MODIFIED 30 CHANNEL HEAD COIL

Coil design

AMI centre's standard 32 channel head coil has two parts: anterior (HEA) and posterior (HEP). The posterior (or lower) part of the helmet has 20 receive coil elements whereas the anterior (or upper) part of the helmet comes with 12 receive coil elements (Figure 1). However, two of the coil elements in the anterior part and their plastic housing surround the subject's eyes and limit the binocular field of view (Figure 2).

In order to provide an open binocular field of view, AMI centre ordered a new customized head coil in which the obstructing coil elements and their plastic housing have been removed (Figure 3). The new modified 30 channel head coil has exactly the same posterior part as the standard 32 channel head coil with 20 receive coil elements, only the anterior part has been modified. In other words, the anterior part of the modified head coil has now 10 coil elements instead of 12 (removed coil elements in Figure 1).

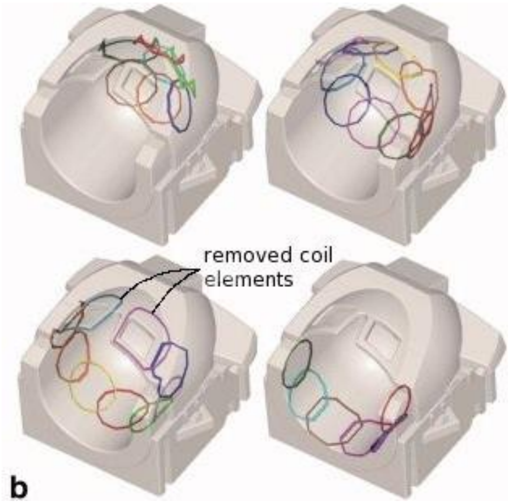

Figure 1: 32 channel head coil with 20 receive coil elements in the posterior part and 12 elements in the anterior part. Source: DOI:10.1002/jmri.22614

Figure 2: Siemens 32 channel head coil.

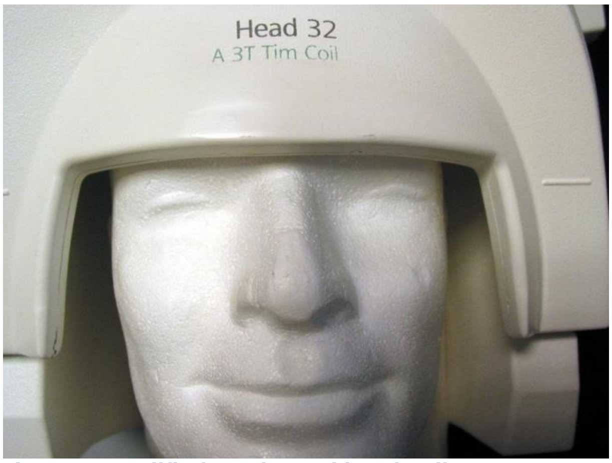

Figure 3: Modified 30 channel head coil.

Performance

The removal of the coil elements may come at the cost of signal loss depending on which part of the brain is being studied. We compared the performance of the standard 32 channel head coil and the modified 30 channel head coil by testing standard imaging sequences, namely

- Standard localizer
- Proton density weighted gradient echo
- T1-weighted 3D anatomical (MP-RAGE)
- Diffusion tensor imaging
- Echo planar imaging (GRE-EPI)

Proton density weighted images

The signal intensity of the proton density weighted images were compared and the relative intensities were overlaid on the anatomical image. These resuls show that signal was lost only in the close vicinity of the missing coils in the frontal lobe whereas in other parts of the brain, the signal was preserved (Figure 4).

