Clinical Case Report

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Recovery of an injured corticobulbar tract in a patient with stroke

A case report

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Abstract

Rationale: The corticobulbar tract (CBT) is known to be involved in the motor function of the non-oculomotor cranial nuclei and controls the muscles of the face, head, and neck. Several studies have reported injury of the CBT in patients with brain injury, however, little is known about recovery of the injured CBT.

Patient concerns: A 59-year-old right-handed male underwent decompressive craniectomy for management of brain swelling and intracerebral hemorrhage following an infarction in the left middle cerebral artery territory. Initially, the patient had showed severe dysphagia and had to be fed using a Levin tube. Five weeks after the onset of stroke, the patient was transferred to the rehabilitation department and underwent comprehensive rehabilitative therapy. Cranioplasty was performed eight weeks after the onset. The patient was completely recovered from dysphagia and the Levine tube was removed nine weeks after the onset.

Interventions: Diffusion tensor imaging was performed twice; at five weeks and nine weeks from the onset.

Outcome: On five-week diffusion tensor tractography (DTT), the right CBT was discontinued at the subcortical white matter and showed severe narrowing and the left CBT was not reconstructed. By contrast, on nine-week DTT, the right CBT was extended to the cerebral cortex and thickened while the left CBT remained not reconstructed in DTT.

Lessons: This case demonstrates the association of the recovery of injured CBT with the recovery of dysphagia using DTT.

Abbreviations: CBT = corticobulbar tract, DTT = diffusion tensor tractography, FMRIB = functional magnetic resonance imaging of the brain, ICH = intracerebral hemorrhage, ROI = region of interest.

Keywords: corticobulbar tract, diffusion tensor tractography, dysphagia, intracerebral hemorrhage, stroke

1. Introduction

The corticobulbar tract (CBT) is known to be involved in the motor function of the nonoculomotor cranial nuclei and controls the muscles of the face, head, and neck.[1] Dysphagia is a representative clinical feature of the injured CBT.[1] Diffusion tensor tractography (DTT), derived from diffusion tensor imaging (DTI), enables 3-dimensional reconstruction and estimation of the CBT in the live human brain.[2,3] Several studies have reported injury of the CBT in patients with brain injury.[4–8] However, little is known about recovery of the injured CBT.[9]

In this study, we report on a stroke patient who showed recovery of an injured CBT with concurrent recovery of dysphagia, demonstrated by serial DTTs.

2. Case report

A 59-year-old right-handed male underwent decompressive craniectomy for management of brain swelling and intracerebral hemorrhage (ICH) after an infarction in the left middle cerebral artery territory at the neurosurgery department of a university hospital (Fig. 1A). The patient did not have any previous history of neurologic or psychologic disease, nor had been on any pharmacologic treatment that can influence the neurologic function. After the ICH, the patient developed severe dysphagia and had to be fed using a Levin tube. Five weeks later, the patient was transferred to the rehabilitation department of the same hospital, and underwent comprehensive rehabilitative therapy, including neurotropic drugs (pramipexole 1.5 mg, amantadine 300 mg, ropinirole 2 mg, and methylphenidate 10 mg per day), neuromuscular electrical stimulation therapy for facilitation of swallowing muscles, and dysphagia therapy.[10] Cranioplasty was performed 8 weeks after the onset of stroke using auto-bone. The Levin tube was removed after affirming that the patient can eat meals orally without any signs of aspiration 4 days after the cranioplasty.

