32-Channel Head Coil Imaging at 3T Case Reports from Scott and White Clinic and Hospital

Val M. Runge, M.D.

Robert and Alma Moreton Centennial Chair in Radiology, Texas A&M University Health Science Center, Temple, Texas, USA

Advanced head coil design with 3T imaging substantially improves the available signal-to-noise ratio (SNR), making possible a substantial reduction in scan time, the use of advanced parallel imaging, high spatial resolution imaging (reduced voxel size in 3D acquisitions, whether for imaging of the brain itself or the vasculature) and implementation of innovative imaging techniques. The use of higher parallel imaging factors in conventional diffusion-weighted echo planar imaging (EPI), together with the implementation of a turbo spin echo (TSE) based BLADE diffusion-weighted scan is illustrated in patients with acute infarction (the latter free of bulk susceptibility artifact and geometric image distortion). With T1-weighted imaging, the 32-channel coil design permits a factor of two reduction in scan time for 2D imaging, and enables the use of a T1-weighted TurboFLASH BLADE technique for motion robust imaging and, alternatively, an ultra-high resolution 3D T1-weighted FLASH scan for more cooperative patients. High resolution, short scan time, 3D T2-weighted scans can also be acquired.

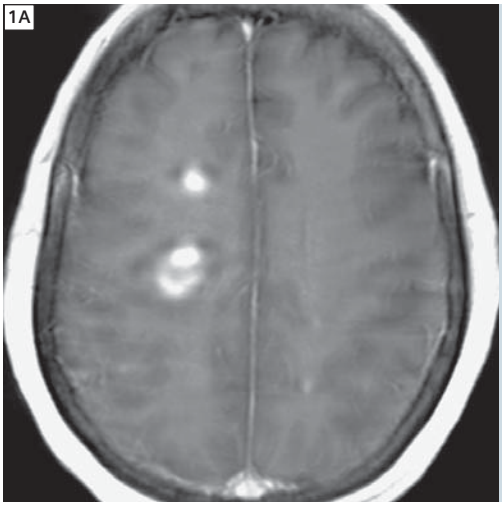
Case 1

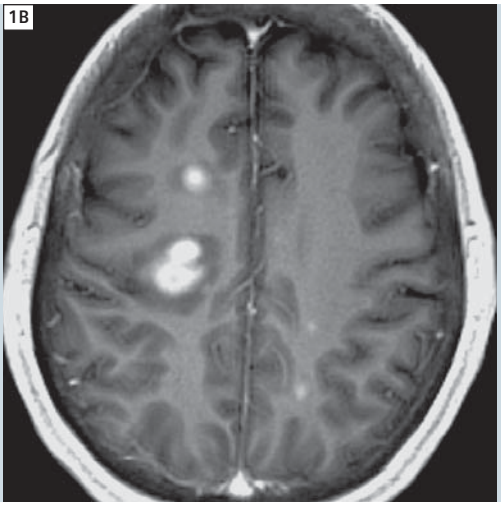
Patient history

This 46-year-old woman presented with relatively sudden onset of left upper extremity/hand weakness. Speech was minimally slurred.

Image findings

Two scans are illustrated, both acquired with the 32-channel coil, in a patient with enhancing (active) multiple sclerosis plaques. The first scan was obtained with a short TE T1-weighted 2D FLASH sequence, with voxel dimensions of 0.9 x 0.9 x 4 mm^3, which is substantially degraded (by image blurring) due to patient motion despite the very short scan time (0:56 min) made possible by use of the 32-channel coil. The second scan was obtained with a T1-weighted *syngo* BLADE TurboFLASH sequence, with equivalent voxel dimension, acquired in 2:45 min. Note the marked improvement in image quality on the BLADE scan, with elimination of the blurring noted in the first scan due to patient motion.





1A, B Post-contrast T1-weighted scans, acquired with slice thickness 4 mm, both using the 32-channel head coil and using 2D FLASH and 3D TurboFLASH respectively.
A: fl2d, TR 250 ms, TE 2.4 ms, FOV 192 x 220 mm^2, matrix 448 x 512 interpolated, bandwidth 320 Hz/pixel, flip angle 70°, 1 acquisition, TA 56 sec.
B: *syngo* BLADE t1w TurboFLASH*, TI 1166 ms, TR 3200 ms, TE 2.8 ms, FOV 230 mm, matrix 256 x 256, bandwidth 280 Hz/pixel, 1 acquisition, TA 48* 3 sec.

