

DEEP BRAIN STIMULATION THERAPY FOR THE VEGETATIVE STATE: SELECTION CRITERIA OF CANDIDATES AND 10-YEAR FOLLOW-UP RESULTS

T Yamamoto, T Kano, K Kobayashi, H Oshima, C Fukaya, Y Katayama

Department of Neurological Surgery and Division of Applied System Neuroscience, Nihon University School of Medicine, Tokyo, Japan

**Object.** As a result of progress in intensive critical care, many patients who would have died previously now recover. Although many lives are saved, the number of patients in a vegetative state (VS) is increasing. We have found that, even if the symptoms are similar from a neurological stand point, the degree of brain injury varies to a considerable degree. Also, there should be a large number of patients who may not be able to recover spontaneously, but who can be saved from the VS by means of appropriate treatment. We evaluated patients in a VS by an electrophysiological approach, and compared the results of the examinations with the long-term prognosis.

**Methods.** Twenty-one cases of the vegetative state (VS), which corresponded to the criteria of the Multi-Society Task Force on PVS (1994), were evaluated neurologically and electrophysiologically at 3 months after brain injury and treated by DBS therapy. We followed these cases up for over 10 years, and examined their long-term functional recovery. The mean age of the VS patients was 44.0 ± 15.9 years old, and the causes of the initial coma were head injury (9 cases), cerebrovascular accident (9 cases) and anoxia (3 cases). The mesencephalic reticular formation was selected as a target in 2 cases, and the thalamic CM-pf complex was selected as a target in the other 19 cases. The electrophysiological evaluations included assessments of the auditory brainstem response (ABR), somatosensory evoked potential (SEP), pain-related P250 and continuous electro-encephalogram (EEG) frequency analysis. Stimulation was given every 2 to 3 hours during the daytime, and was continued for 30 min at one time. The frequency of the stimulation was mostly fixed at 25 Hz, and the intensity was decided according to the responses of each individual patient, being at slightly higher than the threshold for inducing an arousal response.

**Results.** DBS applied to the mesencephalic reticular formation or CM-pf complex exerted a strong arousal response and elicited marked increases in regional cerebral blood flow and regional cerebral metabolic rate of oxygen. Eight of the 21 cases emerged from the VS, and could communicate with some speech or other responses, but needed some assistance with their everyday life in bed. Even after long-term rehabilitation, their state of being bedridden remained unchanged in 7 of these 8 cases. The other 1 case became able to live in a wheel-chair. The other 13 cases were unable to communicate at all and failed to emerge from the VS. In the 8 cases that emerged from the VS following DBS therapy, the Vth wave of the ABR and N20 of the SEP were recorded even with a prolonged latency; continuous EEG frequency analysis demonstrated a desynchronization pattern or slight desynchronization pattern; and the pain-related P250 was recorded with an amplitude of over 7 microvolts. The survival rate among the 21 cases after the DBS therapy was 21 cases (100%) at 1 year, 16 cases (76%) at 2 years, 12 cases (57%) at 3 years, 10 cases (48%) at 4 years, 6 cases (29%) at 5 years, 5 cases (24%) at 6 years, 5 cases (24%) at 7 years, 5 cases (24%) at 8 years, 5 cases (24%) at 9 years, and 4 cases (19%) at 10 years. The causes of death were falling into infectious disease (n=15), ileus (n=1), and occurrence of cancer (n=1).

**Conclusion.** DBS therapy may be useful for allowing patients to emerge from the VS, if the candidates are selected according to appropriate neurophysiological criteria. Also, a special neurorehabilitation system may be necessary for emergence from the bedridden state in the treatment of VS patients. Further, DBS therapy is expected to represent a useful method for minimally conscious state

(MCS) patients to achieve consistent discernible behavioral evidence of consciousness, and emergence from the bedridden state.