Pyramidal Tract Navigation based on Diffusion Weighted Imaging updated by intraoperative open MRI

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Introduction: For treatment of malignant brain tumor existing in or close to the pyramidal tract it is critical to remove the tumor as much as possible with preventing motor paresis. To make it clear visually and correctly if an area manipulated includes motor fibre, an intraoperative MRI [1] is needed. The purpose of this study is to asses the feasibility of a pyramidal tract navigation based on diffusion-weighted imaging (DWI) updated by intraoperative open MRI.

Methods: This study was performed in an operating theatre with an open MRI (0.3T AIRIS®2, Hitachi Medical Co., Chiba, Japan) at Tokyo Women's Medical University. A new surgical coil which has dual functions of head fixation and receiver coil was designed using a non-metal material to prevent susceptible artifact on DWI. Typical scan parameters for DWI were shown in Table1. This scan was repeated three times with slice position slid 3mm to increase the resolution in the slice direction. A navigation system and an optical camera (Polaris, Northern Digital Inc., Waterloo, Canada) were used. The clinical evaluation of navigation was done for patients with a tumor. Informed consent was obtained. As shown in Fig.1, the patient head was fixed on the coil frame using four pins (a), and the surgery was performed outside of the MRI gantry. For intraoperative imaging the upper part of the coil was set (b) and the patient table was inserted into the gantry (c). We examined whether or not motor evoked potentials were detected in the area close to pyramidal tract demonstrated on the navigation image (d).

Table1 Typical parameters for diffusion weighted imaging using echo-planar imaging with fat suppression and peripheral gating (Heart Rate 70 (1/min)). Section was coronal and motion probing gradient direction was anterior-posterior.

FOV (mm)	frequency#	phase#	Thickness (mm)	Interval (mm)	Multi-slice	shot#	b (s/mm^2)	NSA	Scan Time
250	100	92	8	9/3	6×3	4	700	8	1'22"×3

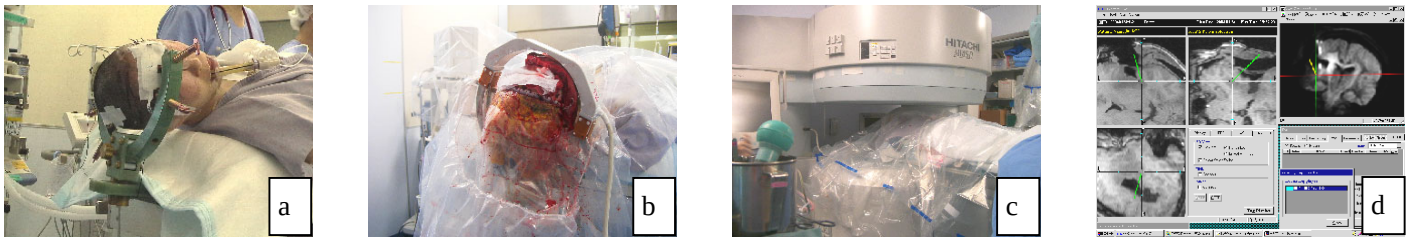

Fig.1 (a) Patient head fixation, (b) a new surgical coil, (c) intraoperative imaging, (d) navigation screen including a DW image (right).

Results: The intraoperative DWI of the patient with a right temporal huge tumor showed good image quality of pyramidal tract as shown in Fig.2 (a-c). The spatial relationship between the tumor, the pyramidal tract, and the treatment position was able to be displayed correctly by the navigation. The surgeons recognized these positions intraoperatively and visually. These images showed that the pyramidal tract was moved due to tumor removal. Motor evoked potentials for left hand were detected in the area close to the pyramidal tract demonstrated on the navigation image. As a result postoperative disturbances such as motor paralysis could be obviated.

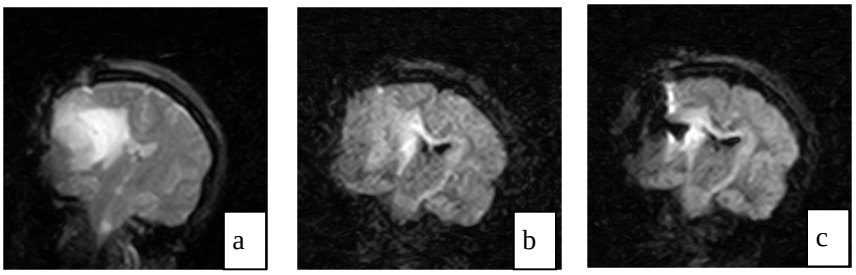

Fig.2 Intraoperative MRI of a patient with a right temporal huge tumor. (a) T2-weighted image, (b) DW image before removal, and (c) DW image after removal.

Conclusion: The navigation based on DWI updated by intraoperative open MRI showed the position of pyramidal tract visually and correctly.

Reference: [1] Y. Muragaki, H. Iseki, T.Maruyama, et al, New system of glioma removal using intraoperative MRI combined with functional mapping, Proceedings of the 15th International Congress of CARS2001, Berlin, Germany, Berlin, Springer, (2001) 1143.