Body MRI: How We Do It

Dynamic Contrast Enhanced MRI/MRA

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In the era of diffusion weighted non-contrast MRI as well as dynamic 4D CT imaging with substantial radiation and contrast media dose reduction, dynamic MRI/MRA had to re-invent itself and address some of the major challenges. These included the demands for an increase in spatial and temporal resolution, new contrast mechanisms for better fat suppression as well as higher robustness in clinical routine.

The combination of established 3D liver gradient echo sequences in combination with current algorithms for temporal undersampling of k-space allowed to implement 4D time-resolved imaging with high quality and at almost no loss in soft tissue contrast and spatial resolution (1). Further improvements became possible by new algorithms for reduced data sampling including parallel imaging in 2 acceleration directions or compressed sensing (CS) techniques (2). The introduction of parallel transmit techniques can further decrease scan time. With the clinical availability of parallel radiofrequency (RF) transmission coils and the potential to utilize spatial information in an array during RF transmission, it is now possible to generate spatially tailored RF pulses to excite small inner volumes instead of the entire field-of-view.

For improved fat suppression dual-echo sequences with DIXON reconstruction scheme are now routinely implemented in 3D sequences for imaging of the abdomen. In one study of the pancreas, the combination of two-direction acceleration strategies and DIXON reconstruction schemes resulted in homogenous fat saturation and reduced motion artifacts due to a faster acquisition, leading to improved delineation of the pancreatic tissue. Signal ratios of pancreatic to fat signal were significantly better for 3D gradient echo sequences with two-direction acceleration strategies compared with a 2D FLASH sequence with standard one-dimensional scan acceleration and spectral fat suppression. Multi-echo sequences allow quantification of liver fat and correction for iron overload (4).

The implementation of other k-space acquisition schemes such as radial imaging with ultra-short echo times or spiral sampling trajectories allows the reduction of motion artifacts as well as sliding window reconstructions for selective calculation of arterial and portal venous data sets (5, 6). The latter is particularly helpful for avoiding bolus timing-errors in the assessment of hypervascular liver lesions with hepatocyte-specific contrast agents which are applied in an overall smaller volume due to their higher relaxivity.

Routine clinical applications include dynamic characterization of liver and pancreatic lesions, follow-up of primary and secondary malignant liver lesions after transarterial chemoembolization and selective intrahepatic radiation therapy (SIRT) as well as characterization of cystic and solid renal lesions. Arising applications are detection of grading of inflammatory bowel disease and detection of intestinal graft-versus-host disease. For time-resolved 4D MR angiography established applications such as monitoring of flow in the true and false lumen of aortic dissection are accompanied by new important indications such as grading of various types corpus cavernosum fractures.

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