CO06-003-e

Exceptional late recovery of prehension after ischaemic stroke: A kinematic and neuroanatomic study (fMRI and DTI)

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Keywords: Stroke; Prehension; Recovery; fMRI; DTI; Cerebral plasticity

Background.– Recovery of a selective prehension after a complete impairment after stroke is rare. Most often, recovery is partial and occurs during the first six months. We report an exceptional case of late recovery of a good prehension ability that occurred between the fifth and the ninth year after a left total sylvian stroke.

Methods.– Recovery was followed by a kinematic analysis of a prehension movement 5, 9 and 12 years after the stroke, and compared to the data of 6 paired healthy subjects. A DTI MRI and an fMRI during a finger-tapping task were realized and compared to the data of 10 healthy subjects.

Results.– The patient shows a rough motricity of the fingers at 2 years, a two-fingers grip at 4 years and a grip comparable to that of the controls at 9 years. The DTI analysis shows a partial lesion of the left M1 area and cortico-spinal tract. The finger-tapping task of the impaired limb elicits an activation of the spared part of contralateral M1 and of the ipsilateral M1.

Conclusion.– Late recovery of a bidigital prehension after stroke is associated to a plasticity of contralateral and ipsilateral M1.

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Usability of non-invasive brain computer interface systems for upper limb recovery after stroke

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Keywords: Stroke; Motor recovery; Upper limb; Brain-computer interface; Effectiveness

Background.– Non-invasive brain computer interface (BCI) is a computer-based communication system in which brain activity signals are recorded and translated into motor commands for an output device (robot, orthosis, FES) to perform a desired action. The aim of this study is to revise usability of non-invasive BCI for upper limb recovery after stroke.

Methods.– A review was carried out of articles published over the last five years in Medline- PubMed, including randomized clinical trials and case series. Mesh key words used were: stroke, motor recovery, upper limb, brain-computer interface, effectiveness.

Results.– Motor imagery based EEG-BCI coupled to FES or robotic devices may improve finger extension, grip strength and upper limb motor function in chronic stroke patients. Motor improvements are correlated with cortical excitability changes assessed with transcranial magnetic stimulation.

Discussion.– Usability of non-invasive BCI for upper limb rehabilitation in stroke patients is influenced by its clinical effectiveness and interface design. Use of new sensors (i.e. dry electrodes) can facilitate the brain signal acquisition process. Monitoring patient physiological responses to detect fatigue or stress linked to BCI training also could improve BCI usability. Future advances on BCI technology may consolidate its use on clinical settings.

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CIPASS: Trial of a daily program of cerebral stimulation by TMS using a PAS paradigm in the recovery phase of stroke patients


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Keywords: Stroke; Motor recovery; Upper limb; Brain-computer interface; Effectiveness

Background.– CIPASS (Chronic IPAS in Stroke) is a new neuromodulation protocol where a PAS (Paired Associative Stimulation) session is performed during 5 days to stroke patients. Our goals are to demonstrate a lasting increase (3 days) of motor cortical plasticity for extensor wrist muscles (ECR), and a functional improvement.

Methods.– PAS consists of a combination of 2 stimulations: electric and TMS (0.1 Hz) over 30 min. This is a randomized, double-blind and placebo-controlled trial. Twenty-four patients (PAS: n = 12 and Placebo: n = 12). One session of PAS stimulation was applied on a daily basis (5 days).

Results.– Our first results have demonstrated, 3 days after the end of the last PAS session (J8), an important increase of MEP surfaces for group PAS (+125% ± 218%), compared to group Placebo (+28% ± 83%). FMMS improvement was slightly higher for group PAS (+5.3 ± 4.5 pts) than group Placebo (+4.5 ± 3.8 pts) at J8.

Discussion.– CIPASS seems to induce long-term (3 days) changes in group PAS; motor effects seem however less conclusive. This trial will help us to better understand brain plasticity processes and to prove the relevance of CIPASS use as a therapeutic adjunct in stroke rehabilitation.

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Instrumented objects for the study and quantitative evaluation of grasping and manipulation strategies

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Keywords: Instrumented objects; Grasping; Manipulation; Assessment

Impairment of grasping ability is very frequent in stroke survivors. However, despite the importance of this question and the numerous rehabilitation techniques dedicated to grasping, there still lacks comprehensive studies on grasping function and manipulation after stroke. In addition, there is also a lack of pertinent methods for the assessment of grasping function in hemiparetic patients; along with devices to evaluate patients’ motor performances in a simple way.

