Dorsal column stimulation (DCS) for persistent vegetative state patients

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Abstract

Dorsal column stimulation (DCS) therapeutic method has been used to control chronic pain and reduce spasticity of hemiplegia, but we experienced obvious improvement of reactions and expressions and increases in activity, in addition to the above actions. It is well known that electrical stimulation changes the neurotransmitter levels and cerebral blood flow, and this therapeutic method began with application of these effects for protracted consciousness disturbance. We have treated more than 200 cases after incorporation of DCS. We investigated the primary disease, age, imaging findings, and preoperative local cerebral blood flow in these patients, and found many common points in effective cases. Here, we report our studies on surgery and decision of application, focusing on DCS.

1. INTRODUCTION

Marked progress of medical techniques in the emergency medicine and neurosurgery fields has improved the survival rate of patients with severe cerebral disorders, but on the other hand, the incidence of protracted consciousness disturbance, that is persistent vegetative state, seems to have increased even though lives have been saved. Such cases were transferred to rehabilitation departments or related hospitals and very little attention has been paid compared to activities dedicated to the acute stage. Protracted consciousness disturbance, which is not a pathology of the acute stage and is unlikely to become a target of active rehabilitation, has not been actively treated at any department.

We have found that DCS is effective for patients with protracted consciousness disturbance. Here, we report our studies on surgery and decision of application, focusing on DCS.

2. METHODS

Dorsal column stimulation (DCS) This therapeutic method has been used to control chronic pain and reduce spasticity of hemiplegia, but we experienced obvious improvement of reactions and expressions and increases in activity, in addition to the above actions. It is well known that electrical stimulation changes the neurotransmitter levels and cerebral blood flow, and this therapeutic method began with application of these effects for protracted consciousness disturbance.

1) Surgery
The patient is placed in the prone position with the neck fully extended under general anesthesia. A 5-cm median incision is made in the posterior neck from the 7th cervical spinous process level. After dissection of the muscle, laminectomy of the 5th cervical vertebra is performed. Electrodes are inserted from the epidural median at the 5th cervical level toward the cranial side, and indwelled at the 2nd, 3rd, and 4th cervical levels. The leads are passed under the skin, and connected to the battery and receiver subcutaneously implanted in a lateral abdominal region. Since the surgical stress is low and general condition is well monitored, surgery is safe if it is performed with protective care. Since the devices are completely implanted, there is no inconvenience in daily life or risk of infection. For the instruments, we use the I Trel system of Medtronic Inc.
2) Electrical stimulation
If there is no fever or problem in the wound, stimulation is initiated 3-7 days after surgery. Regarding the cranial and trunk sides as the negative and positive poles, respectively, the nerve is stimulated at an amplitude of 2.0-3.0 V, rate of 70 Hz, and pulse width of 120 μsec using a cycle mode of 15-minute stimulation and 15-minute resting. This cycle is repeated in the daytime.

3) Indication of surgery
We investigated indications of surgery using these tests. (SPECT, CT) We have treated more than 200 patients after incorporation of DCS. We investigated the primary disease, age, imaging findings, and preoperative local cerebral blood flow in these patients, and found many common points in effective cases (appearance of reactions to verbal orders). We assume the conditions shown in Table to be indications of surgery. However, unfortunately, these are not complete because there are some exceptions. To establish true indications, investigation of the degree of residual brain function in patients with protracted consciousness disturbance is necessary. Brain function is discussed based on only the degree and width of impaired regions, degree of brain atrophy, and degree of local blood flow. It is very important to clarify the degrees of individual residual functions.

3. RESULTS
The effect of DCS is judged based on the improvement of the clinical symptoms. However, conversion of the improvements to numerical values is difficult. Thus, we divided the degree of improvement into ‘Excellent’ and ‘Positive’ as the criteria of the effective cases. Appearance of reactions to orders (understanding of intention is possible), speech, and appearance of swallowing movement (oral ingestion is possible) are judged ‘Excellent’. Appearance of these means withdrawal from a vegetative state. Changes in expression and emotion (joy and anger, feelings) in response to stimulation, awakening, appearance of sleep rhythm, and appearance of pursuit and gaze are judged ‘Positive’. Appearance of these as preferable changes compared to before recognized by medical staff and patient’s family is judged ‘Positive’.
Based on these criteria, we judge the effect 1-2 years after initiation of electrical stimulation. There were 21 patients with trauma, 8 with hypoxic encephalopathy, and 3 with cerebrovascular disorder, 32 patients in total.
(22 males and 10 females), between 2000 and 2002. On the evaluation 1-2 years after stimulation, 15 patients aged 35 years or younger satisfied the above criteria for surgery; 7 (47%) and 5 of the patients were judged Excellent and Positive, respectively, showing that DCS was effective in 80% including the 5 patients judged Positive.

4. DISCUSSION AND CONCLUSIONS

DCS was described as a therapy for protracted consciousness disturbance. The mechanism of exertion of the effect has not yet been completely elucidated. Various other methods, such as stimulation of the CM-p f complex, which is deep brain stimulation, application of electrical vagal stimulation used for treatment of epilepsy, and musical functional therapy, are being investigated. In addition, there are various methods of neuromodulation, such as therapeutic electrical stimulation (TES) for prevention of atrophy and spasm of paralytic limbs and functional electrical stimulation (FES) for functional reconstruction of paralytic limbs, showing the potential of neuromodulation.

References

4) Okuma I, Onouchi K, Yamaguchi S, et al: Examination of regional \( \gamma \)CBF (cerebral blood flow) in PVS (persistent vegetative state) with 3D-SRT (3 dimensional stereotaxic region of interest template) – preliminary report -. STC 12: 2004