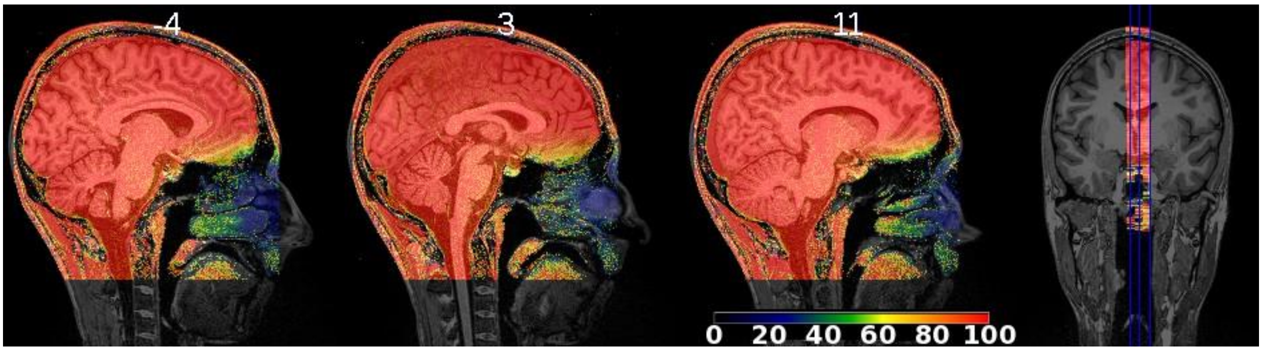

Figure 4: Comparison of the head coils: 30ch vs. 32ch. Proton density weighted images were acquired by using the 30ch and 32ch head coil and after normalization, the former images were divided by the latter ones yielding the procentual signal intensity (100 meaning equal performance). The relative intensity maps have been overlaid on a T1-weighted anatomical image.

Echo planar imaging

Figure 5 and Figure 6 show temporal SNR for the 32 and 30 channel head coils, respectively (tSNR is obtained from the GRE-EPI time series by dividing the voxel wise mean by the voxel wise standard deviation). Average tSNR inside the red ellipse VOI shown in Figure 5 was found to decrease by 9 percent.

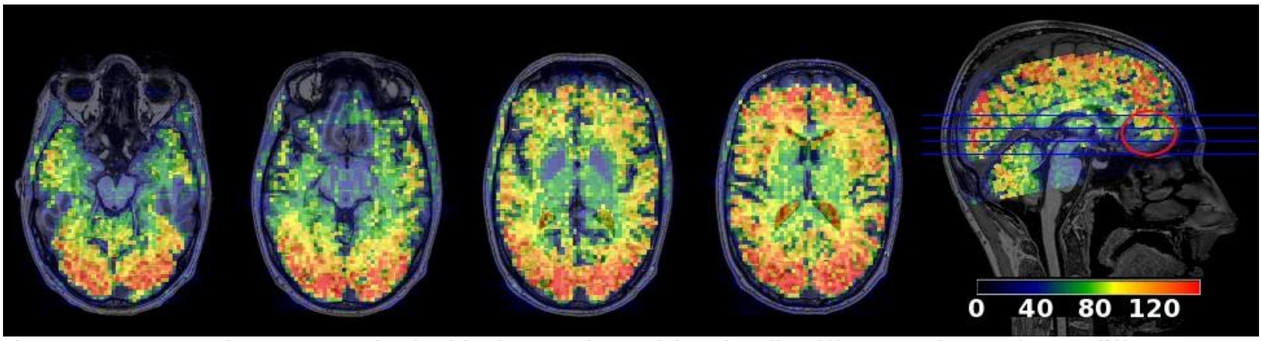

Figure 5: GRE-EPI images acquired with the 32 channel head coil. Different colors refer to different tSNR values (see the colorbar).

