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Improved Upper Limb Motor Control with Intensive Virtual Reality Training in Chronic Stroke

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Abstract

BACKGROUND: Virtual reality (VR) based motor training has been shown to be an effective intervention for upper limb rehabilitation after stroke. In particular, it allows to intensify the therapy dose and to maintain patients' motivation in a game-like scenario.

AIM: In this exploratory study, we evaluated whether exposure to intensive VR-based sensorimotor training leads to an improvement in the upper limb motor control of chronic stroke survivors.

METHODS: Seven chronic stroke patients (34-72 years; 3 males) were recruited (Table 1). Ten one-hour sessions of intensive VR-based training (MindMotionPRO, MindMaze SA) were administered by a physiotherapist twice per week for five consecutive weeks at the *Clinique Romande de Réadaptation* (Sion, Switzerland). The interactive exercises engaged patient's shoulder, elbow and wrist movements through different motor tasks (pointing, reaching, grasping) with various levels of difficulty. The system provided real-time visual feedback on patient's performance, with an avatar reproducing patient's upper body movements in a virtual environment.

RESULTS: Pre- and post-intervention assessments showed equal or higher outcome in Fugl-Meyer Assessment of the upper extremity (FMA-UE) for all patients, except for those with training interference (caused by strong pain in patient P1 and reception of Botox injection by patient P2;). Similarly, the upper limb active range of motion (AROM) revealed an improvement in shoulder flexion (median=15°; interquartile range, IQR=17°; n=6). Patients with highly reduced elbow extension (<20°; n=2) improved by 10° and 65°. Patients also improved forearm pronation (median=15°; IQR=27.5°; n=5) and supination (median=10°; IQR=10°; n=3). Noticeably, the training intensity increased in most patients (n=6; Fig. 1), i.e. the number of goal-directed movements per minute with the affected limb increased from 6.5 movements (median; IQR=4.2) in session 1 to 13.7 movements (median; IQR=3.9) in session 10.

CONCLUSIONS: Intensive VR-based intervention showed an improvement in FMA-UE and AROM in a group of chronic stroke survivors. Further studies are required to fully characterize the impact of VR training in chronic stroke.

Keywords: Stroke, Motor Rehabilitation, Virtual Reality Therapy.

Table 1: Patient details

Patient code	Age (Gender)	Stroke	Pain	Time from stroke	FMA-UE post (pre) intervention	Average session duration	Comments
P1	43 (F)	Right Sylvian ischemic	yes	4 years	33 (36)	40±5.0 min	Swimming activities. ***Strong pain***
P2	50 (M)	Left Sylvian ischemic	no	26 months	54 (47)	55±4.8 min	Daily sport activities (running)
P3	55 (F)	Right Sylvian ischemic	yes	9 years	55 (55)	26±6.0 min	Undergoing physiotherapy
P4	38 (F)	Left rupture cerebral aneurism Sylvian	yes	6 months	24 (17)	24±6.6 min	Undergoing occupational and physical therapy
P5	64 (M)	Left pontine ischemic	yes	22 months	38 (37)	47±8.3 min	Self-reported behavioral changes (e.g. starts using affected arm at home)
P6	72 (M)	Right Sylvian sub-cortical	no	6 years	58 (57)	44±6.4 min	Train on his own at home
P7	34 (F)	Left Sylvian ischemic	no	6 months	17 (18)	32±7.1 min	Undergoing occupational therapy; ***Botox intervention*** before session #4

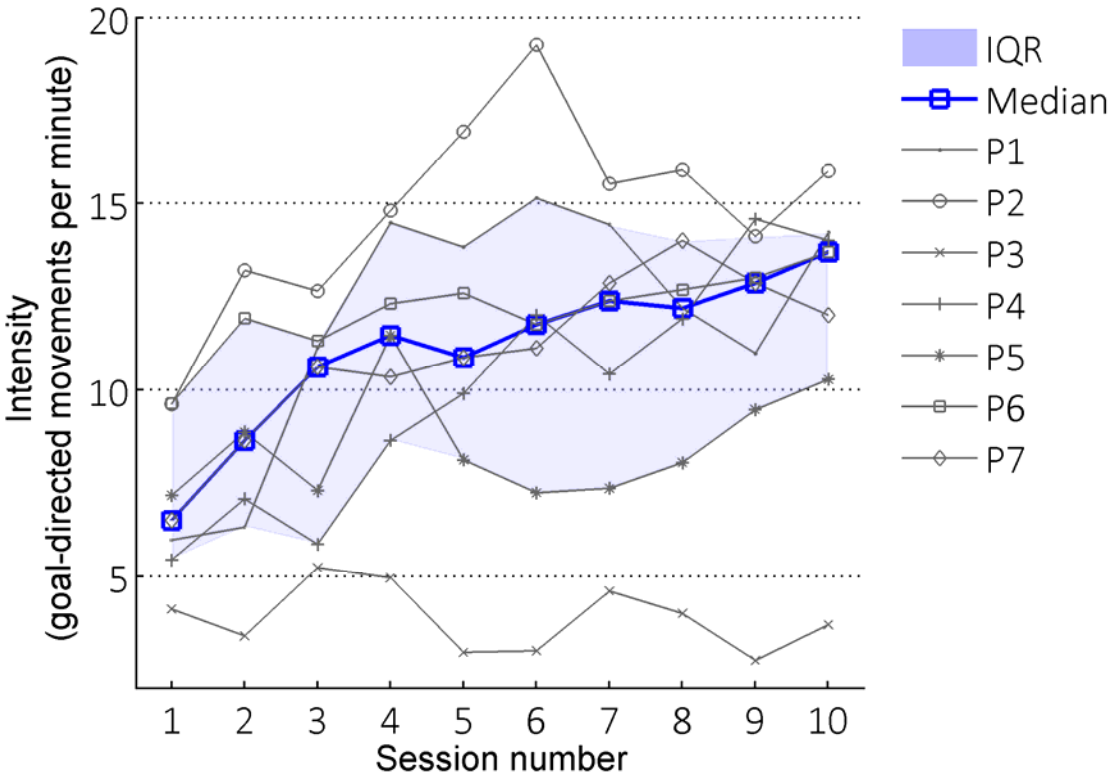

Fig. 1: Evolution of VR exercises intensity across sessions for each patient.