Phased Array 1H-Spectroscopy with a 32 Channel Head Coil at 3T – a new possibility to increase spatial or temporal resolution

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Introduction

In proton spectroscopy the scan time is often dictated by the need to get sufficient Signal to Noise Ratio (SNR) in the data for a proper evaluation. Therefore it is attractive to realize a higher SNR with hardware improvements. Phased array coils are one possibility to get more signal [1,2], whereby an increased number of coils leads to higher SNR values, particularly in regions close to the array elements. In this work a dedicated 32 Channel Head Coil is used to acquire the signals from human brains. The aim of this study is to investigate the gain in SNR with this coil and the opportunities provided by this gain.

Methods

The phased array measurements were performed on 3T whole body system (MAGNETOM Trio, Siemens, Germany) with ‚Tim'-technology. The system was equipped with a 32 channel receive system.

The receive-only head coil consists of 32 circular surface coils arranged on a close-fitting helmet modeled after the European head standard form EN960/1994 for protective headgear and is 629mm in circumference, 222mm maximum in AP, 181mm in RL, and 210mm in SI (Figure 1). There are 26 coils of approximately 8 cm diameter and 6 coils of approximately 6 cm diameter arranged in a geodesic tiling over the dome of the head. Preamplifier decoupling was used to reduce interactions between the coil elements in addition to nulling mutual inductance between nearest neighbors with the coil overlap. A protective cover prevented the volunteer to access the wires during scanning.

For comparison additional measurements were performed with a 8 Channel Head Coil.

The spectroscopy measurements were performed with Spin-Echo SVS- or CSI-sequences (TE = 30 – 300 ms). To achieve shorter measurement times acquisition weighting was used for the CSI measurements.

The coherent combination of the signals from the different receive coils was performed in a phase sensitive mode by weighting the signals by complex factors $W_i(r)$. Optimal SNR is obtained if $|W_i|$ is set to the local reception sensitivity [1]. Additionally the 3D FLASH reference images, obtained from the phased array coil and the body coil, were used to normalize the signal intensities to the homogeneous body coil reception profile.

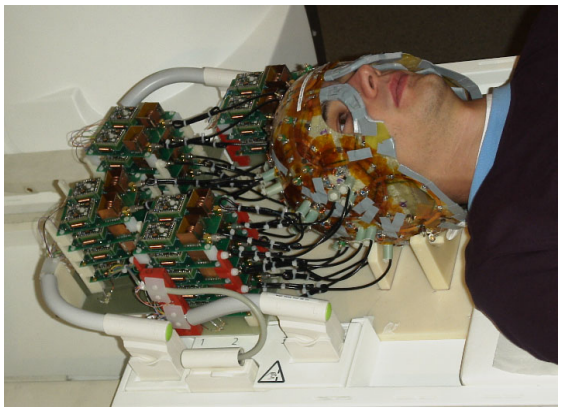

Fig.1: 32-Channel-Head-Coil (without cover)

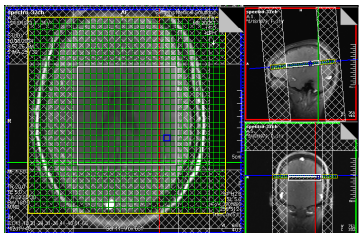

Fig.2: Reference Images for CSI scan

Results and Discussion

A substantial increase in SNR is visible in the acquired spectra. The comparison with the 8 Channel Head Coil already shows a SNR increase of 40% in the shown voxel, which has a distance of 3 cm to the skull. This is a result of the increased number of coil elements but also the very close proximity of these coil elements to the head compared to the 8 Channel Head Coil. The different sizes of the two coils lead to a SNR advantage of the 32 channel coil of 15% in the middle of the coil. CSI measurements (FOV 160mm, matrix 20x20, slice thickness 10mm, TR 1500, TE 30, NA 1, elliptical k-space weighting, TA 6:20min) with nominal voxel sizes of only 0.64cc show a superb SNR (Figure 3), which allows the application of even faster acquisition techniques with less SNR per unit acquisition time.

In conclusion the use of phased array coils with a high number of elements has the potential to perform 1H spectroscopy with higher temporal or spatial resolution.

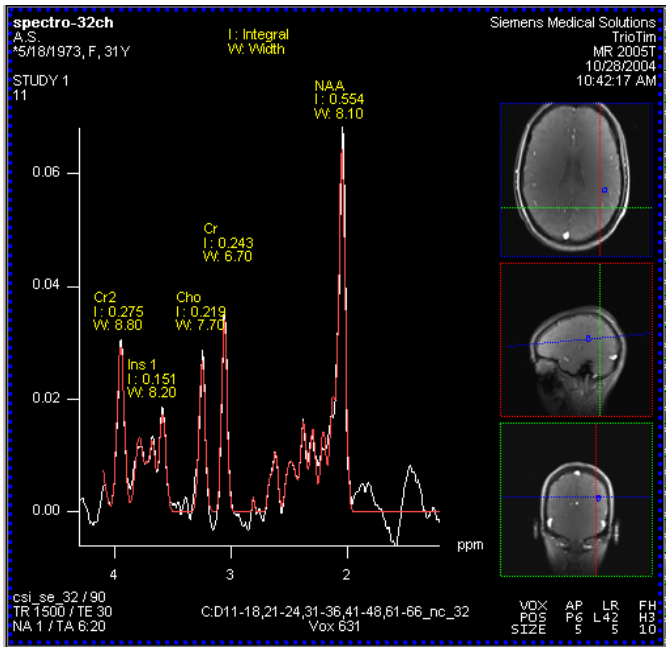

Fig.3: Spectrum of indicated voxel

References

1. Roemer et al.; MRM, 1990, 16: 192-225
2. Wright, Wald; NMR Biomed. 1997 Dec, 10(8): 394-410