Case 2

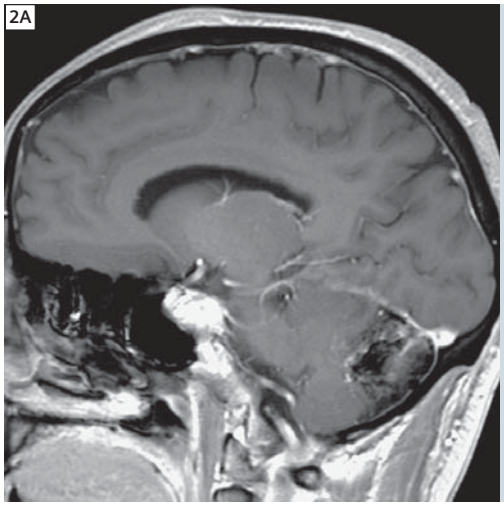
Patient history

This 56-year-old man presented with right facial pain (trigeminal distribution) and was subsequently found to have a right posterior fossa arteriovenous malformation. He underwent embolization by interventional radiology, with resultant marked decrease in size of the lesion and resolution of his facial pain. Imaging following this treatment revealed a marked decrease in size of the lesion, with the residual nidus measuring less than 2 cm.

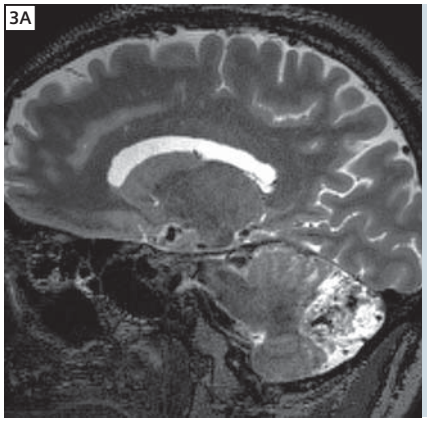
Image findings

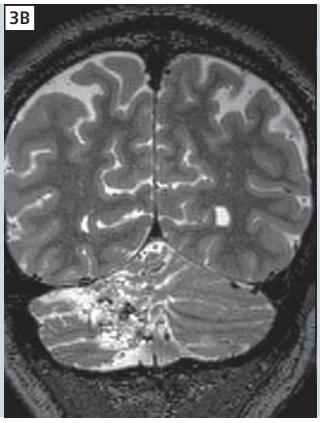
In Fig. 2, post-contrast T1-weighted scans are compared using the (A) 12 and (B) 32-channel coils. Image quality is equivalent, despite a two-fold reduction in scan time for (B) as opposed to (A), permitted by the use of the 32-channel coil. The low signal intensity noted within the cerebellum reflects predominantly the embolized portion of this lesion.

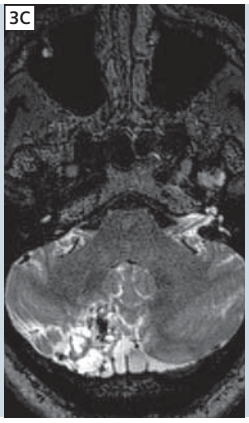
In Fig. 3A 0.9 x 0.9 x 0.9 mm^3 voxel size, 2:12 min acquisition time, 3D T2-weighted SPACE scan is illustrated, acquired with the 32-channel coil. This partially embolized, posterior fossa, arteriovenous malformation is well visualized, with high image quality on reformatted images in the (A) sagittal, (B) coronal, and (C) axial planes.



2A, B T1-weighted fl2d, TR 250 ms, TE 2.5 ms, FOV 220 mm, matrix 512 x 512 interpolated, slice thickness 4 mm, bandwidth 320 Hz/pixel, flip angle 70°. Comparing results obtained with **(A)** the 12-channel head coil using 2 averages (TA 2:08 min) to that obtained with **(B)** the 32-channel head coil using 1 average (TA 1:04 min).







