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Brief Report

Is computer-assisted training effective in improving rehabilitative outcomes after brain injury? A case-control hospital-based study

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Abstract

Background: Rehabilitation of impaired cognitive functions begins to be considered a standard component of medical care after acquired brain injury. Indeed, many evidences support the effectiveness of the two major categories of techniques, i.e. the traditional and computer-assisted ones, which are widely used in cognitive rehabilitative treatment.

Objective: Aim of this study is to evaluate the effects of pc − cognitive training in brain injury patients.

Methods: We studied 35 subjects (randomly divided into two groups), affected by traumatic or vascular brain injury, having attended from January 2010 to December 2012 the Laboratory of Robotic and Cognitive Rehabilitation of IRCCS Neurolesi of Messina. Cognitive impairment was investigated through psychometric battery, administered before (T0) and two months (T1) after the cognitive pc-training, which was performed only by the experimental group, in addition to conventional treatment. Statistical analysis was performed using Wilcoxon test with a $p < 0.01$.

Results: At time T0, all patients showed language deficits and cognitive alterations in visual attention and memory abilities. After the rehabilitation program we noted a global improvement in both the groups. However, at T1, the experimental group showed a greater cognitive improvement than the control group, with significant differences in nearly all the neuropsychological tests performed.

Conclusions: Our data suggest that cognitive pc-training may be a promising methodology to optimize the rehabilitation outcomes following brain injury.

Keywords: Computerized cognitive training; Recovery; Rehabilitation outcomes; Stroke; TBI

Disorders of language, spatial perception, attention, memory, calculation and praxis are frequent consequences of acquired brain damage determining a wide range of disability.[1] Traumatic or vascular brain impairment can be considered a "silent pandemic" for their high levels of incidence especially in the young adults.[2] Cognitive deficits are the most common cause of disability resulting from traumatic brain injury (TBI) in patients with moderate or good motor recovery.[3,4] Indeed, cognitive impairment may be so invaliding to worsen patient's quality of life (QoL), with a significant reduction in autonomy. Cognitive Rehabilitation (CR) is a therapeutic approach designed to improve cognitive functioning after central nervous system's accidents. CR includes a set of methods that retrain or alleviate problems caused by deficits in attention, visual processing, language, memory, reasoning, problem solving, and executive functions. CR refers to different interventions, aimed at improving the personal ability in performing cognitive tasks by retraining previously learned skills and teaching compensatory strategies.[5,6] Thus, rehabilitation of impaired cognitive process begins to be considered a standard component of medical care after TBI or stroke. Many evidences supporting the efficacy and effectiveness of neurocognitive rehabilitative treatment showed how it has become the most important treatment for cognitive impairments, improving cognitive and psychosocial functioning of brain injured patients.[7–10] Two major categories of techniques, i.e. traditional and computer-assisted, are widely used in cognitive neurorehabilitative treatment. Traditional techniques involve the use of cognitive strategies to retrain or alleviate deficits in attention and concentration, visual processing, language, memory, reasoning and problem - solving, and executive functions.[11,12] The computer-assisted methods focuses on similar neuropsychological processes by using computerized exercises that train

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neuropsychological functions. Computer-assisted cognitive rehabilitation (CACR)[13] uses multimedia and informatics resources with direct utilize of peculiar hardware system and software, by using specific programs to "reactivate" neurocognitive compromised performances.[14–16] Indeed, CACR extends to memory training,[17,18] attention,[19] problem solving and job simulation.[20] The aim of this study is to evaluate the neuropsychological profile and the functional level of the post-brain injury patients undergoing a proper computer-assisted cognitive training.