We therefore developed a set of instrumented objects that can be grasped and manipulated by patients whileWireless recording accelerations, orientations and forces applied over their surfaces. We present here the results obtained with one of this object (an instrumented rectangular box). An experimental protocol based on grasping/lifting and manipulation tasks was developed and run on a population of healthy subjects. Analysis was conducted on the data recorded, thanks to suitable developed metrics (timings analysis, force levels and repartition over the object, smoothness etc.).

Results indicates that such simple instrumented object could be suitable to characterize sensorimotor impairments, which may help the understanding of
grasping and manipulation strategies in hemiparetic patients and complement assessment using standard clinical scales.

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Validation of instrumental indices for the upper limb function assessment in neurological patients

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Keywords: Upper limb; Assessment; Stroke; Robotics

Background.– We previously developed software to enable Armex® Spring in assessing reaching movements through indices of accuracy, velocity and smoothness. In this study we tested concurrent validity of these indices by comparing them to Wolf Motor Function Test (WMFT).

Methods.– Sixteen stroke patients were enrolled. Residual upper limb function was assessed at admission and after 12 rehabilitation sessions through: WMFT score and time and the numerical indices computed by software on 3D end-point trajectory during “Vertical Capture” task. Four indices assessed accuracy: global Hand Path Ratio (HPR), local HPR in the area of the target, vertical and horizontal overshoot. Two indices assessed velocity: maximum and mean velocity. Three indices assessed smoothness: mean/maximum velocity ratio, number of peaks in velocity profiles and normalized jerk. These indices were compared to WMFT score and time by the non-parametric Spearman’s correlation coefficient.

Results.– Thirty-two instrumental assessments on 16 subjects were considered. One accuracy index (HPR), both velocity indices and all smoothness indices were correlated with WMFT score and time. Moreover, these indices have been able to identify problems of accuracy, speed and fluidity in patients with same WMFT score.

Conclusion.– Instrumental indices are validated as evaluation tool of reaching movements in stroke.

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An analysis of sensitivity to change of a functional scale of the upper limb: UL-ADL

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Keywords: Upper limb; Hand; Functions; Scale; Sensitivity

Objective.– The UL-ADL scale analyzes the difficulties of hemiplegic patients in active and passive functions of the upper limb in daily life (questionnaire) and test situations. We analysed its sensitivity to change.

Methods.– Ninety-two patients were included for two years in 18 French centers. The scale was presented before the 8th week after stroke and after a time of 4–12 weeks. The change was analysed by classical indexes of change and the sensitivity/specificity with respect to a predefined criterion (an increase in the Motor Index > 20/100).

Results.– The standardized response mean (questionnaire: 0.86; test: 0.71) showed a moderate to good sensitivity, greater than the effect size (0.66, 0.49). These indexes were comparable to those of the Rivermead scale (0.91; 0.63). The area under the ROC curve (sensitivity/specificity) was relatively large, but comparable to that of the Rivermead scale. Correlations were strong (P < 0.0001) between changes in UL-ADL scores and the Motor Index.

Conclusion.– The UL-ADL scale showed an overall sensitivity similar to that of the reference tests. But in this population, the change was variable and often absent.

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Information throughput quantifies heterogeneity of upper-limb workspace post-stroke

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Keywords: Stroke; Fitts’ law; Motor control; Information throughput; Upper-limb

Objective.– Stroke patients have a diminished capacity to reach targets direct and precisely. The information throughput in the sensorimotor system, as quantified by Fitts’ law for fast and accurate pointing [1], may provide a different way to understand difficulty of motor control post-stroke.

Methods.– Thirteen hemiparetic post-stroke patients and 12 healthy controls performed a Fitts’ pointing task. Movement direction, target width and distance varied. Information throughput and kinematics quantifying movement quality were compared between groups and over directions.

Results.– Hemiparetic movements were slow, segmented and indirect. Kinematics differentiated between inward and outward movements, whereas information throughput differentiated between sides of workspace, with a lower throughput for the paretic workspace. Kinematic measures were loosely linked to the information throughput.

Conclusion.– Movement kinematics captured a different aspect of motor control than information throughput. We propose that kinematics reflect the outcome of adaptations to neuromotor noise, whereas the information throughput quantifies the extra burden necessary to overcome the neuromotor noise. Therefore, information throughput may provide a complementary assessment to adapt rehabilitative gaming exercises to the capacity of the patient.

Reference

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