REVIEW

Advanced Applications of MRI in Human Brain Science

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Abstract. Magnetic resonance imaging of the brain is now generally indispensable to state of art clinical medicine. Robust, high resolution imaging systems are currently available worldwide. The availability of MRI has, in little more than a decade, revolutionized the certainty and efficiency of clinical diagnosis and management. As a dividend of this revolution, clinicians and radiologists who are expert in the many and varied applications of MRI methods are able to relate this expertise to a confident mastery of the topographic anatomy of the brain as revealed in magnetic resonance images. Whereas the yield to clinical objectives has been massive, the clinician as yet draws upon a relatively limited sampling of the potential informational harvest from this technology which in theory could further enrich both clinical concerns and those of fundamental neuroscience. Here we will review early explorations into these other offerings with the expectation that the coming decade will see them established comfortably with current uses. We will also consider potential offerings of the extended applications of brain MRI to the characterization and insights into biological origins of certain obscure developmental disorders. (Keio J Med 49 (2): 66–73, June 2000)

Key words: MRI, brain morphometry, neural systems, developmental disorders

Three Stages of Application

MR represents the brain as a range of gray scale images which may be formatted in any or all three of the cardinal coronal, axial or sagittal planes. Planes may be sampled only selectively from the brain with variable plane thickness and interplane gaps or the image set may be fully 3 dimensional. The imaged set is an algebraic transform of the imaged brain. Respecting these electively obtained properties of an image data set, we consider three potential stages of analytic operation. These stages build, one upon the other, a systematic interpretation and view of the human brain as imaged by the MRI system.

Pattern recognition

By pattern recognition we intend judgements made practically with reference only to the gray-white patterns as viewed in the images (Fig. 1a). That is, the judgement is made as to whether the gray scale and shape of the principal cerebral, brain stem and cerebellar regions and the gray scale compartments of these regions match or do not match those of the standard of normal brain. This level of application is sufficient to those requirements needed to judge many developmental malformations as abnormal.[1] It is sufficient for the recognition of stroke or tumor.

Knowledge-based

Here the observer, drawing upon a base of knowledge of the structure, organization and development of the normal brain, looks beyond the raw gray scale and shape presentation of the brain and makes inferences in these domains from the image presentation of pattern (Fig. 1b). The interpretations of image pattern provided by the skilled radiologist and clinician will be richly reinforced by such knowledge. Conceptual frameworks and technologies only now beginning to mature will soon contribute much more at this level of analysis.

The critical issue here is the relationship of neural

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