Comprehensive Neurovascular Evaluation Using an Automatic Optimal SNR-based Channel Combination from a 62 Element Coil Array at 3T

A. Pednekar[1], C. Arena[2], G. Wilson[3], C. Possanzini[4], C. Saylor[2], and R. Muthupillai[2]
[1]Philips Healthcare, Houston, Texas, United States, [2]Diagnostic and Interventional Radiology, St. Luke's Episcopal Hospital, Houston, Texas, United States, [3]Philips Healthcare, Cleveland, United States, [4]Philips Healthcare, Best, Netherlands

Introduction: The rapid growth of multi-channel surface coils with large number of independent coil elements has contributed to a significant increase in signal-to-noise ratios (SNRs) and increased anatomic coverage for a variety of applications. In, MR imaging coil arrays are designed with self-competing goals: 1) large element coil arrays to cover larger anatomic region to minimize repeated patient positioning within an exam; and 2) dedicated small element coil arrays over a small region of interest to increase local SNR to image smaller anatomic structures. Such a conflicting design demands can be addressed with coils with combination of larger and smaller elements to provide global coverage without sacrificing local SNR. However, availability of the large number of coil elements presents two challenges: 1) careful manual selection of coil elements for imaging small regions of interest; and 2) computational and memory burden while processing data from a large set of independent elements. Manual selection of coil element is tedious and operator dependent. In this abstract, we describe our clinical experience with a 62 element/channel neurovascular coil array that within a single coil positioning setup provides high-resolution coverage of the entire neurovascular tree (from aortic arch to intracranial vessels, 30cm), as well as dedicated high-resolution vessel wall imaging of the carotid arteries. The Automatic optimal SNR-based channel combination relieves the operator of careful coil selection task and also compresses the number of elements used for imaging a given region of interest [1].

Materials and Methods: Five subjects (5 male, 42 ± 6 yrs) were imaged on a wide aperture (70cm) 3T (Ingenia, Philips Healthcare) system equipped with two independent RF transmit channels using a 62 element/channel neurovascular receive coil array, with VCG gating. All subjects provided written informed consent. The receive coil array consisted of 32 elements covering the entire head, 6 posterior elements covering the neck and shoulders, 16 thoracic anterior elements and 8 dedicated elements for the carotids.

Parameter	3D ToF Head	3D ToF Neck	3D ToF Aortic Arch	Multi-slice DIR T_2W^*	Multi-slice DIR PDW*
Acqd. Voxel (mm^3)	0.5x0.9x1.6	0.5x0.5x2	0.5x0.75x2	0.55x0.55x2	0.55x0.55x2
Recon. Voxel (mm^3)	0.4x0.4x0.8	0.25x0.25x1	0.5x0.5x1	0.32x0.32x1	0.32x0.32x1
TR(ms)/TE(ms)/Flip°	20/3.45/15	20/3.45/25	20/3.45/20	>4000 (4 beats)/50/90	>4000 (4 beats)/9/90
Coverage (mm^3)	180x180x48	180x136x100	180x248x150	140x140x32	140x140x32
SENSE/Partial Fourier	RL=2.5 / 1	AP=3 / 0.625	AP=2 / 0.625	1/1	1/1
Scan Time	1min 4s	2min 24s	4min 24s	3min 30s	3min 30s

*Table 1: MRI acquisition parameters for the high-resolution time of flight (ToF) survey and high-resolution vessel wall imaging are shown above. *Note: The high-resolution Multi-Slice dual inversion recovery (DIR) prepared T_2 weighted (T_2W) and proton density weighted (PDW) black blood vessel wall images are acquired twice, once with manual selection of 8-element carotid elements only, and once with automatic optimal selection of the 62 element coil array based on the local SNR. Each multi-slice DIR scan had two dynamics, where second dynamic was a noise scan with identical acquisition parameters with gradients and RF turned off.*

<u>Data Analysis:</u> The coil elements automatically selected by the system for each stack were noted. The local SNR was computed over the regions-of-interests drawn on the skeletal muscle adjacent to carotid artery at the level of bifurcation using noise scan.

Results: The entire neurovascular tree from the aortic arch to the intra-cranial vessels (300mm) was well visualized in all subjects using the multi-stack, multi-chunk 3D ToF approach (Fig. 1). The automatically selected coil elements based on the optimal local SNR are listed in Table 2.

Stack / Elements	32 Head	6 Posterior Neck	8 Carotid	16 Thoracic Anterior	Total
Head	32	1±1	7±1	0	40±2
Neck	26±1	4±1	8	3±1	41±2
Aortic Arch	20±2	4±1	8	4±1	36±3

Table 2: The optimal SNR-based automatic coil element selection chose 40±2 elements for the head stack, 41±2 elements for the Neck stack, and 36±3 for the aortic arch based on the individual patient body habitus. Representative T_2W and PDW Multi-Slice DIR black blood images at the level of the carotid bifurcation are shown in Fig.2. The SNR analysis comparing the manual choice of carotid coil elements only against the automatic optimal SNR based coil element selection showed that there wasn't a significant difference in SNR for skeletal muscle (~4%). Thus local SNR in close proximity of the dedicated carotid coils was optimized without any operator intervention.

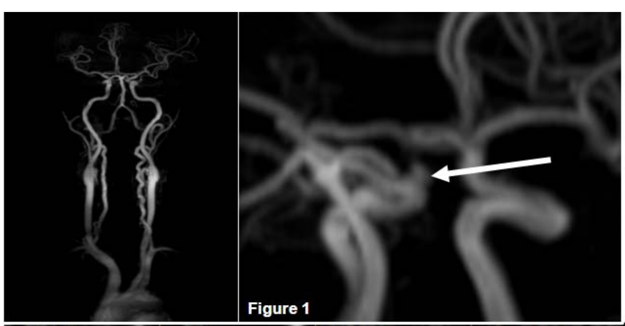

Figure 1: High-resolution survey of the entire neurovascular tree (left), and note the visualization of a small aneurysm in the intra-cranial circulation (arrow);

Figure 2: The effectiveness of automated SNR based coil element selection for high-resolution vessel wall imaging is shown. Compare the closeness of image quality with auto-coil selection (left panels) with manual coil selection (right panels), for PDW and T2W vessel wall imaging.

Conclusions: The results from the study suggest the following:

(a) It is feasible to obtain a high resolution 3D-ToF images of the entire neuro-vascular tree from the aortic arch to the intra-cranial vessels (< 8 min), as well as targeted high-resolution carotid vessel wall imaging (< 7 min) using a 62 element coil array without operator intervention;

(b) Automated selection of coil elements using SNR contribution to the region of interest performed just as well as manual selection of dedicated coil elements; and

(c) Diverse demands of spatial coverage as well as optimal local SNR over a small region of interest can be effectively met by a combination of large number of elements and automatic optimal SNR-based coil element selection.

References: 1. MRM 57:1131-1139 (2007).