O10

A novel robot-assisted upper-limb rehabilitation program in acute management of post-stroke patients: a randomized controlled trial

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Background: Aim of the study is to evaluate the effectiveness of a rehabilitation protocol consisting in a mix of robotic (by *NeReBot*) and non-robotic techniques.

Methods: Twenty-one subjects within 3 weeks after stroke were randomized in the experimental group (EG; n=11) and control group (CG; n=10). Both received 120 minutes/day treatment for five days a week for five weeks. Daily treatment in EG included traditional rehabilitation therapy (~65%) and robotic therapy (~35%, 20 minutes, twice a day) consisting of peripheral manipulation of the shoulder and elbow of the impaired limb, correlated with visual stimuli. The CG received only traditional rehabilitation treatment. The motor and functional outcome measured at the end of treatment, 3 and 7 months follow-up included: (1) the Medical Research Council Scale to assess the upper limb muscles; 2) the shoulder/elbow, coordination and wrist/hand subsections of the Fugl-Meyer Assessment; 3) the Motor-Functional Independent Measure; 4) the Box and Block test).

Results: The 2 groups were matched for demographic and clinical characteristics at baseline. Both groups showed motor and functional recovery of the upper limb at the end of treatment and after 3 and 7 months' follow-up. No significant differences were found between CG and EG.

Conclusion: A rehabilitation programme including *NeReBot* training in substitution of part of traditional therapy, seems to lead to an improvement in the impaired upper limb, similarly to traditional rehabilitation treatment, and persists at follow-up.

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O11

Loss of independent joint control in acute stroke quantified by the ACT3D system

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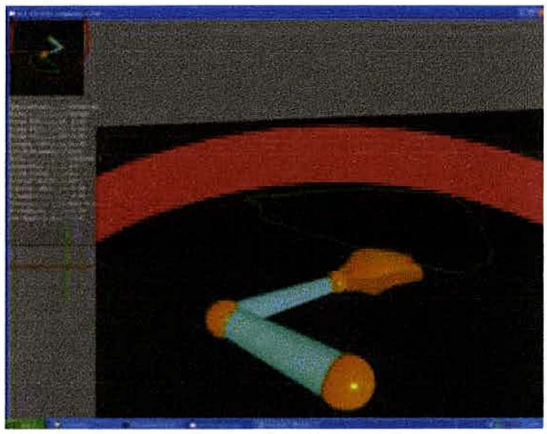
Introduction: One of the mechanisms known to negatively influence functional movement after stroke is abnormal muscle co-activation patterns, such as between shoulder abductors and elbow/wrist/finger flexors. This loss of independent joint control, measured by work area as a function of abduction loading, is strongly correlated with performance of ADL. The objective of this ongoing study is to identify the emergence and progression of the loss of independent joint control in individuals with sub-acute stroke.

Methods: To date, 11 individuals with sub-acute stroke have participated. Individuals were included if they could elevate the arm to 90° against gravity (100% limb weight). Robotic evaluations of horizontal plane reaching workspace (figure) as a function of shoulder abduction loading (0%-200% of limb weight) were performed weekly for 12 weeks followed by monthly for 3 months.



Results: There was an immediate presence of loss of independent joint control after stroke measured as a rapid reduction in work area as a function of limb loading as early as 3 weeks post-stroke. All participants showed an exponential rate of recovery over time.

Conclusions: Rapid recovery suggests this cohort represents mildly impairment individuals. The emergence of loss of independent joint control immediately after stroke suggests an immediate plastic response of the central nervous system. Quantification of work area represents a powerful evaluation of upper extremity movement and demonstrates the necessity of immediately targeting the underlying impairment. Ongoing research is attempting to better understand the persistence of loss of independent joint control in sub-acute individuals with severe stroke.

O12

Stimulation of the proprioceptive system in neurorehabilitation

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Objectives: The aim of the study was to investigate the human proprioceptive system in healthy subjects and in patients with severe brain damage and to develop a paradigm for the brain mapping of proprioceptive foot stimulation with vibration.

Participants, Materials/Methods: 15 healthy male subjects and 22 patients were stimulated with a vibrotactile stimulus on the right foot by a moving magnet actuator system and at the first and second toe with a cuff-type pneumatic stimulator.

Results: Brain activity within the main centers of the primary and secondary sensorimotor cortex, within the pre- and postcentral gyrus bilaterally and the right inferior, medial and middle frontal gyrus, within the inferior parietal lobule, the superior temporal gyrus, the temporal transverse gyrus, the caudate nucleus, the middle cingulate gyrus, the insula and the hippocampus on the left side. Only in 7 out of 22 patients a specific response within the primary and secondary sensorimotor cortex could be elicited.

Conclusions: It could be shown that vibrotactile stimulation of the foot in healthy subjects can elicit specific brain responses in main centers of the sensorimotor system and in centers of attention and arousal. It was possible to map in detail the cortical representation of the proprioceptive system of the foot for a functional diagnosis

and a monitoring of the proprioceptive system in neurorehabilitation, e.g. in subjects with degradation of the proprioceptive system (space disease, bedrest syndrome) and in patients with severe brain damage for the planning of specific rehabilitation strategies and the induction of arousal.