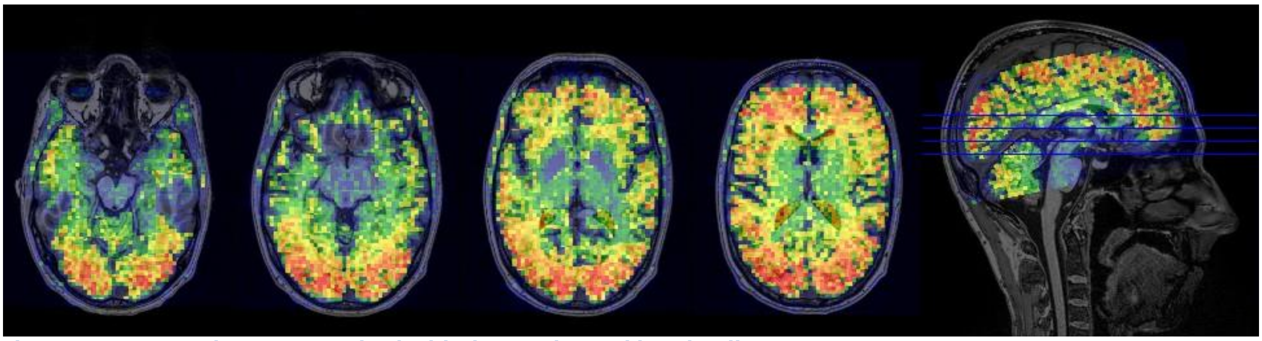
Figure 6: GRE-EPI images acquired with the 30 channel head coil.

Table 1 shows mean values and standard deviation of several different VOIs (volume of interest) plotted on the tSNR GRE-EPI images (Figure 5 and Figure 6). The location of the VOIs are shown in Figure 7. Significant signal losses were observed only some parts of the frontal lobe.

Table 1: Analysis of the tSNR within VOIs (volume of interest) whose location is shown in Figure 7.

	tSNR 32ch head coil				tSNR 30 ch head coild			
VOI	**mean**	**SD**	**SEM**		**mean**	**SD**	**SEM**	**%difference**
A	101.02	27.37	2.84		111.14	32.15	3.33	10.02
B	64.67	29.37	4.11		55.27	23.52	3.29	-14.52
C	112.76	40.03	3.67		111.56	35.67	3.27	-1.06
D	117.73	28.71	2.98		121.33	29.34	3.04	3.06
E	109.19	29.73	3.26		120.47	29.54	3.24	10.33
F	129.35	31.8	3.83		137.33	35.97	4.33	6.17
G	56.72	37.78	3.19		51.64	34.83	2.94	-8.97
H	102.91	30.55	3.68		113.78	31.27	3.76	10.56
I	125.02	25.27	2.62		135.29	27.23	2.82	8.21
J	52.94	17.77	1.95		53.73	17.79	1.95	1.5
K	65.59	19.11	2.3		71.62	22.74	2.74	9.19
L	53.71	23.55	2.16		56.08	23	2.11	4.43

