Thalamocortical Connection Changes with Recovery of Impaired Consciousness in a Stroke Patient with Parietal Lobe Injury

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Research Article

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Abstract

A 52-year-old female patient underwent craniectomy and hematoma removal for a spontaneous intracerebral hemorrhage in the left parietal lobe, as well as intraventricular and subarachnoid hemorrhages (Fig. 1-A). Brain magnetic resonance images obtained three months after onset showed leukomalactic lesions in the left parieto-occipital lobes (Fig. 1-A). Initially, the patient was in a vegetative state with a Coma Recovery Scale-revised score of 11 (auditory function: 2, visual function: 4, motor function: 2, verbal function: 1, communication: 0, and arousal: 2) (1). Subsequently, she underwent comprehensive rehabilitation, which included neurotropic drug treatments (armodafinil, pramipexole, amantadine, levodopa, and baclofen) and physical and occupational therapies (including tilt table standing). In addition, transcranial direct current stimulation was administered by using a neuroConn DC-stimulator. The anode was placed on the left parietal lobe (centered on the supraparietal lobule) and the cathode was placed on the opposite supraorbital region. The transcranial direct current stimulation intensity was 2 mA and the duration was 20 minutes/session with one session/day and seven sessions/week. Repetitive transcranial magnetic stimulation using a MagPro stimulator was applied to mid-portion of the right intraparietal sulcus at a frequency of 10 Hz with an 80% motor threshold intensity and 160 pulses for 8 minutes/session with one session/day and seven sessions/week. After one month of rehabilitation, the patient had recovered to a nearly normal conscious state with a Coma Recovery Scale-revised score of 21 (auditory function: 4, visual function: 5, motor function: 5, verbal function: 2, communication: 2, arousal: 3) [1]. The patient's sister provided signed, informed consent, and the study protocol was approved by our institutional review board.

Main Text

A 52-year-old female patient underwent craniectomy and hematoma removal for a spontaneous intracerebral hemorrhage in the left parietal lobe, as well as intraventricular and subarachnoid hemorrhages (Fig. 1-A). Brain magnetic resonance images obtained three months after onset showed leukomalactic lesions in the left parieto-occipital lobes (Fig. 1-A). Initially, the patient was in a vegetative state with a Coma Recovery Scale-revised score of 11 (auditory function: 2, visual function: 4, motor function: 2, verbal function: 1, communication: 0, and arousal: 2) (1). Subsequently, she underwent comprehensive rehabilitation, which included neurotropic drug treatments (armodafinil, pramipexole, amantadine, levodopa, and baclofen) and physical and occupational therapies (including tilt table standing). In addition, transcranial direct current stimulation was administered by using a neuroConn DC-stimulator. The anode was placed on the left parietal lobe (centered on the supraparietal lobule) and the cathode was placed on the opposite supraorbital region. The transcranial direct current stimulation intensity was 2 mA and the duration was 20 minutes/session with one session/day and seven sessions/week. Repetitive transcranial magnetic stimulation using a MagPro stimulator was applied to mid-portion of the right intraparietal sulcus at a frequency of 10 Hz with an 80% motor threshold intensity and 160 pulses for 8 minutes/session with one session/day and seven sessions/week. After one month of rehabilitation, the patient had recovered to a nearly normal conscious state with a Coma Recovery

Scale-revised score of 21 (auditory function: 4, visual function: 5, motor function: 5, verbal function: 2, communication: 2, arousal: 3) [1]. The patient's sister provided signed, informed consent, and the study protocol was approved by our institutional review board.

Diffusion tensor imaging data were obtained at three and four months after stroke onset by using a 6-channel head coil on a 1.5 T Philips Gyroscan Intera. For the first portion of the ascending reticular activating system, the seed region of interest was placed on the pontine reticular formation, while the target region of interest with a termination option was placed on the thalamic intralaminar nucleus [2]. The second portion included the thalamocortical connections and the seed region of interest was placed on the thalamic intralaminar nucleus [3].

On diffusion tensor tractography (DTT) performed at 4-months after stroke onset, the right lower dorsal ascending reticular activating system was observed to be thicker than that on DTT at 3-months post-stroke. Moreover, on 4-month DTT there was an increase in neural connections to the right frontoparietal lobes compared to that on 3-month post-onset DTT, the increase was particularly notable at the right medial prefrontal cortex and the precuneus (Fig. 1-B).

In this study, the main changes were increased thalamocortical connection to the right (unaffected hemisphere) frontoparietal cortex, especially to the medial prefrontal cortex and precuneus. Because the medial prefrontal cortex and precuneus have been reported to function as important neural correlates for consciousness, we think the changes observed in these areas were mainly responsible for the patient's recovery from a vegetative state to a nearly normal conscious state [4, 5].

Declarations

Ethics approval and consent to participate

The patient's sister provided signed, informed consent, and the study protocol was approved by our institutional review board.

Consent for publication

Written consent for publication was obtained from the patient's sister

Availability of data and material

The datasets used and/or analysed during the current case reports are available from the corresponding author on reasonable request.

Competing of interests

The authors declare that they have no competing interests

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Author Contributions

Sung Ho Jang, study concept and design, manuscript development, writing, and funding.

Chul Hoon Chang, study support, data processing.

Sung Jun Lee, critical revision of manuscript for intellectual content, drafting/revising the image

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Figures

Figure 1

(A) Brain computed tomography images at onset show hematoma in the left parietal lobe and subfalcine herniation. (B) Brain magnetic resonance images at three months after onset reveal leukomalactic lesions in the left parieto-occipital lobes. (C) Results of diffusion tensor tractography (DTT). On 4-month post-onset DTT, thickening of the right lower dorsal ARAS is observed compared with that on 3-month DTT. Decreased neural connections to the right frontoparietal lobes on 3-month DTT are shown to be increased on 4-month DTT, especially in the right medial prefrontal cortex (green arrows) and precuneus (blue arrows).