Identification of the Pyramidal Tract using Neuronavigation based on Intraoperative DWI and Subcortical Stimulation

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Introduction

In surgical resection of brain tumor in the vicinity of the pyramidal tract, identification and preservation of the tract is extremely important to protect the motor function. Although DWI/DTI is useful to demonstrate the position and the direction of the deep white matter bundles, intraoperative imaging is essential during neurosurgical procedure which could cause brain deformation. The purpose of this study was to identify the pyramidal tract using neuronavigation based on intraoperative DWI in combination with subcortical electrical stimulation.

Method

Intraoperative DWI scanning was performed on seven patients with brain tumor in the vicinity of the pyramidal tract, to depict the white matter bundles and use the obtained images for neuronavigation. An informed consent was obtained from each patient. DWI and T1, T2-weighted images were obtained by 0.3-tesla intraoperative MRI[1] after craniotomy, tumor removal and additional removal. The protocol of the DWI included a peripheral gating multi-shot DW-SE-EPI sequence with MPG pulses applied to the anterior-to-posterior direction, a slice thickness of 8mm and a scan matrix of 100 x 92. When it was confirmed on the neuronavigation display that the surgical manipulation has reached near the pyramidal tract, the surgeons performed subcortical electrical stimulation at a stimulation current ranging from 4 to 20 mA and measured the myogenic potentials at the extremities. The tissues around the stimulated point were preserved when motor-evoked potentials were obtained. We examined the white matter bundles depicted on the intraoperative DWI images to measure the distance between the stimulated point and the bundle on the neuronavigation display.

Results

The intraoperative DWIs on the neuronavigation display are shown in Figure 1. Motor-evoked potentials were obtained from 5 patients (8 times) out of the 7 patients. The distance between the stimulated point and the white matter bundle was from 0 to 4.7mm (mean: 1.4±2.1 mm). Stimulations with the distance of more than 5.0 mm resulted in negative responses.

Conclusion

We identified the pyramidal tract using a neuronavigation system based on intraoperative DWI in combination with subcortical stimulation, allowing preservation of the tract. Our findings indicate that the white matter bundles depicted on the DW images include the pyramidal tract.

Reference

[1] Ozawa N, Muragaki Y, Shirakawa H, *et al*. Pyramidal Tract Navigation based on Diffusion-Weighted Imaging updated by Intraoperative open MRI. ISMRM, 2004. p.2155

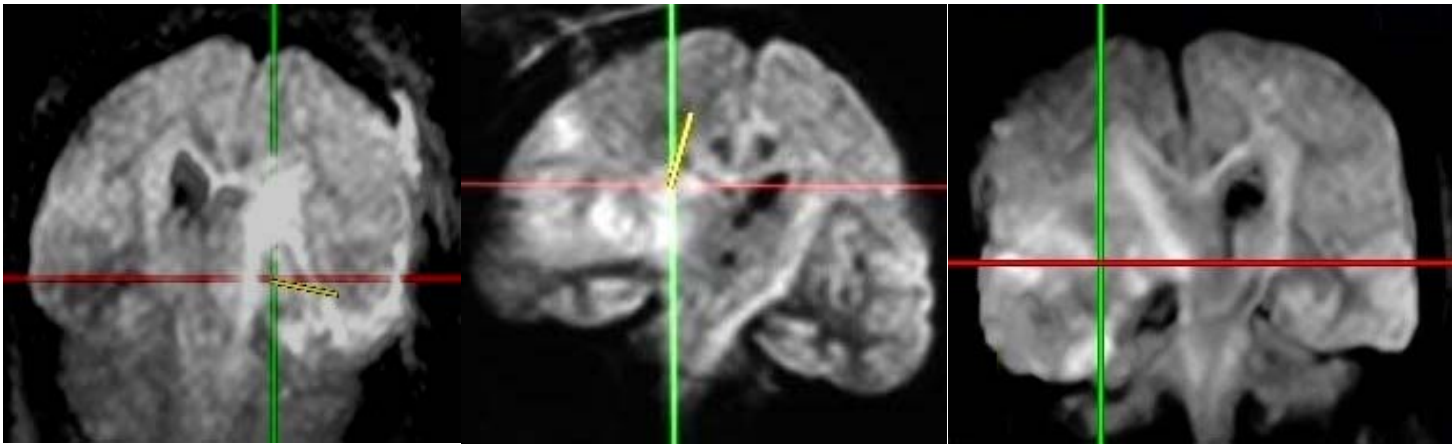

Fig.1 Intraoperative DWIs depicting the white matter bundles, with the cross cursor indicating the position of electrical stimulation. (Left) Patient 1 with a positive response of the motor-evoked potentials in the right upper extremity (20mA). The distance between the stimulated point and the bundle was 4.7 mm. (Middle) Patient 2 with a positive response in the left upper and lower extremities (10mA). The distance was 0 mm. (Right) Patient 3 with a negative response in the left extremities. The distance was 18.7 mm.