CLINICAL NEUROIMAGING

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Clinical experience with parallel imaging techniques (in our case SENSE) is of course based on the availability of SENSE capable coils. The capability of parallel imaging is increasingly incorporated in coil design thus a broad field of applications could benefit from parallel imaging techniques.

Several different techniques for parallel imaging have been proposed by different MR system vendors (ASSET, IPAT, SENSE); they currently allow a reduction of phase encoding steps by a reduction factor of 2 to 6 (and recently even higher). The drawback of decreased SNR by parallel imaging techniques is compensated at high field imaging at 3T due to the signal gain given by the increased field strength.

The SENSE-mediated reduction of acquisition time can be traded for improved temporal or spatial resolution of any given pulse sequence, without change of image contrast.

In neuro-imaging, SENSE is used to reduce image acquisition time in the setting of acute stroke. In a systematic intra-individual comparative analysis of SENSE versus Non-SENSE neuro-imaging at 1.5T, we found that in spite of a reduced numeric SNR, image contrast, lesion conspicuity and image quality were equivalent in SENSE and conventional, non-SENSE images. It is questionable if a further increase in in-plane resolution will add diagnostic value but the possibility to reduce slice thickness without an increase in acquisition time will be at least helpful e.g. for the detection of epileptogenic foci which often originates in subtle cortical dysplasia masked by partial volume averaging effects in “thick-slice” imaging. 3D T1 FFE datasets with an isotropic voxel size of $1mm^3$ and 150 slices took only 2:30 minutes applying a SENSE factor of 3.4. Furthermore this dataset is suitable for orthogonal and curved MPR and different types of postprocessing.

T2 weighted TSE images at 3T are hampered by SAR limitations. Parallel imaging techniques helps reduce RF deposition (regular phase encoding requires an RF puls for every step) – this proves extremely helpful for high field imaging, where, due to the higher SAR (specific absorption rate), most pulse sequences need to be “slowed down” to avoid excessive heating of the patient. Only with parallel imaging like

SENSE and variations of the refocusing pulses, the actual high-field SNR advantage can be fully exploited. The combination of this techniques allows to obtain T2 weighted TSE images of the whole brain in about 10 seconds.

Several effects at 3T result in substantial improvement of Inflow (or TOF) MRA compared to 1.5T. Time constraints limits the anatomic coverage to the circle of willis. In the “non-SENSE” setting 100 slices (thickness 0.5mm) take 7:50 minutes while 150 slices with SENSE can be obtained in 5:30 minutes including the cerebellar arterial blood supply.

The use of a novel keyhole technique (CENTRA-Keyhole) in combination with SENSE allows a time resolved contrast enhanced MRA of the whole brain with a temporal resolution of one 3D dataset per second remaining a high spatial resolution.

In addition to the mere increase of image acquisition speed, the reduction of phase-encoding steps brings about two further advantages that are particularly, but not only, important for high field MRI: First, in single-shot EPI applications that are usually used for e.g. Diffusion Imaging, Diffusion Tensor Imaging or for functional BOLD-contrast MR studies, SENSE helps to shorten the echo train length in proportion to the reduction factor. The considerably shorter echo train reduces the accumulation of phase errors during the EPI readout and, accordingly, reduces susceptibility effects like image distortions and blurring. In addition, the shorter echo train translates into a significantly higher SNR compared to sequentially phase encoding.

SENSE diffusion imaging can be used to considerably improve image quality in particular in patients with suspected medullar, fronto-basal or temporobasal ischemia. and improves diagnostic confidence.

Combined with PRESTO perfusion imaging, SENSE is applied to double the temporal resolution, thus improving the signal intensity curve fit and, accordingly, the accuracy of derived parametric images (e.g., TTP, T0, rCBV). In addition, SENSE-enhanced PRESTO MRI can be used for functional brain imaging studies that require a high temporal resolution, in particular all event-related paradigms.