



## Verticalization of Patients with Severe Acquired Brain Injury: A Randomized Pilot Study

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### ABSTRACT

A stroke is an acute disorder of cerebral circulation in which an area of the brain dies. Depending on which specific part of the brain is affected, a stroke patient loses certain brain functions and various organs stop functioning. There are two key types of stroke - ischaemic and haemorrhagic. In an ischaemic stroke, the patient suffers a thrombus in one of the cerebral arteries which "clogs". This leads to an end to blood flow through the artery and gradual death of the brain tissue "downstream". Haemorrhagic stroke is a cerebral haemorrhage due to disruption of the integrity of the vascular wall. This type of stroke is less common but the consequences are usually catastrophic. Verticalisation improves the level of arousal and consciousness in patients with severe acquired brain injury (ABI) and is safe in the intensive care unit. We evaluated the effectiveness of a very early step verticalisation protocol on their functional and neurological outcome.

### Keywords:

verticalization, stroke, brain

### Introduction

In this paper, our group demonstrated the feasibility and safety of very early use of a tilt table with a stepping device in neuroresuscitation patients with DOC due to severe craniocerebral trauma (CCI). Patients started a stepping protocol of verticalisation (30-minute daily sessions, five days a week for three consecutive weeks) 12.7±8.7 days after the event; none of them had any dangerous haemodynamic changes or adverse events. The same results were obtained in patients with DOC after a cerebral haemorrhage disorder (personal data).

### Study Aim

To investigate whether a very early staged verticalisation protocol compared to conventional bed mobilisation in the intensive care unit leads to greater functional and

neurological improvement in patients with VS and MCS after severe LPR.

### Methods

Consecutive patients with a vegetative state or state of minimal consciousness were admitted to the intensive care unit on the third day after LPI. They were randomised to receive conventional physiotherapy alone or in combination with fifteen 30-minute sessions of verticalisation using a tilt table with robotic stepping. After stabilisation, patients were transferred to our Neurorehabilitation Unit for individual treatment. Outcome measures (Glasgow Coma Scale, Coma Recovery Scale, Revised -CRSr-, Disability Rating Scale -DRS- and cognitive functioning levels) were assessed on day three after injury (T0), on discharge from the intensive care unit (T1) and on discharge from the rehabilitation centre. (T2). Comparisons between and within groups were

made using the Mann-Whitney U-test and Wilcoxon's sign-rank test, respectively.

## Results

Of the 40 included patients, 31 completed the study without adverse events (15 in the verticalisation group and 16 in the conventional physiotherapy group). Early verticalization started  $12.4 \pm 7.3$  (mean  $\pm$  standard deviation) days after LPI. Length of stay in OIT was longer in the verticalization group ( $38.8 \pm 15.7$  vs  $25.1 \pm 11.2$  days,  $p = 0.01$ ), while total length of stay (OIT + neurorehabilitation) was not significantly different ( $153.2 \pm 59.6$  vs  $134.0 \pm 61.0$ ). days,  $p = 0.41$ ). All outcome measures improved significantly in both groups after the total period (T2 vs T0,  $p < 0.001$  for all), and after ICU stay (T1 vs T0,  $p < 0.004$  for all) and after neurorehabilitation (T2 vs T1,  $p < 0.004$ ). all). Improvement was significantly better in the experimental group for CRSr (T2-T0  $p = 0.033$ , T1-T0  $p = 0.006$ ) and (borderline) for DRS (T2-T0  $p = 0.040$ , T1-T0  $p = 0.058$ ).

Acquired brain injury (ABI) occurs as a result of traumatic and non-traumatic (predominantly haemorrhagic, hypoxic, ischaemic, infectious and toxic) brain events and can lead to coma in the acute phase. The most severe patients often do not achieve full recovery of consciousness, developing a vegetative state (VS) or a state of minimal consciousness (MSC). The prevalence of disorders of consciousness (DRS) is about 0.2-6.1/100 000 inhabitants. Given the increasing number of survivors, the long and costly hospitalisation and the persistence of functional disability, LDI is an urgent clinical and social problem.

International guidelines support indications for hospitalisation of patients with brain injuries in neurological intensive care units (NeuroICUs) in order to better manage the primary and secondary mechanisms of injury. In addition, some authors have emphasised the value of an integrated approach, in which both emergency care and rehabilitation treatment are provided simultaneously by one multidisciplinary team. Indeed, a growing body of evidence shows that initiating rehabilitation in neurorehabilitation is safe and feasible, helps improve patients' functional outcomes, and leads to shorter

hospital stays at lower costs. Early general mobilisation by a physiotherapist improves circulation, ventilation and muscle metabolism, leading to reduced physical deterioration, ventilator dependence and risk of complications (e.g. bed rest syndrome, infections, bedsores, osteoporosis, deep vein thrombosis) and improved arousal, functional communication and psychological profile. However, due to a lack of widely approved protocols, how and when patients with LPI should be lifted out of bed is still controversial. Recently, the AVERT (A Very Early Rehabilitation Trial) researchers stated that very early mobilisation of patients with ischaemic and haemorrhagic stroke in bed and out of bed in the stroke unit leads to a less favourable outcome. However, their very early rehabilitation was carried out in the first 24 hours after the event (in the acute unstable phase of the brain injury) and only five hours before the physiotherapy deadlines of the control group.

Regarding patients with DOC, one of the most important components of their mobilisation is the change of position possible by placing the patient on an inclined table. Verticalisation stimulates several sensory pathways and postural responses, increases arousal and awareness, and is safe, even if started in the ICU. Unfortunately, the use of the tilt table in patients with PLI has often been restricted (and thus verticalisation delayed) due to the occurrence of orthostatic hypotension and syncope due to blood pooling in the lower extremities. A breakthrough came when, in 2004, Czell et al demonstrated how, in healthy subjects, greater haemodynamic stability could be achieved during table tilting by passive stepping or cyclic leg movements. In this area of research, Luther et al. studied the effects of a tilt table with integrated robotic stepping in patients with VS or MCS > 30 days after craniocerebral trauma. The authors showed that compared to a conventional tilt table, patients treated with this robotic stepping table had a lower rate of syncope.

## Conclusion

The present study shows that an intensive stepping-protocol of verticalization, initiated

from the acute stages of severe PLI, improves short-term and, more convincingly, long-term functional and neurological outcome in patients with DOC. In this regard, we propose the use of a tilt table with robotic stepping for rehabilitation of this group of patients from the first days of hospitalization in the ICU, when hemodynamic, respiratory and intracranial stability is achieved.

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