3A, B, C T2-weighted SPACE, TR 3200 ms, TE 546 ms, 0.9 x 0.9 x 0.9 mm^3 voxel dimension, bandwidth 745 Hz/pixel, PAT 4, TA 2:12 min.

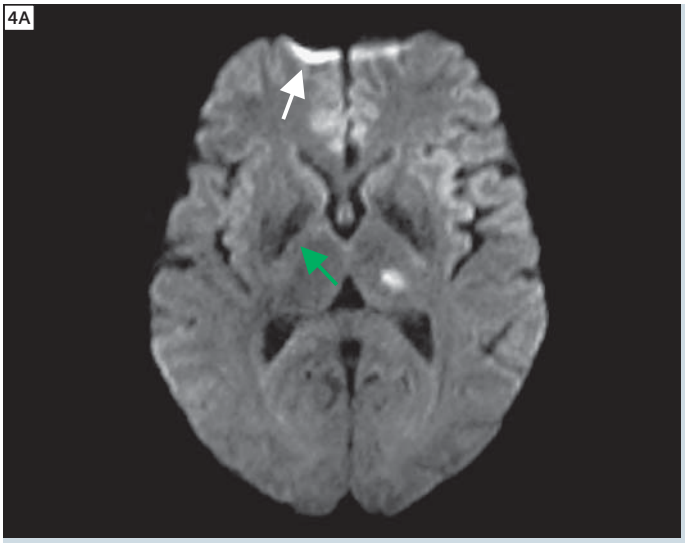
Case 3

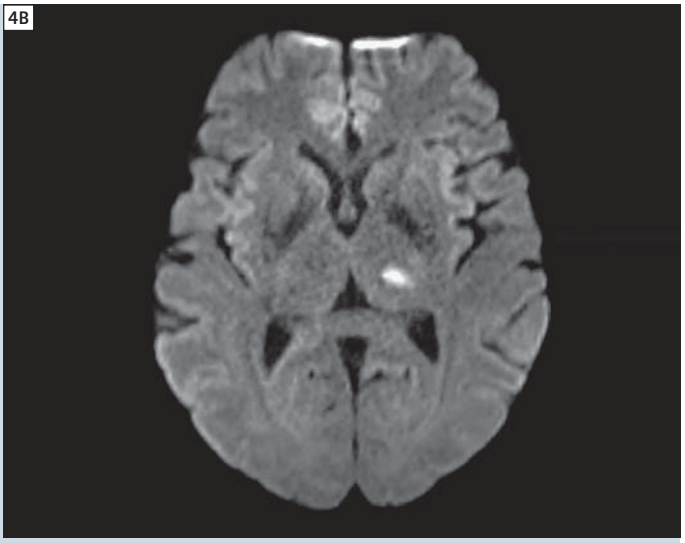
Patient history

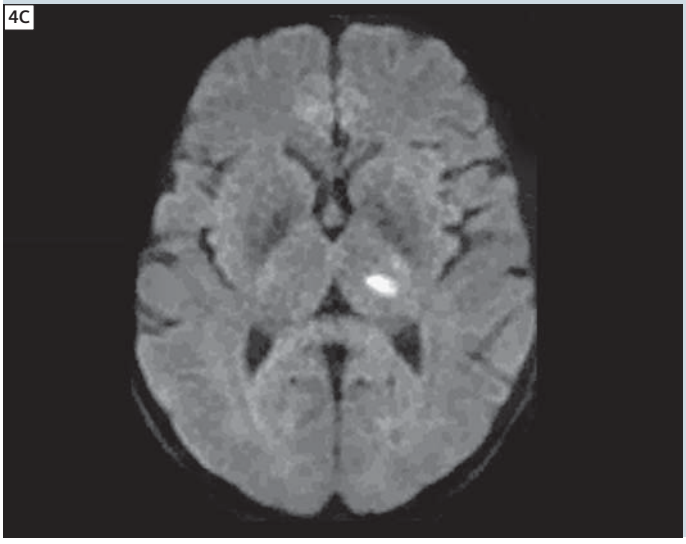
This 58-year-old woman presented to the hospital following three episodes of tingling/paresthesias involving her lips and right side of the body. She was noted during her hospital stay to have labile hypertension. Imaging revealed an early subacute left thalamic infarct.

