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**Letter to the Editor**

# Safety and Feasibility of a Very Early Verticalization in Patients With Severe Traumatic Brain Injury

AN EARLY REHABILITATION of patients hospitalized in the intensive care unit (ICU) in the acute phase of traumatic brain injury (TBI) can improve patients' outcomes.[1–9] However, the rehabilitation treatment is generally limited to a passive mobilization and an attempt to regain a sitting position on the bed, because the possibility of a very early verticalization can be limited by the occurrence of syncopal symptoms.[10,11] Recently, a tilt-table has been developed with an integrated stepping device that decreases the risk of syncope, reducing venous stasis.[12,13]

We hypothesized that a very early verticalization and mobilization, using this tilt-table with stepping device during hospitalization in the ICU, could lead to a faster and maybe better neurological improvement in patients with TBI.

The first step, and the aim of this study, is to evaluate the feasibility and safety of the very early use of a tilt-table with stepping device in neuro-ICU patients with severe disorders of consciousness due to TBI.

From June to December 2013, we enrolled 4 patients (mean age = 39.5 ± 3.9 years) with TBI and related severe disorder of consciousness (Glasgow Coma Scale score ≤8), diagnosed as vegetative state or minimally conscious state,[14] on the third day from the injury. Two patients had a diffuse axonal injury, and 2 patients had multiple brain bleedings (see Table 1, part A). They did not have respiratory failure, instable hemodynamics, uncontrolled intracranial pressure, deep vein thrombosis, or fractures (at thoracic, abdominal, or lower limbs level).

The treatment consisted of 30-minute daily sessions (5 days per week for 3 consecutive weeks) of patient verticalization in the ICU, using a tilt-table with stepping device. Sessions were started 12.7 ± 8.7 days from the injury-determining event. After patient positioning, the slope of the tilt-table was gradually increased from 0° to 60° in a time span of 9 minutes (see Figure 1). The stepping frequency was set at 20 steps/min for the entire treatment. Cardiovascular and respiratory parameters were continuously monitored and recorded every 20 seconds.

No adverse events occurred during all treatments, and there were no interrupted sessions. We recorded various hemodynamic changes during the procedures; all minimum and maximum values reached by each parameter stayed within the safety range: cardiac output, 3 to 12.3 L/min; heart rate, 53 to 147 beats/min; mean arterial pressure, 51 to 170 mm Hg (see Table 1, part B). No changes in the neurological status appeared during the single sessions.

With regard to the feasibility of the intervention, we did not experience any problems: in our ICU; the tilt-table is located in the patient room and does not need to be moved (a procedure that would imply waste of time, space, and personnel resources). Each session had a mean duration of 46 ± 4 minutes, including 12 ± 3 minutes for the patient transfer (from bed to tilt-table, and vice versa), 4 ± 1 minutes for the cardiovascular monitor setting, and 30 minutes of treatment. The sessions were fully completed and continuously supervised by a nurse and a physiotherapist, while the intensive care physician was always available in case of emergency. Considering the good results of the safety outcomes, we can even propose to carry out this treatment only under the supervision of the physiotherapist, with the nurse helping just in the patient's transfer procedures and in case of emergency, to reduce the personnel involvement.

In conclusion, our results show that an intensive rehabilitation of patients with severe disorder of consciousness due to TBI in the early stage, carried out using a tilt-table with robotic stepping device, is safe and feasible.

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**TABLE 1** *Patients characteristics (A) and mean values of the cardiovascular parameters for each patient across all 15 sessions (B)*

| | Patient | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| A | | | | |
| Gender | M | M | M | M |
| Age, y | 34 | 43 | 40 | 41 |
| Type of brain injury | DAI | MBB[a] | SH and MBB, midline shift, brain stem damage[a] | DAI |
| *Treatment starting (day from TBI)* | 5 | 25 | 12 | 9 |
| B | | | | |
| CO basal, L/min | 6.3 ± 0.7 | 6.8 ± 0.8 | 6.3 ± 1.2 | 7.1 ± 1.7 |
| CO delta, % | −14.8 ± 7.8 | −7.3 ± 11.9 | −30.1 ± 8.2 | −26.4 ± 9.4 |
| CO min, L/min | 3.8 | 4.3 | 3.8 | 3 |
| CO max, L/min | 7.7 | 8.5 | 8.7 | 11.1 |
| HR basal, bpm | 70.7 ± 1.7 | 83.7 ± 7.8 | 89.9 ± 10.1 | 78.7 ± 17.4 |
| HR delta, % | 0.8 ± 1.8 | 16.1 ± 10.9 | 23.7 ± 16.9 | −3.6 ± 5.4 |
| HR min, bpm | 69 | 69 | 66 | 53 |
| HR max, bpm | 92 | 125 | 134 | 125 |
| MAP basal, mm Hg | 112.7 ± 6.5 | 92.7 ± 8.5 | 91.3 ± 10.6 | 131.8 ± 17.2 |
| MAP delta, % | −3.1 ± 7.2 | −1.5 ± 11.5 | −10.5 ± 6.5 | −19.6 ± 8.6 |
| MAP min, mm Hg | 73 | 66 | 51 | 80 |
| MAP max, mm Hg | 137 | 132 | 121 | 170 |