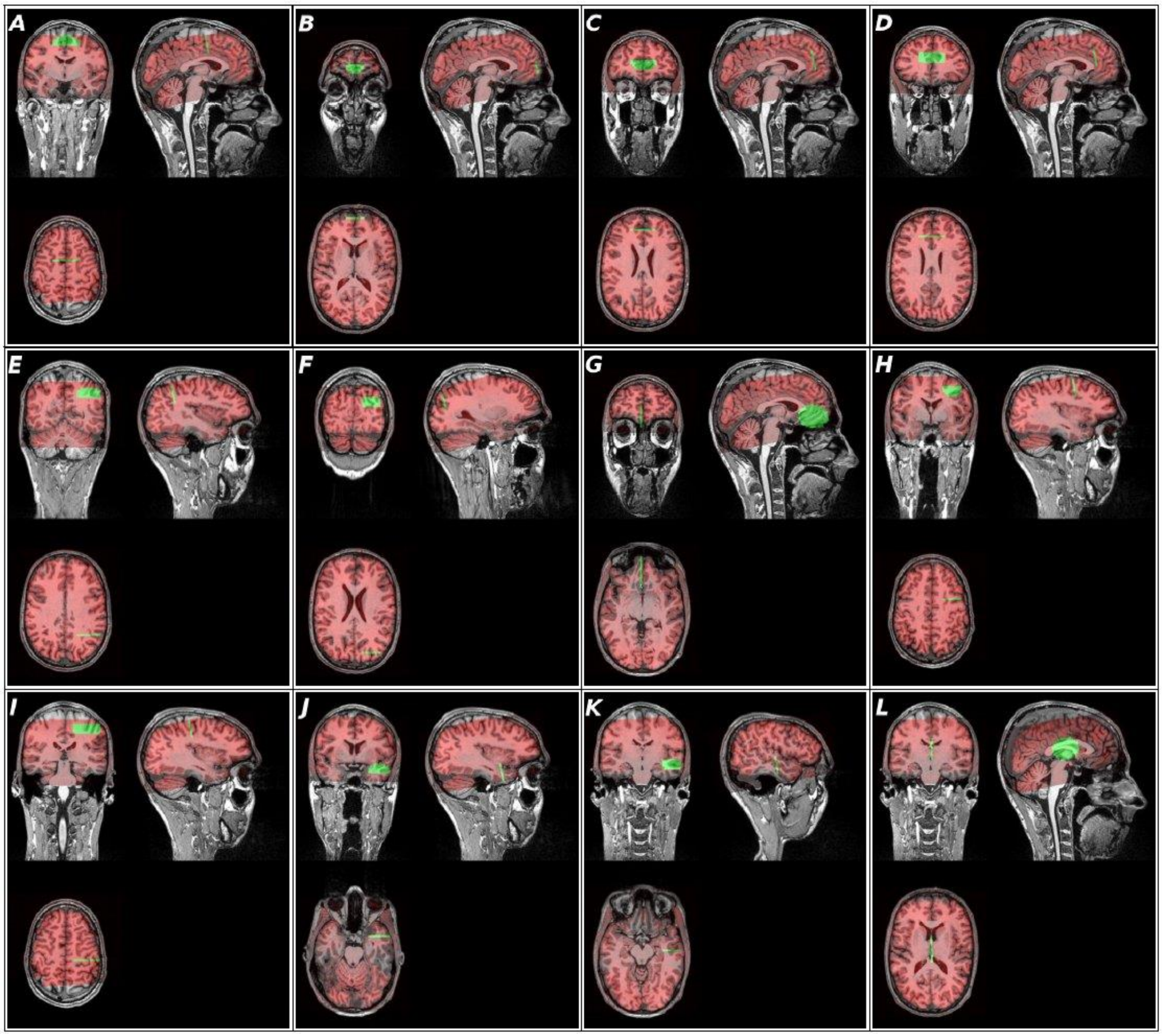

Figure 7: Volumes of interest (from A to L) are show in green, the GRE-EPI images in red and the anatomical images in grayscale.

Diffusion tensor imaging

Figure 8 and Figure 9 show fractional anisotropy maps acquired by using the 32 channel and the 30 channel head coils, respectively. Images do not show any significant signal loss. Tractography analysis was performed on a seeded ROI that was placed in close proximity to the genu of the corpus callosum which is located rather close to the missing coil elements. Tractography results did not show significant differences between the 32 channel and 30 channel head coils (Figure 10 and Figure 11).

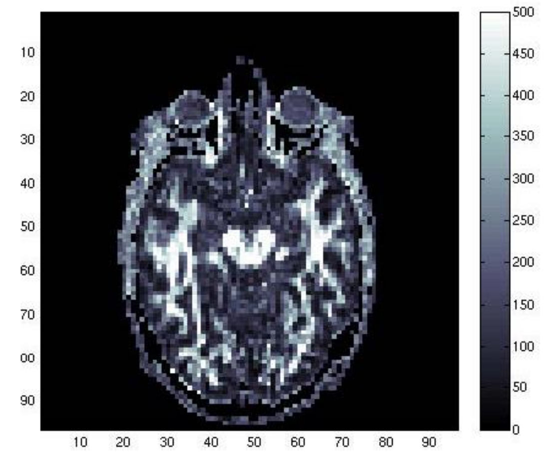

Figure 8: FA map (32ch head coil)