Methods

Thirty-five subjects (19 males and 16 females) with a mean age of 35.97years ± 14.26, affected by severe brain injury (with a traumatic etiology of the brain damage in the 48.57% and vascular in the 51.43%), having attended from January 2010 to December 2012 the Laboratory of Robotic and Cognitive Rehabilitation of IRCCS Neurolesi of Messina entered the study, which was approved by the Local Ethical Committee. Only one participant (assigned to the control group) was excluded from the study for secondary cardiologic complications. Either the patient or the relative were adequately informed about the study and offered their collaboration and written consent. The patients were randomly assigned to one of two groups (experimental or standard treatment – namely the control group) in order of recruiting. Patients enrolled were in a post-acute phase (i.e. 3–6 months from the acute neurological event). The experimental group consisted of 15 subjects (9 males and 6 females with a mean age of 30.93years ± 11.10), whereas the control group consisted of 20 subjects (10 males and 10 females, mean age 39.75years ± 15.43). As showed in Table 1 the two groups were quite homogenous for age, sex, and education. All participants were selected according to the following inclusion criteria: i) diagnosis of acquired brain injury (vascular or traumatic); ii) presence of moderate to severe cognitive impairment, i.e., an MMSE score ranging from 10 to 26; iii) absence of severe spasticity with a Ashworth Scale ⩽ 3; iv) absence of disabling sensory alterations, severe psychiatric and medical illness. All the participants in the experimental group completed the specific rehabilitative training, consisting of 24 sessions of pc-cognitive training, 3 times per week for 8 weeks, in addition to standard neurorehabilitation. Pc-cognitive training was realized with proper software which was selected for specific cognitive abilities (attention, language, memory and executive functions) to stimulate each cognitive residual function, by using tasks with increasing difficulty. PC – cognitive training was realized combining some web-resources (rehabilitative software free-ware, included in a specific battery training for specific ability) and some of the computerized software programs commercially available. This rehabilitative tool is based on the experiences of the United Kingdom specialist (cognitive rehabilitation program realized by Trevor P. and Kit M.) for brain injury subjects. The rehabilitative battery included a series of pc-activities divided in three sessions training: memory, executive functions and abilities of thinking (i.e., the exercises of identification, categorization, association, problem solving etc.). The cognitive therapist assigned a qualitative score to patient's execution, according to the increase in accuracy of pc-task performance, the reduction the numbers of errors, the frequency of breaks and the presence or not of cooperation and motivation during the implementation's program. Each participant was evaluated by a neuropsychologist, through the administration of a complete neuropsychological battery and functional scales. The evaluation was carried out before and after treatment (T0 and T1, respectively) and 2 months after the end of rehabilitative treatment. Neuropsychological assessment consisted of a screening test, i.e., the MMSE, and peculiar tests, including the Category Verbal Fluency (CVF), the Letter Verbal Fluency (LVF), the Reversal Motor Learning (RML), the Attentive Matrices (AM), the Rey Auditory Verbal Learning Test (RAVLI immediate and RAVLR recall). The functional scales, which were filled with the help of the caregivers, included: Basic Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL), Levels of Cognitive Functioning (LCF) and Barthel Index (BI). Also behavioral scales were administered (i.e. Hamilton Rating Scale for Anxiety – HRS-A – and for Depression – HRS-D) to evaluate the possible impact of mood and anxiety on cognition. In addition to the psychometric evaluation, to better investigate the brain damage, all subjects underwent a Magnetic Resonance Imaging (MRI) examination. Statistical analysis was performed using the Wilcoxon signed - rank test for comparing the psychometric test results of subjects in the same group, between T0 and T1. On the other hand, to compare the clinical evaluation scores of the two groups (both at baseline and at follow-up), we used the Mann-Whitney–U test. Finally, in order to investigate whether the improvement was more significant in the experimental group rather than in the control group, we applied the Mann-Whitney–U test (one-tailed) to the test score variations from baseline to follow-up (i.e., for each clinical test we computed the difference between the two times |score at T1- score at T0). A p value <0.05 was considered as significant level.

Table 1
Demographic description by means and standard deviations of both the whole sample and the two groups

	Age		
	Male	Female	Education
Whole sample	32.68 (±12.66)	39.87 (±15.45)	10.4 (±2.64)
Experimental group	29.67 (±11.89)	32.83 (±10.55)	11.08 (±2.53)
Control group	35.40 (±13.33)	44.10 (±16.83)	10.2 (±2.73)