For the comparison with the CBT of the patient, 3 age and sex-matched normal subjects (55, 57, and 60-year-old men) without any neurologic or psychologic diseases were recruited. The patients' wife had provided signed informed consent, and the

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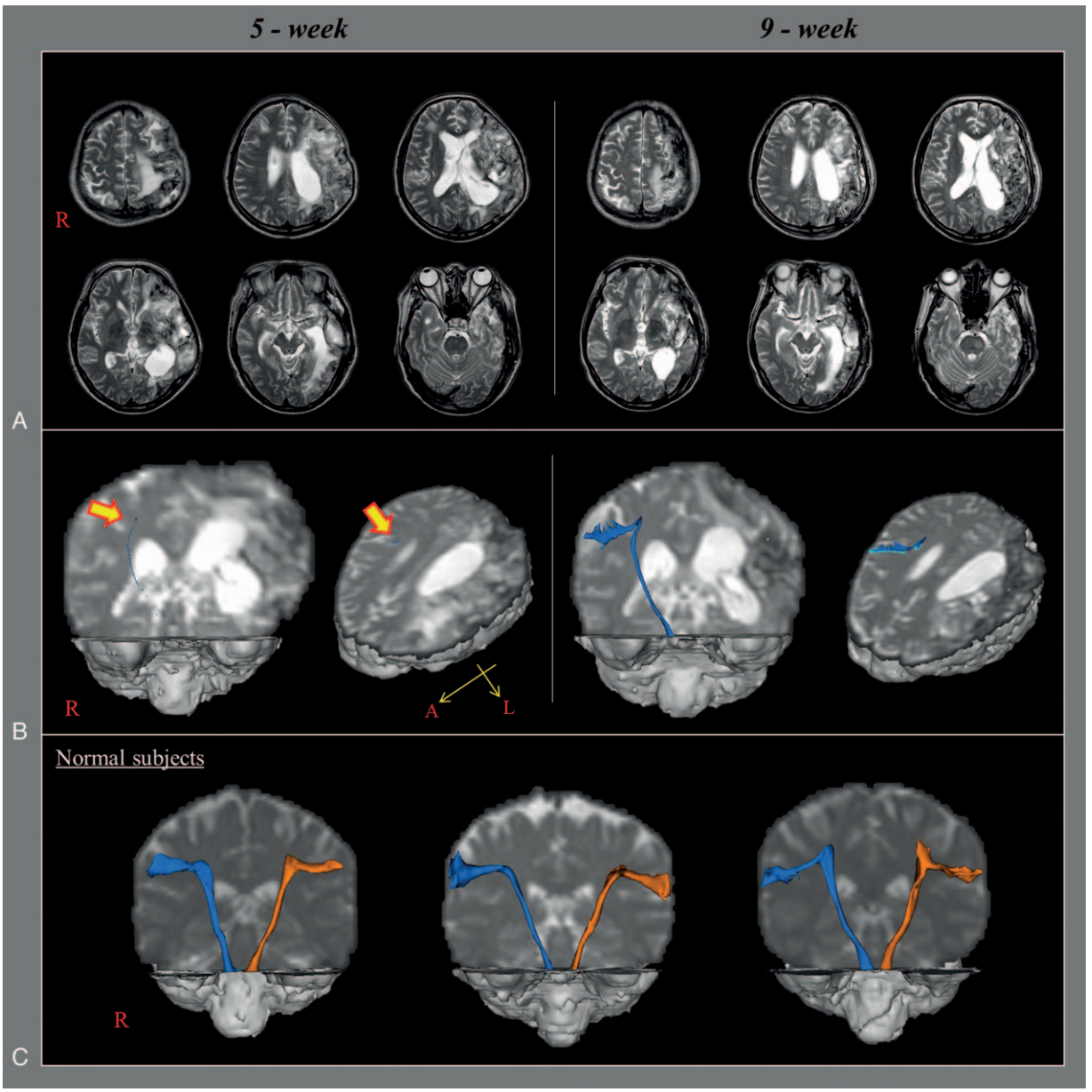

Figure 1. (A) T2-weighted brain magnetic resonance (MR) images at 5 and 9 weeks after onset show leukomalactic lesions in left middle cerebral artery territory. (B) Diffusion tensor tractography (DTT) for the corticobulbar tract (CBT). On 5-week DTT, the right CBT is discontinued at the subcortical white matter and shows severe narrowing compared with those of normal subjects, whereas the left CBT is not reconstructed. By contrast, on 9-week DTT, the right CBT is extended to the cerebral cortex with thickening, whereas the left CBT is still not reconstructed. (C) Reconstructed CBT of normal subjects (55-year-old man, 57-year-old man, and 60-year-old man).

institutional review board of the university hospital approved the study protocol.