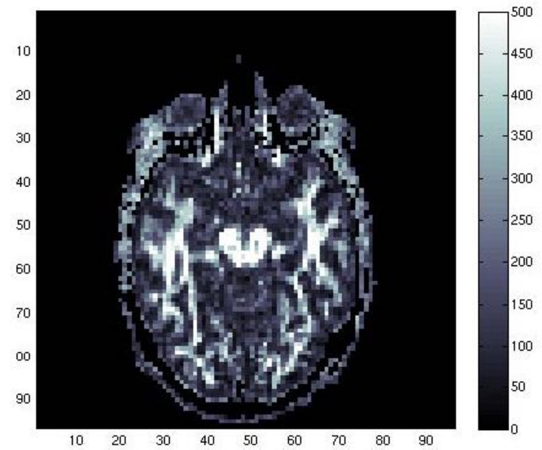

Figure 9: FA map (30ch head coil)

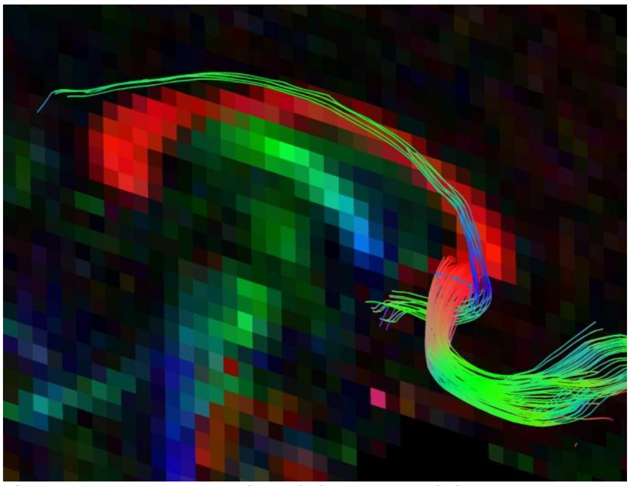

Figure 10: Tractography of the genu of the corpus callosum (32ch head coil).

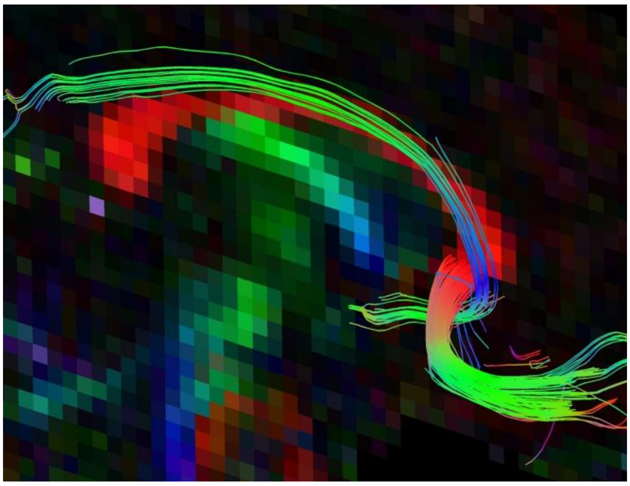

Figure 11: Tractography of the genu of the corpus callosum (30ch head coil).

Anatomical images (MP-RAGE)

Anatomical images are compared in Figure 12. Signal loss is clearly visible next to subject's nose whereas other parts of the subject's head mainly retain their signal intensity. Here we have used a so-called prescan normalize option (very commonly used) which means that the scanner acquires a preliminary homogenization scan before the actual measurement. This scan is used to correct for signal intensity decays caused by the coil profiles and could explain why the two head coils seem to have equal performance.