Image findings

Bulk susceptibility artifact (white arrow) is reduced by increasing the PAT factor to 4 in (B) as compared to 2 in (A). Despite the increase in PAT factor, scan quality (specifically SNR) is maintained, due to the use of the 32-channel coil in (B) as opposed to the 12-channel coil in (A). Note the elimination of the bulk susceptibility artifact (seen in A, arrow, in this instance originating from the frontal sinus) using the BLADE TSE diffusion-weighted approach (C). This sequence has inherently lower SNR, with the 32-channel coil making this scan approach clinically viable. Note also the reduced T2* effect, in this instance due to normal hemosiderin content in the globus pallidus, with the BLADE TSE scan as opposed to the echo planar scan (green arrow). Hemorrhage will have less of a deleterious effect on BLADE TSE diffusion-weighted scans, a finding confirmed in early clinical experience.







4A–C Diffusion-weighted scans, all acquired with b=1000 s/mm², FOV 230 mm, matrix 192 x 192, slice thickness 4 mm.
A: Echo planar, TR 4100 ms, TE 92 ms, PAT 2, 12-channel head coil.
B: Echo planar, TR 4100 ms, TE 80 ms, PAT 4, 32-channel head coil.
C: *syngo* BLADE TSE DWI*, TR 4000 ms, TE 124 ms, PAT 2, 32-channel head coil.

