Prehension

Oral communications

CO38-001-e
Review of upper limb kinematics after cervical spinal cord injury: Implications for rehabilitation
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Introduction The aim of this literature review is to provide a clear understanding of motor control and kinematic changes during open-chain upper limb (UL) movements after tetraplegia.

Method Using data from MEDLINE between 1966 and August 2014, we investigated kinematic UL studies after tetraplegia.

Results We included fourteen control case and three series case studies with a total of 161 SCI participants and 126 healthy control participants. SCI participants efficiently perform a broad range of tasks with their UL. This is achieved by effective scapulohumeral and glenohumeral compensation which provide a dynamic mechanical coupling between the shoulder and elbow joints thus palliating elbow extension despite triceps brachii paralysis. The mechanism is incomplete, however, since C5-C6 SCI individuals are forced to reduce overhead workspace to keep the elbow extended and to maintain the mechanical dynamic interaction between the shoulder and elbow. Furthermore, motion slowing is a clear kinematic characteristic, caused by:
– decreased strength;
– triceps brachii paralysis disrupting normal agonist-antagonist co-contraction;
– accuracy requirements at movement endpoint;
– grasping.

Conclusion Rehabilitation and surgical restoration should take these kinematic characteristics into account to reinforce proximal and distal compensations allowing elbow extension and grasp using tenodesis and consequently favoring greater autonomy of individuals after SCI.

Keywords Kinematic; Tetraplegia; Upper limb; Reach-to-grasp; Rehabilitation; Compensation

Disclosure of interest The authors have not supplied their declaration of conflict of interest.

http://dx.doi.org/10.1016/j.rehab.2015.07.279

CO38-002-e
Kinematic analysis of upper limb motion: Feasibility, preliminary results in controls and hemiparetic subjects, prospects
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Objectives The aim of this study is to develop a valid and standardized instrumental analysis of upper limb (UL) motion in stroke patients.

Methods Sixteen controls and 15 hemiparetic subjects (mean age = 54 ± 18.2 years old; Fugl-Meyer Upper Limb 41.4 ± 12.4) underwent kinematic motion analysis (passive markers, Optittrack) of pointing and grasping tasks. We examined the ability to perform a single pointing task and three reach-to-grasp tasks: key turning, reaching and grasping a can, reaching and grasping a cube; at a self-selected speed and as fast as possible. Speed, accuracy and efficiency of each movement were quantified and compared between controls.
and hemiparetic subjects, and between the ipsilateral of control subjects and the affected side; to describe reaching and grasping.

**Results** For reaching, movement time of hemiparetic UL was longer, less smooth (peak velocity, jerk), less direct (higher index path ratio) and associated with more trunk compensation (higher trunk/hand ratio). Movement time, jerks and trunk/hand ratio were the most discriminant variables between hemiparetic UL and ipsilateral/control UL, in any task analysed. Trunk displacement was greater in grasping than in reaching tasks. For grasping tasks, movement time is the most discriminant factor between hemiparetic and control/ipsilateral UL, especially for the key turn task. Movement alterations were also found for ipsilateral limb. Association between kinematic variables and clinical features during reaching time (Fugl-Meyer, MAL, WFMT, ARAT) was greater for the task “grasping a can”.

**Discussion/conclusion** Our results are similar to those of the literature, but suggest that we have to privilege some of the most relevant kinematic parameters. This standardization phase emerging after a validation phase of the techniques can make the biomechanical analysis of the upper limb as easy and valid as gait analysis and should help to develop the quantified measurement of prehension. This protocol is currently in process to objectively assess the therapeutic effects of rehabilitation treatments (botulinum toxin, induced constraint therapy).