O13

Impairment of the rightsided homologous broca-area by repetitive transcranial magnet stimulation (rTMS) in patients with aphasia due to leftsided brain infarct leads to improvement of regional cerebral blood flow (rCBF) and speech performance

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Introduction: In leftsided cerebral ischemia reversal of aphasia partially depends on activation of the rightsided homologous Broca-Area. Reactivation of the leftsided Broca area is best for rehabilitation. Impairment of the right Brodman area 44 prior to speech therapy by rTMS might lead to forced activation of the leftsided Broca area.

Study aim: Do patients with leftsided brain infarct and aphasia benefit from repetitive impairment of the homologous Broca area by rTMS prior to speech therapy? Is this reflected by alteration in rCBF?

Patients und Protocol: Righthanded aphasic patients were treated with daily speech therapy. Over 2 weeks rTMS (1Hz, 20 min) led to transient impairment of the rightsided area 44. This homologous Broca area was identified using MRI. rCBF during speech production was measured with PET prior to begin and at the end of the 2 weeks protocol. The double blind randomized protocol included sham treated patients (rTMS over the vertex). Outcome parameters for speech performance were Aachener Aphasia-Test (AAT), Amsterdam-Nijmegen Everyday Language Test, Regensburger word fluidity-test, and naming test.

Results: Patients treated with rTMS over the right homologous Broca area experienced a better speech improvement than the sham group. rCBF shifted from the right to the left Broca area only in verum and not in sham treated patients indicating a reinstallation of functional capacity of the Broca area.

Summary: Patients with aphasia benefit from a daily rTMS treatment of the right homologous Broca area plus speech therapy. This is reflected by improvement of rCBF in the true Broca area.

O14

Post-stroke fMRI, a comparison of BOLD, cerebral blood flow, and cerebral blood volume responses

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Introduction: Blood oxygenation level-dependent (BOLD) fMRI is a neuroimaging approach that is influenced by multiple hemodynamic parameters, and has shown inconsistent prognostic capabilities in patients with cerebrovascular disease. New, noninvasive fMRI techniques have emerged with specific sensitivity to cerebral blood flow (CBF) and blood volume (CBV). We aim to determine whether these techniques can provide more precise contrast indicative of impairment in post-ischemic stroke patients than BOLD fMRI alone.

Methods: Post-stroke patients (n=11) and age-matched healthy volunteers (n=11) were scanned (3T) using T1-weighted structural imaging, BOLD-fMRI, 3D CBF-weighted (CBFw) arterial spin labeling (ASL), and 3D CBV-weighted (CBVw) vascular-space-occupancy (VASO). All subjects performed four blocks of 60s/30s rest/1Hz-wrist-extension/flexion using a custom-built joystick. Primary motor cortex in the hemisphere contralateral to the moved hand (affected hand for patients) was used as the region of interest(ROI). Within this ROI the BOLD, CBFw and CBVw reactivity was separately calculated for healthy subjects and patients.

Results and Discussion: Significant changes ($\Delta S \pm$std) in fractional BOLD ($\Delta S=0.33\pm0.15$, $p<0.0001$), CBFw-ASL ($\Delta S=17.7\pm4.3\%$, $p<0.0001$) and CBVw-VASO ($|\Delta SI|=1.42\pm0.28\%$, $p<0.0001$) were found in healthy subjects, within the normal range of neurovascular coupling. In patients no significant change in BOLD was found ($p>0.05$), despite significant increases in fractional CBF ($\Delta S=15.4\pm6.74\%$, $p=0.0003$) and CBV ($|\Delta SI|=0.80\pm0.48\%$, $p=0.001$). Our results suggest that impaired cerebrovascular reserve capacity among stroke patients may have influenced the BOLD response, which is a phenomenon that has been described to a limited extent in the literature. CBFw-ASL and CBVw-VASO may therefore potentially be superior to BOLD when investigating post-stroke plasticity and recovery.

O15

Plasticity and response to action observation: A longitudinal fMRI study in patients with subcortical stroke

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Background: Action observation has been suggested as an approach to retraining motor function in patients post stroke. To understand brain plasticity, a new action observation fMRI task is proposed and applied in subacute stroke patients with reduced arm movement ability.

Methods: From an ongoing study, six patients (65±10.7 years) with infarctions in either the pons or internal capsule were scanned twice; 1-2 and 12 weeks post stroke (3T, GE, US). The task-dependent fMRI acquisitions included coordinated bimanual movements (twisting a cylindrical device) and action observation (watching a video showing in alternating sequences either the same movements or a still image of a person performing the same task). fMRI activation maps (threshold $p<0.005$, SPM8, UK) from patients and 11 controls (61.5±6.1 years) were analyzed.

Results: During action observation, the peripheral occipital lobe including the dorsal stream of visual cortex extending towards parietal areas was activated in all participants. In controls, premotor and Broca's areas were observed. In patients 1-2 weeks post stroke, activations were reduced to fewer clusters with less frontal involvement. After 12 weeks, the spatial extent of activation was again significantly larger, particularly in parietal areas. At this stage also putamen (regulating movement) and the posterior lobe of the cerebellum (fine motor coordination) were involved, and most patients had regained full movement ability.

Conclusions: During the first three months post stroke an approximation towards normal activation patterns was seen, in accordance with clinical recovery. The proposed action observation task holds potential to identify plasticity changes in these patients.

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