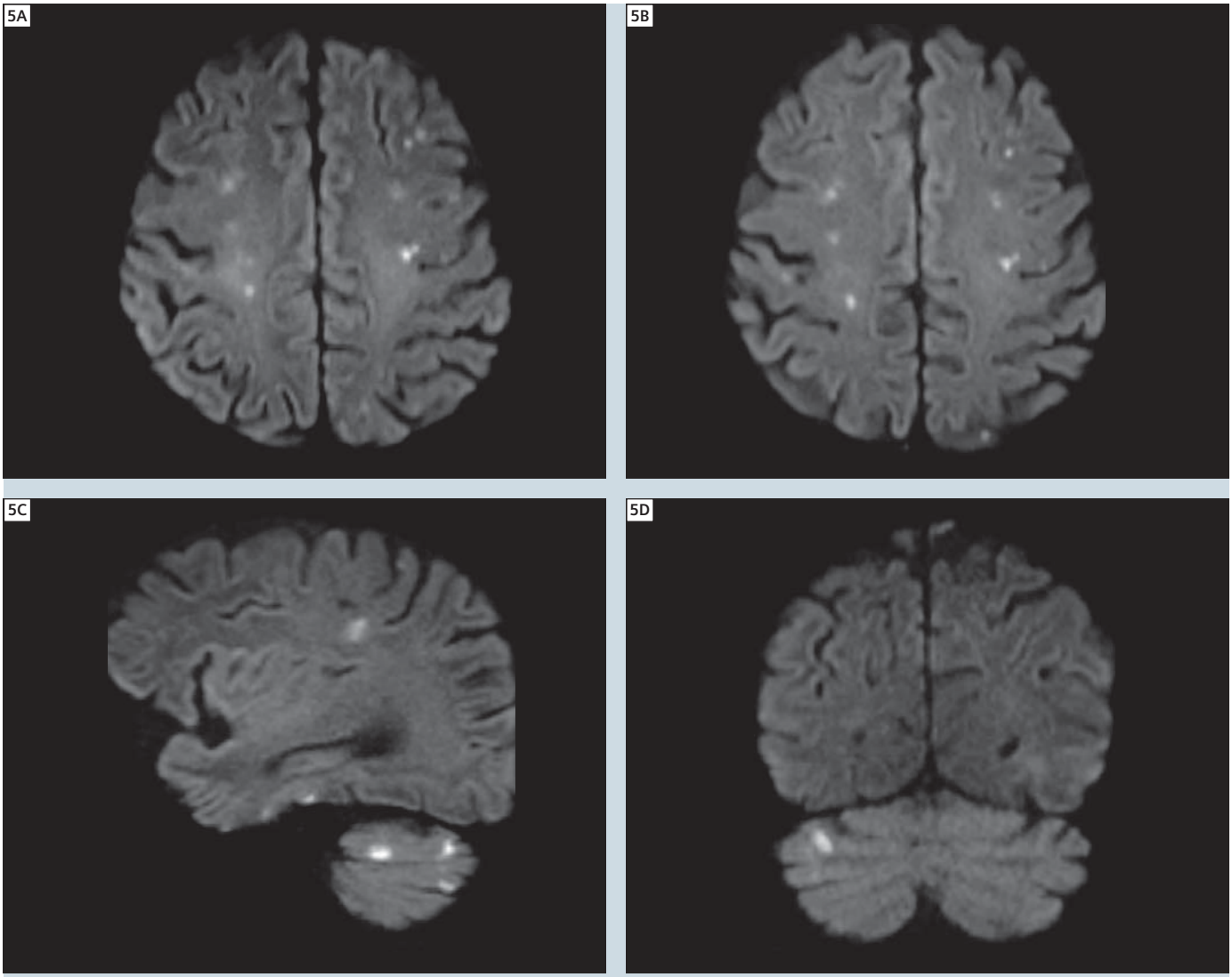
Case 4

Patient history

This 65-year-old man with stage IV pancreatic cancer presented for evaluation three days following a transient episode of aphasia, with right hand weakness that has since persisted. The leading diagnosis is embolic infarction from non-bacterial thrombotic endocarditis, with the primary risk factor being the known mucin-producing adenocarcinoma.

Image findings

Multiple punctate early subacute infarcts are illustrated. In (A), echo planar diffusion-weighted imaging was performed using the 12-channel coil and a PAT factor of 2. The capability of the 32-channel coil for higher PAT factors (without increasing the number of scan averages, and so prolonging scan time), and thus less bulk susceptibility artifact, in all planes is illustrated in figures B–D with PAT 4 scans in the axial, sagittal, and coronal planes.



5A–D Echo planar diffusion-weighted scans, all acquired with b=1000 s/mm², FOV 230 mm, matrix 192 x 192, slice thickness 4 mm.
A: TR 4100 ms, TE 92 ms, bandwidth 1240 Hz/pixel, PAT 2, 12-channel head coil.
C–D: TR 4100 ms, TE 80 ms, BW 1240 Hz/pixel, PAT 4, 32-channel head coil.