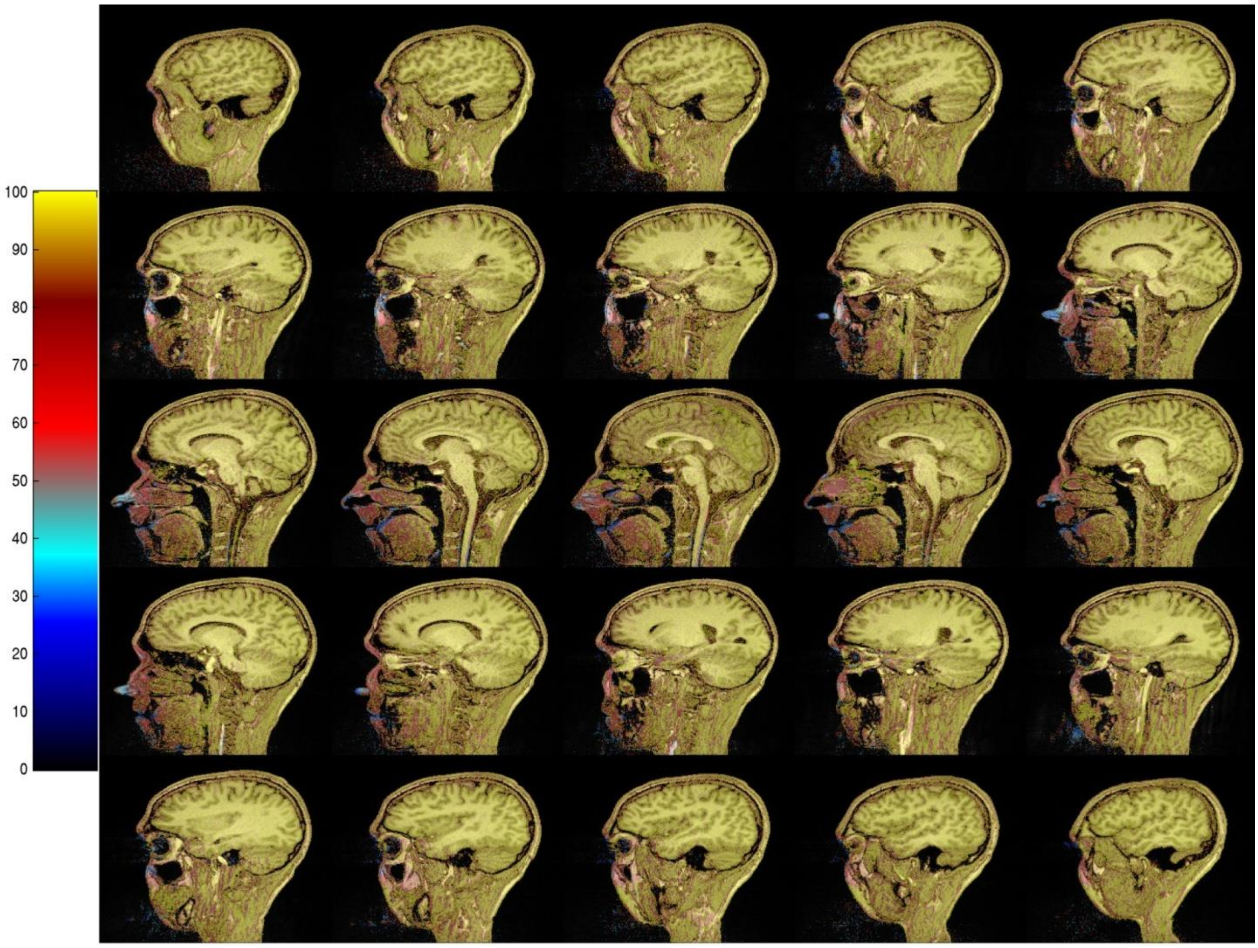

Figure 12: Comparison of the head coils: 30ch vs. 32ch. T1 weighted images were acquired using the 30ch and 32ch head coil and after normalization, the former images were divided by the latter ones yielding the procentual signal intensity (100 meaning equal performance). The relative intensity maps have been overlaid on a T1 weighted anatomical image.

Remarks

- The new modified 30 channel head coil offers a free binocular field of view.
- The performance of the modified head coil was tested and compared with the standard 32 channel head coil. Signal losses were found next to the missing coil elements in the frontal lobe whereas in other parts of the brain, the signal was preserved.
- The new head coil is especially useful for vision studies whereas studies which concentrate to the frontal lobe (e.g. orbitofrontal cortex) may suffer from signal loss (as compared to the standard 32 channel head coil). In the latter case, the signal losses can be minimized by positioning the subject so that his/her pate is touching the far end of the head coil.
- The new modified head coil works exactly the same way as the standard 32 channel head coil which means that you can use the same protocols for these two coils.