2.1. Diffusion tensor imaging

Diffusion tensor imaging data were acquired twice (5 and 9 weeks after the onset) using a sensitivity-encoding head coil on a 1.5-T Philips Gyroscan Intera (Hoffman-LaRoche Ltd, Best, the Netherlands). Sixty contiguous slices (acquisition matrix, 96×96; reconstruction matrix, 192×192; field of view, 240×240 mm^2; repetition time, 10,726 ms; echo time, 76 ms; $b = 1000$ s/mm^2; number of excitations, 1; and thickness, 2.5 mm) were acquired for each of the 32 noncollinear diffusion-sensitizing gradients. For reconstruction of the CBT, diffusion-weighted imaging data were analyzed using the Oxford Centre for Functional Magnetic Resonance Imaging of the Brain (FMRIB) Software Library (FSL; www.fmrib.ox.ac.uk/fsl).[11] A probabilistic tractography method was adopted for fiber tracking and tractography routines that are implemented in FMRIB diffusion (5000 streamline samples, 0.5 mm step lengths, and curvature thresholds: 0.2) were applied in the current study.[12,13] Fiber passing through both regions of interest (ROIs), the seed and target ROI, were depicted; the seed ROI was placed at the lower portion of the precentral gyrus where the uppermost part of the lateral ventricle is seen on the axial image, and the target ROI was placed between transverse pontine fibers and the middle cerebellar peduncle at the level of mid pons on the axial image.[12]

On 5-week DTT, the right CBT was discontinued at the subcortical white matter and showed severe narrowing, whereas the left CBT was not reconstructed. By contrast, on 9-week DTT, the right CBT was extended to the cerebral cortex with thickening, whereas the left CBT was still not reconstructed (Fig. 1B).

3. Discussion

In this patient, it appears that the right CBT was severely injured in the first DTT because it was discontinued at the subcortical white matter level showing severe narrowing.[2,14] The most probable mechanism of injury is considered to be subfalcine herniation after an extensive ICH in the left hemisphere.[15,16] The injured right CBT showed significant recovery after rehabilitation and cranioplasty in that the discontinued right CBT in the first DTT has not only extended to the cerebral cortex but also thickened in the following DTT. However, the left CBT remained not reconstructed in the second DTT, reflecting a severe injury. These findings suggest that the recovery of dysphagia, which is observed 9 weeks after the onset of stroke, is associated with the recovery of the injured right CBT.

Several studies have reported neurological recovery after cranioplasty in patients who underwent decompressive craniectomy.[17,18] Because the immediate precranioplasty DTI was not performed in this patient, it was not possible to discern the effect of rehabilitation from that of cranioplasty. However, it might be possible that both rehabilitation and cranioplasty had contributed to the recovery of the injured right CBT and dysphagia in this patient.

Regarding the recovery of the CBT injury, to our best knowledge, only 1 study has reported a patient who showed reorganization of a CBT on DTT at a chronic stage (3 years after onset) after bilateral middle cerebral artery territory infarctions.[9] As a result, this would be the first study to demonstrate the recovery of an injured CBT using serial DTTs in a patient with brain injury.[4–8] However, the limitations of DTT should be considered: crossing fiber and partial volume effects might result in false-negative results on DTT.[19]

4. Conclusions

In conclusion, the recovery of an injured CBT concurrent with recovery of dysphagia was demonstrated in a stroke patient using serial DTTs. Our results suggest that serial DTTs might be useful to detect the state of the CBT in patients with dysphagia after brain injury.

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