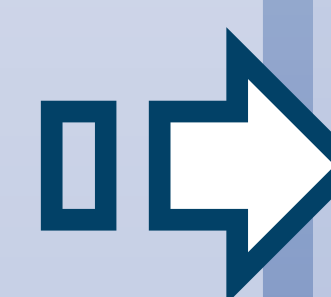


Figure 2 Measurement setting Freebal applied at the wrist and below the elbow. Measurement of muscle activation of eight superficial muscles and 3D optical movement tracking of the upper extremity and thorax by VICON.

RESULTS

During reach and retrieval task with arm support:

- Most subjects performed movement execution was closer to the body.
 - All subjects showed decreased elbow extension (11.0-0.1°).
 - EMG amplitude of muscle activation decreased especially in anti-gravity muscles.
 - Timing of muscle activation was not influenced.
 - Large variety of muscle activation patterns between subjects.
- Maximal reaching task with arm support
- Seven subjects showed less elbow extension (range 1.8-4.5 degrees).



DISCUSSION

Plausible explanations

- No trick movement possible without gravity.
- Less muscle force used to hold the arm against gravity.
- Less use of additional agonists in example the medial part of the deltoid muscle.
- Large variety in subject characteristics, with different motor levels and AIS.

CONCLUSIONS

Arm support of the upper extremity influenced the kinematics of the upper extremity, and the amplitude of the muscle activation, however, the timing of the muscle activation was not affected. This might have implications for exercise therapy.



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