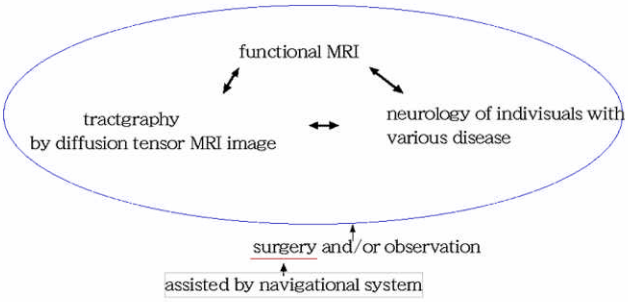
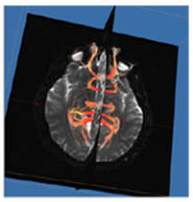
FUSION OF MULTIPLE IMAGING SYSTEM TO VISUALIZE REAL-FUNCTIONAL ANATOMY OF BRAIN

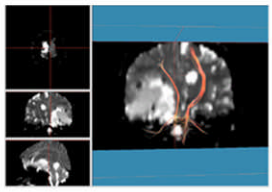
Study Group Neurosurgery / Neuroradiology
Teikyo University and University of Tokyo



Normal brain anatomies and their relation to brain function have been widely studied by neurologist and anatomist. However unexpected recovery of brain function after damage of a functionally critical structure has often been observed in clinical situations. The redundancy of brain structures and unknown substitute for each system might be the reason for these phenomena. In clinical neurosurgery or neurology, we have to estimate the future functional recovery after insult to the brain such as trauma or cerebrovascualr disease for the better management of the disease. We often encounter a dilemma between functional preservation and better surgical excision of brain which is invaded by malignant tumor cells, also. Better understanding of clinical functional anatomy of brain, especially diseased brain leads us to improved management of patients.

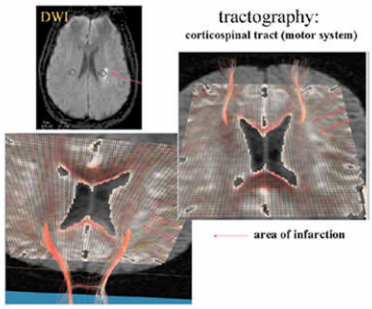
We propose a project on clinico-anatomical study of brain function based on MRI using diffusion tensor image tractgraphy and functional MRI. Neurological and neurosurgical case study with this technique will give detailed and practical functional structure of brain.



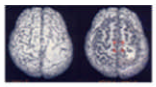


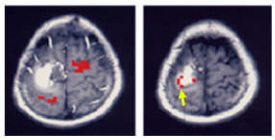
Diffusion tensor tractgraphy which is calculated from diffusion tensor MRI image data shows various neurological system (trancts) in the brain including the corticospinal tract to organize mortor system in 3D images.

In a patient with recurrent malignant astrocytoma, preoperative neurological examination revealed right hemiparesis. Tractgraphy which calculated and visualized with preliminary software showed that the corticospinal tract is displaced but not involved in MRI T2 high area which highly possible to represents tumor cell infiltration in malignant or brain tumor. After surgical excision of the tumor, the patient hemiparesis recovered remarkably since corticospinal tract to organize motor system is well spared in this patient.



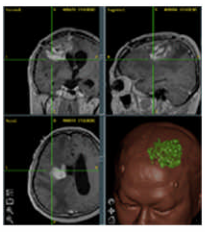
In a patient who has several days history of right hemiparesis had a small infarct adjacent to internal capsule which is also a part to be believed the corticospinal tract is passing. The paresis was severe however the tractgraphy showed the corticospinal tract is spared in this patient. The patient recovered well which documents the exact localization of corticospinal tract in the internal capsule.





Healthy side / Injured side : motor area is not fully visualized :

Functional MRI (f-MRI) which measures the oxyhemoglobin and deoxyhemoglobin content to assess increased cerebral blood flow during task (eg. finger movement during MRI examination) and shows the cortical area which is activated during the particular task. With this technique we can confine the "motor area" where the motor neuron of the particular movement is located. Figure shows a f-MRI image of a patient with a hematoma (bleeding) from a tumor (cavernous angioma). This examination showed that the patient functional area for finger movent is injured with the hemorrhage. After removal of the tumor and the hematoma, the patient's paresis was improved but remained.



Navigational surgery : With the aid of navigation system, the surgeons can know where and what part of the brain they are exactly handling. One of such case is presented in the figure. Exact excision of the tumor is possible with this system.

Discussion

Although functional MRI and navigator assisted neurosurgery have been reported by several investigators, tractgraphy is a developing area of MRI and only a few reports describes this technique.

Previously there is no report which combine these modalities and examine clinical patients. Study of patients give us not only the information of impaired side but the normal side compared to the affected side.

In our study group, fairly good number of patients who will be eligible for this study will give us increased knowledge in terms of more detailed functional anatomy of normal brain

The most recent article from Johns Hopkins University showed the corticospinal tracts with MRI tractgraphyt, however it took 20 minutes for their systtem to calculate one tract. In our system which we are developing, it takes only 10 seconds for obtaining one tract. The difference is so remarkable and we would like to improve this software to achieve followings. 1) Shorter calculating time. 2) The sensory system is hard to visualize on the program that we use now but the reason is not clear so far. During the project period, we would like to develop improved software which can visualize almost all tracts in the brain. 3) The calculation in the brainstem is still deviated because of be distortion of MRI system. We would like to improve calibration software.

Conclusion

The integration of information from functional MRI, tractgraphy, clinical patients (with or without surgery) will give us practical functional detailed anatomical mapping of the brain. It will also give us the redundant or reserve neurological system which we do not know by classical anatomical or physiological study. These information will be a great boon to patients who are suffer from neurological diseases