Pediatric MRI Symposium ll_body

SY27-1

Advanced MRI in Pediatric Musculoskeletal Imaging

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Diffusion-weighted image

DWI of the musculoskeletal system is a relatively fast and robust technique that can be implemented for evaluation of soft-tissue and bone tumors, bone marrow infection or infiltrative lesions as well as post treatment follow-up. DWI is performed with echo-planar imaging (EPI) technique, which is the fastest technique that employs rapidly oscillating frequency-encoding gradient and completes k-space filling after a single RF pulse. Lesion detection is enhanced in DWI with high b-value where the signal from the lesion persists with anatomic background signal is suppressed.

***IVIM**

Intravoxel incoherent motion (IVIM) imaging is a non-contrast-enhanced DWI technique to quantitatively assess all the microscopic translational motions that occur in each image voxel during an MRI acquisition. Three parameters can be derived by means of biexponential IVIM imaging modeling, including D, the diffusion-related parameter, which represents the true molecular diffusion; D*, the pseudo–diffusion coefficient, which macroscopically reflects the incoherent movement of blood in the microvascular compartment; and f, the perfusion fraction, which reflects the percentage of incoherent signal that arises from the vascular compartment in each voxel as a proportion of the total incoherent signal.

Functional cartilage imaging

-dGEMRIC (delayed gadolinium enhanced MRI of cartilage)

D-GEMRIC technique uses the inverse relationship between the amount of glycosaminoglycan (GAG) in cartilage and an intravenously administered, negatively charged contrast agent. Ga-DTPA2- is distributed in higher concentration in areas of cartilage where the GAG is relatively low.

-T2 mapping

Quantitative MR using T2 relaxation time mapping (T2 map) is a biochemical imaging technique that enables investigation of the microstructural changes of the cartilage. The T2 map is highly sensitive to the orientation of the collagen fibers and to water content within the cartilage. A multi-echo SE technique is used to measure T2 values in each pixel.

Perfusion imaging: Dynamic contrast-enhanced (DCE) MRI

A fast gradient-echo sequence can be used with multiple dynamic phases as a DCE-MRI sequence. Dynamic contrast imaging provides important information about the vascularity of tissue and its surrounding environment, and quantitative parameters can be derived from the sequence that more comprehensively describe the pharmacokinetics of an area of interest. More in-depth DCE analysis includes pharmacokinetic contrast enhancement (PK) modeling approaches that can quantify blood flow, microvasculature, and capillary permeability in tumors. A well-known PK-DCE metric is the volume transfer constant (K_{trans} (min^{-1})), which characterizes the transfer of the contrast agent from the plasma. These metrics can be used to develop the vascular profile of a musculoskeletal tumor, important to defining the viability of tumor and assessment of treatment response following neoadjuvant therapy.

Fusion Imaging: PET/MRI

The integrated PET/MRI systems acquire PET and MRI data simultaneously in the same bore. This strategy may improve scanning efficiency and reduce misregistration but requires technical adaptations of the PET components. Whereas the CT component of PET/CT directly provides electron density information that can be readily used to generate attenuation-corrected PET images, the MRI signal acquired during simultaneous PET/MRI instead correlates with proton density and tissue T1/T2 properties.

Keywords : Diffusion-weighted imaging, Cartilage imaging, Dynamic contrast enhancement MRI

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Advanced MR Techniques In Pediatric Liver Imaging

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MRI plays an important role in pediatric liver imaging. In addition to conventional morphologic imaging, liver MRI can aid the quantitative imaging of liver disease. However, most advanced MRI techniques are challenging to apply in pediatric patients. Therefore, this lecture will discuss advanced liver MRI techniques and their feasibility in pediatric imaging.

Diffusion-weighted imaging is a widely applicable technique in MRI that reflects the Brownian motion of water molecules. However, the monoexponential model may not accurately reflect water molecular diffusion which is influenced by the microcirculation of blood in capillaries. The biexponential diffusion model can separate pure water molecular diffusion and perfusion by using multiple high and low b-values. Recently, the biexponential model was also found to be confounded by a mismatch originating from the heterogeneous nature of tissues. Therefore, the stretched-exponential model was introduced to measure heterogeneity in the environment. This stretched-exponential model will be discussed along with its potential to reflect organ heterogeneity in pediatric liver MRI.

MR elastography can quantify tissue stiffness using mechanical stress and has been increasingly adapted in pediatric imaging. It is known as a more accurate and reliable method to measure whole-liver stiffness noninvasively. Several specific issues need to be considered for pediatric application and recent results in pediatric diffuse liver disease will be discussed.

T1 and T2* mappings are parametric quantitative sequences which provide tissue-specific values. T1 values can reflect tissue status such as fibrosis and T2* values can be used to calculate hepatic iron content. The technical considerations and its utility for pediatric liver disease will be assessed.

Dynamic contrast-enhanced MRI consists of the continuous acquisition of images before, during, and after the injection of a contrast agent. Using this technique, several quantitative parameters including the transfer constant (Ktrans), rate constant (Kep), and extravascular extracellular space volume fraction (Ve), and semiquantitative parameters such as the initial area under the gadolinium concentration-time curve (iAUC) can be measured. We will discuss DCE MRI in pediatric liver MRI and its potential for diagnosing liver tumors.

Advanced MR techniques have many benefits even though their application is challenging in pediatric patients. These techniques are expected to play a larger role in the imaging of pediatric liver disease in the future.

Keywords : Pediatric, Liver, MRI