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Editorial

Recent Advances in Neuroimaging

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Editorial

A wide variety of disease patterns are found in the practice of neurology, which has led to the development of numerous advanced MR (Magnetic Resonance) imaging techniques. Some techniques such as DWI have found such widespread application that they have been incorporated into nearly all-imaging protocols for a variety of neurological conditions, and yet others are used to answer specific clinical questions. The advent of higher strength MR magnets have allowed for clinical application of exciting new MR techniques like BOLD fMRI imaging, DTI, and ASL perfusion. The subsequent sections briefly highlights various advanced imaging technique and its clinical application.

Diffusion-Weighted Imaging (DWI)

Diffusion represents the random movement of molecules in an environment, and is affected by a variety of factors including the microenvironment and temperature. DWI is extensively used clinically, most commonly in the setting of stroke. DWI detects tissue injury within minutes from onset of ischemia, long before any other MR sequence. DWI is also useful in differentiating arachnoid cysts from epidermoid tumors, characterizing hypecellular tumors and pyogenic abscess, and detecting neurodegenerative disorders like Creutzfeldt-Jakob disease's well as metastatic disease and myeloma.

Susceptibility Weighted Imaging (SWI)

SWI is a gradient- echo technique that exploits the magnetic susceptibility differences of various materials, such as blood products, iron, and calcification. The SWI is particularly useful for detecting microhemorrhage in the setting of trauma and variety of other conditions, including hypertension and amyloid angiopathy. SWI also improved

depiction of slow-flow venous structures, such as developmental venous anomalies and venous component of Arteriovenous Malformations (AVMs).

Proton MR Spectroscopy (MRS)

MRS plots proton signal intensity against an observation frequency, and variations in metabolite ratios in different pathologies are evaluated. Clinical applications of MRS include diagnosis and grading of brain tumors as well as differentiation of tumor progression from treatment-related necrosis. Various metabolic and hypoxic/ischemic

disorders are also evaluated using MRS.

Double Inversion-Recovery Imaging

DIR sequences improve gray-white matter differentiation by suppressing signals from the CSF and the white matter. This has been found useful in evaluation of multiple sclerosis and epilepsy.

Steady-State Free Precession Imaging (SSFP)

SSFP provides high contrast between Cerebrospinal Fluid (CSF) and surrounding structures when performed with heavy T2 weighting. SSFP sequences such as the Constructive Interference in the Steady State (CISS) and Fast Imaging Employing Steady State Acquisition (FIESTA) sequences have shown utility in the evaluation of trigeminal

neuralgia, hemifacial spasm, sensor neural hearing loss as well as for the detection of CSF leaks and or posttraumatic pseudomeningoceles.

Gadolinium Cisternography

Cisternography is the imaging of the cerebrospinal system after intrathecal administration of contrast material into the subarachnoid space. Although heavily T2- weighted SSFP sequences provides satisfactory morphological information noninvasively, the physiologic information like actual demonstration and rapidity of CSF leak is obtained by gadolinium Cisternography. Clinical applications include detection of cranial and spinal CSF leaks in setting CSF rhinorrhea, otorrhea and spontaneous intracranial hypotension.

Contrast-Enhanced Time-Resolved MR Angiography (CE-TR MRA)

CE-TR MRA allows evaluation of vascular enhancement in a temporally sensitive manner. This is particularly useful to evaluate AVM and dural arteriovenous fistulas (dAVFs), and also for monitoring of treated intracranial aneurysms.

Cine Phase Contrast Flow

Phase Contrast (PC) MR imaging generates a differentiation between flowing and stationary nuclei by sensitizing the phase of the transverse magnetization to the velocity of motion. The primary application of this technique is detection of alterations in CSF flow in conditions like the Chiari 1malformation.

Dynamic Susceptibility Contrast (DSC) Perfusion Imaging

DSC MR Perfusion analysis has been found to be useful in the initial workup of intracranial mass, its grading, and for guiding biopsy. It is also useful in differentiating treatment-related necrosis from true tumor progression.

Arterial Spin-Labeled Perfusion Imaging

ASL perfusion techniques use "labeling" of arterial blood water flowing into a labeling plane with radiofrequency energy and imaging the brain tissue of interest after a predefined delay. Its main application is in cerebrovascular disease imaging.

Diffusion Tensor Imaging

DTI is a form of DWI that images WM tracts by assessing physiologic water directionality and motion. This has been found useful in presurgical planning for resection of primary glial neoplasms and AVMs used in conjunction of fMRI.

Blood Oxygenation-Dependent Functional MR Imaging (BOLD fMRI)

BOLD fMRI assumes that an increase in neuronal activity will cause an increase in blood oxygen consumption and a resultant increase in local cerebral perfusion. It has been applied to better understanding basic brain function and a variety of derangements in disease states. Clinical application is again in presurgical planning in conjunction of DTI.

Automated Segmentation and Volumetric Analysis

These tools have been validated and successfully used to detect and quantify hippocampal atrophy in Alzheimer disease and temporal lobe epilepsy.

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