Are Therapeutic Effects on Pusher Behaviour Based on Conflicting Sensory Information?

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***Summary*—Pusher behaviour is associated with deficits in body orientation with respect to gravity. Patients attempt to align their body with an internal vertical reference that is tilted in the coronal plane. This study is aimed at interventions to treat patients with pusher behaviour. Of the applied therapeutic approaches these have proven to be more effective which lead to conflicting sensory information.**

INTRODUCTION

A substantial proportion of hemispheric strokes are associated with deficits in body orientation with respect to gravity. Some hemiparetic patients attempt to align their body with an internal vertical reference that is tilted in the coronal (roll) plane. Unaided, they would shift their centre of gravity towards the paretic side, impairing postural balance so severely that sitting or standing becomes impossible sometimes. When patients actively push with the non-affected extremities towards the paretic side and exhibit resistance to passive correction, the condition is called pusher behaviour (PB).

Patients with PB experience a mismatch between visual vertical, based on vestibular and visual inputs on the one side, and the tilted orientation of subjective body verticality on the other. Thus, treatment strategies to reduce the pusher behaviour should focus on or manipulate these different sources of postural information in order to recalibrate the biased sense of verticality.

METHODS

Fourteen patients (11 male; age: 68 ± 8 years) participated in the study. They had hemiparesis caused by left or right hemispheric ischemic stroke or intracerebral haemorrhage with a diagnosis of PB.

Patients were treated with 3 different interventions:

- galvanic vestibular stimulation (GVS), Eldith DCStimulator, NeuroConn, Ilmenau, Germany;
- locomotor therapy within a driven-gait orthosis (DGO), Lokomat, Hocoma, Switzerland;
- physiotherapy with visual feedback (PT-vf), i.e., therapists used visual information. This information gives the patients feedback about their body orientation. In addition patients should align themselves to surrounding vertical structures.

The study was designed as a cross-over trial, each patient receiving one treatment of each intervention in pseudo-random order on separate days over one week. Patients were measured by means of the the Burke lateropulsion scale (BLS) immediately before (pre-test) and after each single session of the specific interventions (post-test).

RESULTS

Intra-individual changes from pre-test to post-test for the BLS were calculated to compare the interventions. Median changes (25^{th} - 75^{th} percentile) caused by

- GVS: 1 (0-1),
- DGO: 1 (1-2), and
- PT-vf: 0 (-1-1).

A significant difference was found between the interventions; Kruskall–Wallis test: chi2(2) = 7.956; p = 0.019). Paired comparisons with the Mann–Whitney U-test indicated that patients showed significant improvement after DGO therapy compared to PT-vf (U = 34.5; Z = -2.628; p = 0.009), but there was no significant difference between GVS and PT-vf (U = 42.5; Z = -1.761; p = 0.093), nor between GVS and DGO (U = 50.5; Z = -1.263; p = 0.228).

DISCUSSION

This recently published study [1] discussed the advantage of an early locomotor therapy in light of several aspects: DGO therapy is an active, task-oriented training in an earthvertical position, which takes into account both the patients' impairment in perception of body alignment in space and their fear of falling. Although not statistically significant, GVS did also show a positive effect on pusher behaviour.

Compared to PT-vf, both therapies, GVS and DGO, produced a conflict of sensory information, i.e. one or two sensory systems provide adequate situational information, whereas the others do not. Throughout DGO therapy, proprioceptive inputs from the lower extremity mimic an appropriate stepping pattern on a moving support surface while vestibular and visual cues remain relatively stable. Throughout GVS, the electrical application enables a selective stimulation of vestibular afferents causing a illusion of rotation in the roll plane and therewith a body sway response to the opposite side, whereas proprioceptive and visual information remain relatively stable.

Consequently, it could be hypothesized that these positive therapeutic effects are based on conflicting sensory information, leading to constantly challenging sensory re-weighting processes.

[1] C. Krewer, K. Riess, J. Bergmann, F. Müller, K. Jahn, and E. Koenig, "Immediate effectiveness of single-session therapeutic interventions in pusher behaviour", Gait & Posture, 37, 246-250, 2013.