

Diffusion Tensor Imaging in Epilepsy Surgery

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Purpose

Diffusion tensor imaging (DTI) visualizes white matter microanatomy and integrity in vivo. Recent advances of high-end MR technology and more robust algorithms provide higher quality DTI and more reliable tractography results. Commonly applied clinical field is preoperative evaluation of brain tumors and other space occupying lesions, various white matter and neurodegenerative diseases. DTI can be also used in epilepsy surgery with the same way as used in neuro-oncology. The purpose of this educational poster is to review the current status of DTI in epilepsy surgery and future directions.

Outline of contents

1. Review of DTI methodology: Clinical DTI can be used in two different ways. The first way is tractography method, either stream line and probability techniques, which can be used pre-operative localization of major white matter tracts such as motor, sensory, visual and language fibers. The second way is mass data analysis with voxel based analysis (VBA). MRI negative epilepsy patients and various psychiatric diseases can be studied by DTI and VBA.

2. Clinical application in the field of epilepsy surgery: Geometrical relationship between the lesion and major tract can be assessed non-invasively. However, critical determination of resection margin often needs more invasive techniques such as ECoG or electrode mapping because DTI and tractography still has limitations and needs more validation for its results. Sometimes, tractography provides better differential points than other conventional imaging. Cortical dysplasia (CD) is a kind of migration anomaly and characterized by cortical thickening, gray-white matter interface blurring and subcortical white matter signal change. Decreased FA around gray-white matter junction is seen in CD and FT describes decreased subcortical fiber connections in the affected cortex. FT is more sensitive than other conventional anatomic images. In the case of heterotopic gray matter in the white matter, the arrested neurons exist in the white matter bundles and might have some degree of directivity like the normal white matter tracts and show increased anisotropy. Gray matter in the white matter, that is, nodular or band heterotopia, showed a higher anisotropic value compared to the normal cortex with statistical significance. Epilepsy patients with normal MRI findings, such as juvenile myoclonic epilepsy, normal appearing temporal cortex in TLE are good candidates for VBA. This method cannot be used individually in case by case, but understanding detailed pathophysiology of neurological disease is the main advantage of VBA. Tract based spatial statistical analysis (TBSS) is a recently developed mass data analysis with detailed assessment of fiber structures.

Summary

DTI is a clinical tool providing additional information in localization of epileptogenic lesion and pathophysiology of neurological disorders. Continuous evaluation and validation will strengthen its clinical feasibility.

References

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