PARALLEL BODY IMAGING AT 3T

Dr. M. von Falkenhausen
University of Bonn

Virtually all existing MR imaging techniques require both, a high temporal and a high spatial resolution for optimum detection and classification of disease states. Prior to the introduction of parallel imaging techniques, increasing gradient strength has been the only strategy to meet the increasing demands of advanced diagnostic imaging applications. Yet, this strategy is limited by physical, economical, and medical considerations: Increasing gradient strength is technically difficult, it is associated with significant hardware costs, and goes along with the risk to induce unwanted side effects such as peripheral neuro-stimulation. With the advent of parallel imaging techniques like SENSE, this dilemma can be overcome. The SENSE-mediated reduction of acquisition time can be invested in different ways: To improve spatial resolution at a given imaging time, or as well cut down acquisition time at a given spatial resolution; further, it can be used to reduce echo time in order to avoid susceptibility artifacts. For abdominal MRI, we combine SENSE with all existing pulse sequence protocols. It is used to shorten breathhold times – which proves particularly useful in sick patients who cannot hold their breath for an extended period, e.g. in patients with liver cirrhosis / portal hypertension and ascites. In dynamic contrast-enhanced studies e.g. for liver protocols, we use SENSE to double spatial resolution at a given (short) breathhold time. The gain in resolution enables assessment of the morphologic pattern of liver lesions like the lobulated appearance of haemangiomas which is helpful in differential diagnosis. In abdominal MRA spatial resolution can be increased without compromise of the acquisition time. This does not only result in a better depiction of small peripheral vessels but it will improve the reliability of qualitative measurements of stenotic vessel segments.
Because SAR increases with the square of field strength, SAR limitations became an important issue in high field abdominal imaging. Especially T2 weighted turbo -/ or fast spin echo sequences which are the backbone of abdominal MRI are decelerated. To overcome this restrictions technical solutions which reduces the energy deposition are mandatory. One approach is the flip angle reduction of the refocusing pulses known as Hyperecho or Flip Angle Sweep (FAS). A second way is reducing the number of refocusing pulses with parallel imaging techniques. In contrast to 1.5T the SNR reduction due to parallel imaging is at least compensated at higher field strength e.g. at 3T. Of

course both methods could be combined giving the opportunity to choose between going for high resolution or speed. As an example pelvic studies can be performed with a true matrix of 800 reconstructed to 1024 (29 slices) prolonging acquisition time by only three minutes compared to the standard 512 Matrix. Even if this may not result in the detection of additional pathologies it increases the diagnostic confidence and reduces chemical shift artifacts. On the other hand the signal gain at 3T allows the combination of high acceleration factors in parallel imaging with Flip Angle Sweep and half fourier techniques without relevant loss of image quality. T2 weighted imaging can be preformed in 39 seconds maintaining the “standard” spatial resolution (512^2 Matrix, 4mm slice thickness). With a slight decrease in image quality acquisition time can be further reduced to 19 seconds.

For breast imaging it is crucial to combine a high spatial resolution for the assessments of the morphological pattern of breast lesions like spiculae or internal septations and a high temporal resolution in dynamic contrast enhanced imaging to calculate a reliable time – intensity curve which contains important information for lesion characterization.

Parallel imaging is the first technique that holds promise to replace the currently used „dinosaur“ plain gradient echo pulse sequence that has been in use for the last 10 years. The reason is that all other „fast“ imaging applications such as Turbo Spin or Gradient Echo imaging, EPI, Half Fourier Imaging, keyhole imaging and so forth all were associated with a substantial change of lesion contrast enhancement characteristics. SENSE, however, does not change image contrast and seems to be useful to considerably improve the spatial and/or temporal resolution of dynamic breast MR imaging.