**Keywords** Upper limb; Motion analysis; Kinematics; Reaching; Grasping; Hemiplegia

**Disclosure of interest** The authors have not supplied their declaration of conflict of interest.

http://dx.doi.org/10.1016/j.rehab.2015.07.280

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**CO38-003-e**

**Coordination of the shoulder complex for pointing in the peripersonal workspace**

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**Objective** The shoulder complex allows a large redundancy for the control of goal directed movements. Our aim was to investigate the contribution of scapula-thoracic motion to pointing movements in the peripersonal workspace.

**Methods** Ten healthy participants performed pointing movements with both sides toward nine targets. The kinematics of the shoulder was recorded using a Polhemus Fastrak 6 DoF electromagnetic device with 4 sensors fixed on the trunk, scapula, upper arm and wrist. The 3D rotations between trunk, scapula and humerus and the 3D displacement of the center of the scapula were measured at rest and for each pointing movement. Ratios of the global angles were used to compute a scapula-humeral rhythm. We performed a principal component analysis to study the coupling between scapula movements. A direct kinematic procedure was used to compute the contribution of scapula motion to the workspace of the hand.

**Results** Trunk and shoulder (glenohumeral [GH] and scapulothoracic [ST]) movements were finely tuned to target position, with small asymmetries. For all pointing movements, 3D global rotation angles of the GH and ST joints varied according to a scapulohumeral rhythm approximately equal to 2/1. Three principal components (1: internal rotation and lateral and anterior displacement, 2: posterior tilt and inferior displacement, 3: lateral rotation) could explain 76.5% of the variability of scapula motion. The direct kinematics showed that the contribution of ST motion to the hand workspace was major (reaching ~15 cm) and depended on the target.

**Discussion/conclusion** ST motion contributes significantly to the workspace of the hand. The scapulo-humeral rhythm classically described in the planar movements of the shoulder can be generalized in 3D and remains constant during pointing movements. ST motion should be taken into account in the evaluation and understanding of the movements of the upper limb.

**Keywords** Coordination; Scapula; Pointing; Scapulohumeral rhythm

**Disclosure of interest** The authors have not supplied their declaration of conflict of interest.

http://dx.doi.org/10.1016/j.rehab.2015.07.281

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**CO38-004-e**

**Combining rTMS and task-oriented training to enhance arm function after stroke**

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**Objective** Repetitive transcranial magnetic stimulation (rTMS) is a promising technique for enhancing rehabilitation of upper extremity function after stroke. The objective of this study is to evaluate the feasibility of conducting a randomized controlled trial aimed at determining the efficacy of rTMS as an adjunct to task-oriented therapy in facilitating restoration of arm and hand function after stroke.

**Methods** Eleven individuals living in the community (Montreal, Canada) with mild to severe arm deficits following a stroke were recruited and randomized. The experimental intervention consisted in a session of real-rTMS immediately followed by ninety minutes of arm and hand functional tasks designed to improve function. The control intervention involved a session of sham-rTMS followed by ninety minutes of arm and hand functional tasks. Subjects in both groups attended sessions twice weekly for four weeks. The main outcome measures were: The Box and Block Test (BBT), the Wolf Motor Function Test (WMFT), the Stroke Impact Scale (SIS) and neurophysiological measures.

**Results** Medium to large, statistically significant effect sizes (0.49 to 1.63) were observed in both groups on the BBT, the SIS and the functional score of the WMFT at the post-intervention evaluation. Three out of four subjects in the real-rTMS condition showed an increase in baseline levels of corticomotor excitability after the first stimulation session.

**Conclusion** It is possible to conduct a study comprising two ninety-minute therapy sessions weekly for arm function. However, preliminary evidence suggests that an rTMS protocol potent enough to induce transient increases in cortical excitability of the lesioned hemisphere did not show promising results as an adjunct to task-oriented training for improving upper extremity function.

**Keywords** Stroke; Transcranial magnetic stimulation; Upper extremity

**Disclosure of interest** The authors have not supplied their declaration of conflict of interest.

http://dx.doi.org/10.1016/j.rehab.2015.07.282