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Original Article

Effect of passive limb activation by Functional Electrical Stimulation on wheelchair driving in patients with unilateral spatial neglect: A case study

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Activities of daily living;
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Summary *Background/Objective:* Limb activation is one of the behavioural interventions to improve unilateral spatial neglect (USN). However, the effect of passive limb activation on activities of daily living (ADL) is not clear. This study examined the effect of passive limb activation by functional electrical stimulation (FES) on wheelchair driving for patients with USN, and to discuss the possibility of application of this treatment to occupational therapy.
Methods: A single subject design-baseline-intervention-baseline (ABA′), was applied to 2 stroke patients with USN. Phase A and A′ consisted of the wheelchair driving task only. Phase B consisted of the wheelchair driving task with FES. Each phase lasted for 2 weeks. The wheelchair driving task was maneuvering on a square passage in the clockwise and counter clockwise conditions for 8 minutes respectively, and four obstacles were set at each side. FES was applied to the affected forearm extensor muscles. Assessor recorded: 1) The distance participants drove wheelchair for 8 minutes, and 2) The number of collisions with obstacles and the wall, for 10 days.
Results: For one participant, the distance of maneuvering significantly increased in phase B ($p < .05.$), and USN on the cognitive test in the extrapersonal space indicated a tendency to improve after phase B.

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Conclusion: Passive limb activation by FES improved wheelchair driving and cognitive performance for patients with USN. It can be used with instruction from occupational therapists to enhance the performance on ADL.

Introduction

Unilateral spatial neglect (USN) is defined as failure to orient to, respond to or detect stimulation in the affected side (Heilman & Valenstein, 1979). It is a common disorder occurring after the onset of stroke, and its prevalence has been estimated to be approximately 40% in patients with right hemisphere stroke (Diller & Gordon, 1981). Patients with USN have been shown to have more significant limitations in activities of daily living (ADL; e.g., eating, dressing, transfers and locomotion) compared with non-neglect patients and commonly require assistance or wardens during their ADL due to their difficulties avoiding risks (Ota, 2011; Nijiboer, van de Port, Schepers, Post, & Visser-Meily, 2013). Therefore, the improvement of USN is important for independence during the ADL of neglect patients.

Over the past 60 years, several interventions to improve USN, including visual scanning training (VST), prism adaptation (PA), and limb activation have been reported (Luauté, Halligan, Rode, Rossetti, & Boisson, 2006). VST is a method to promote visual scanning on the affected side. Visual cues (e.g., a red line) are located on the affected side, and patients are asked to look at the visual cues before carrying out tasks such as reading. In addition, the method of pointing and watching light moving from the sound side to the affected side on a board was also used (Weinberg et al., 1977). Previous research demonstrated the effects of this method for cognitive tasks (e.g., reading and copying). The maintenance of the improvement induced by VST is unclear (Luauté et al., 2006). PA works on visuo-motor adaptation. Patients with USN wear prismatic goggles to make the patient's sight move 10° toward the sound side, followed by successfully performing pointing. After taking off the prismatic goggles, improvement of USN was observed during the line bisection task, the cancellation task, drawing task, and reading task (Rossetti et al., 1998), and the improvement was maintained for 2 weeks. However, few studies have indicated the effects of these methods on ADL.

Robertson and North (1992) reported that active affected limb movement in the affected space significantly reduced USN on the letter cancellation test and the reading test. It is based on the suggestion that limb activation causes the amelioration of representation in the affected space of the body surface (personal space) and integration with space within reaching distance (peripersonal space). Robertson and North (1992) concluded that only active limb activation reduced USN. However, Làdavas, Berti, Ruozzi and Barboni (1997) showed that even passive limb activation in the affected space reduced USN on the naming test. Passive limb activation is considered to have benefits because it can be used regardless of the severity of the motor paralysis.

As one of the popular ways to induce passive limb movement, functional electrical stimulation (FES) has been used in clinical settings. Polanowska, Seniów, Paprot, Lésniak, and Członkowska (2009) hypothesised that FES applied to the left hand can have positive effect on the attentional system of the right hemisphere and on improvement for USN through stimulation of exteroceptive and proprioceptive sensory pathways. Because large hand somatosensory fields are in the parietal region, the sensory stimulation might have activated in these cerebral areas, which is important for spatial attention. Eskes, Butler, McDonald, Harrison and Phillips (2003) reported that passive wrist extension by FES reduced USN on the visual scanning test. In addition, Harding and Riddoch (2009) also reported that FES for the affected forearm extensor reduced USN on the star cancellation test and the baking tray test. In this way, there are several reports that showed the effect of passive limb activation on cognitive tasks; however, the reports showing the effect of passive limb activation on ADL is very few. Although a few reports have suggested the relationship between the neglect on cognitive tasks and on ADL, this relationship is not clear because of the variety of factors causing unilateral spatial neglect (Sasaki, Sengoku, Nakashima, Sugama, & Kitajima, 2005). The effects on ADL besides the effects on cognitive tasks are required in the assessment of USN because occupational therapists have to focus on both functional elements and ADL. In addition, USN symptoms occur on ADL in the personal space (e.g., not shaving and wearing clothes), the peripersonal space (e.g., not noticing the dishes), and the space out of reaching (extrapersonal space; e.g., not perceiving and not turning the corner of a corridor) on the affected side. Thus, the assessments for USN in the various spaces are crucial to ameliorate USN effectively.

The purpose of this study was to examine the effect of passive limb activation by FES on ADL, especially wheelchair driving for patients with USN, and to discuss the differences in the effect of passive limb activation on features of USN for application to occupational therapy.

The study protocol was approved by the Ethics Committee of Nagoya University (Ref. no: 13-608) and the Kamiiida Rehabilitation Hospital.

Methods

Participants

The participants were recruited from a Rehabilitation Hospital and screened by the following inclusion and exclusion criteria. Inclusion criteria were (a) stroke patients who exhibited USN in any of the following: the line bisection task