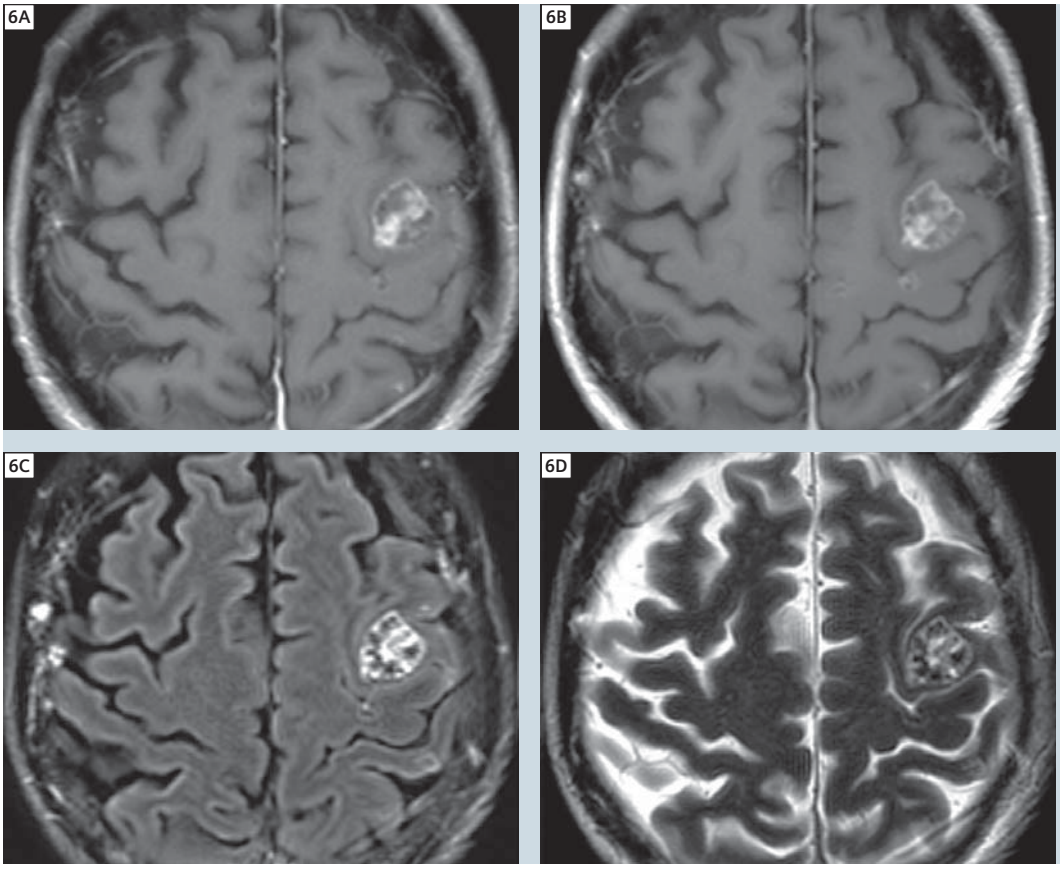
Case 5

Patient history

This 60-year-old woman has metastatic breast cancer, and has been treated with multiple chemotherapeutic regimens. She received whole brain radiation for brain metastases eleven months prior to the current MRI.

Image findings

Short TE 2D T1-weighted FLASH scans are presented, comparing a scan acquired (A) with the 12-channel coil in a 1:52 min scan time to that acquired (B) with the 32-channel coil in a 0:56 min scan time. Image quality is equivalent for depiction of the large enhancing parenchymal brain metastasis, as well as two smaller metastases. (C, D) FLAIR and T2-weighted 2D axial *syngo* BLADE scans are also illustrated, both acquired with the 32-channel coil. An iPAT (integrated Parallel Acquisition Technique) factor of 2 was used for both scans, with these scans typically performed when using the 12-channel coil without iPAT, leading to a two-fold reduction in scan time. In this instance, the scan times were 1:03*2 and 0:28* 2 min, with both scans providing whole brain coverage using a 4 mm slice thickness.



6A, B T1-weighted fl2d, TR 250 ms, TE 2.5 ms, FOV 193 x 220 mm², matrix 448 x 512 interpolated, slice thickness 4 mm, bandwidth 320 Hz/pixel, flip angle 70°. Comparing results obtained with (A) the 12-channel head coil using 2 averages (TA 1:52 min) to that obtained with (B) the 32-channel head coil using 1 average (TA 0:56 min).
C, D: 32-channel FLAIR axial imaging with *syngo* BLADE and T2-weighted TSE with *syngo* BLADE illustrating a reduction in scan time by half when compared to conventional imaging with the 12-channel coil.
C: FLAIR BLADE, TI 2500 ms, TR 9000 ms, TE 118 ms, FOV 220 mm, matrix 256 x 256, slice thickness 4 mm, bandwidth 290 Hz/pixel, ETL 33, PAT 2, TA 1:03*2.
D: T2-weighted BLADE, TR 3500 ms, TE 118 ms, FOV 220 mm, matrix 320 x 320, slice thickness 4 mm, bandwidth 290 Hz/pixel, PAT 2, TA 0:28*2.

*Work in progress (WIP). The information about this product is preliminary. The product is under development and not commercially a vailable in the U.S., and its future availability cannot be ensured.

Contact
Val M. Runge, M.D.
Scott and White Clinic and Hospital
Texas A&M University Health Science Center
Temple, TX, USA
val.runge@mac.com

→ **Visit www.siemens.com/magnetom-world** for the technical aspects of the 32-channel coil: "Highly Parallel Detection for MRI" by Lawrence L. Wald and Graham Wiggins. MAGNETOM Flash 38 (1/2008) page 34-44.