Abbreviations: basal, mean value in the first 3 minutes (0°); CO, cardiac output; DAI, diffuse axonal injury; delta, maximum percentage variation within each session compared with the basal value; HR, heart rate, M, male; MAP, mean arterial pressure; MBB, multiple brain bleedings; min and max, minimum and maximum values reached; SH, subdural hematoma; TBI, traumatic brain injury.
[a]The patient underwent a neurosurgical procedure before treatment.

This evidence represents the first important step toward future investigations that would help define whether the very early treatment described could be useful to improve the patients' clinical and neurological outcomes and to reduce or simplify the social assistance charge.

**Figure 1.** Patient verticalized in the intensive care unit using a tilt-table with stepping device.

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## REFERENCES

1. Choi JH, Jakob M, Stapf C, Marshall RS, Hartmann A, Mast H. Multimodal early rehabilitation and predictors of outcome in survivors of severe traumatic brain injury. *J. Trauma.* 2008;65:1028–1035.
2. Greenwood RJ, Strens LH, Watkin J, Losseff N, Brown MM. A study of acute rehabilitation after head injury. *Br J Neurosurg.* 2004;18:462–466.
3. Mackay LE, Bernstein BA, Chapman PE, Morgan AS, Milazzo LS. Early intervention in severe head injury: long-term benefits of a formalized program. *Arch Phys Med Rehabil.* 1992;73:635–641.
4. Sorbo A, Rydenhag B, Sunnerhagen KS, Blomqvist M, Svensson S, Emanuelson I. Outcome after severe brain damage, what makes the difference? *Brain Inj.* 2005;19(7):493–503.
5. Andelic N, Bautz-Holter E, Ronning P, et al. Does an early onset and continuous chain of rehabilitation improve the long-term functional outcome of patients with severe traumatic brain injury. *J Neurotrauma.* 2012;29:66–74.
6. Seel RT, Douglas J, Dennison AC, Heaner S, Farris K, Rogers C. Specialized early treatment for persons with disorders of consciousness: program components and outcomes. *Arch Phys Med Rehabil.* 2013;94:1908–1923.
7. Tepas JJ, Leaphart CL, Pieper P, et al. The effect of delay in rehabilitation on outcome of severe traumatic brain injury. *J Pediatr Surg.* 2009;44:368–372.
8. Mammi P, Zaccaria B, Franceschini M. Early rehabilitative treatment in patients with traumatic brain injuries: outcome at one-year follow-up. *Eura Medicophys.* 2006;42:17–22.
9. Elliott L, Walker L. Rehabilitation interventions for vegetative and minimally conscious patients. *Neuropsychol Rehabil.* 2005;15:480–493.
10. Welch R. Tilt-table therapy in rehabilitation of the trauma patient with brain damage and spinal injury. *Nurs Clin North Am.* 1970;5:621–630.
11. Riberholt CG, Thorlund JB, Mehlsen J, Nordenbo AM. Patients with severe acquired brain injury show increased arousal in tilt-table training. *Dan Med J.* 2013;60(12):A4739.
12. Czell D, Schreier R, Rupp R, et al. Influence of passive leg movements on blood circulation on the tilt-table in healthy adults. *J Neuroeng Rehabil.* 2004;1:4.
13. Luther MS, Krewer C, Muller F, Koenig E. Comparison of orthostatic reactions of patients still unconscious within the first three months of brain injury on a tilt-table with and without integrated stepping. A prospective, randomized crossover pilot trial. *Clin Rehabil.* 2008;22:1034–1041.
14. Giacino J, Kalmar K, Whyte J, The JFK. Coma Recovery Scale-Revised: Measurement Characteristics and Diagnostic Utility. *Arch Phys Med Rehabil.* 2004;85:2020–2029.