We have been using the 1.5T MAGNETOM Aera for a year now and it is perhaps time to reflect on how the system is performing in a busy environment. My experiences with the MAGNETOM Aera are summarized in this article.

Compared to our earlier 1.5T MAGNETOM Symphony a Tim system, MAGNETOM Aera’s new RF system – Tim 4G – introduces signal increase that is used to scan at higher resolution than before whilst keeping the same acquisition time or can be combined with parallel imaging for higher speed.

Section 1: fast brain imaging with Tim 4G and Dot

In our center we use eight sequences for brain evaluation in a 20-minute time slot that includes getting the patient in and out of the MRI suite. Figure 1 shows the details of the brain protocol we follow. The Brain Dot Engine helps us to acquire all brain examinations with consistent accurate coverage from the foramen magnum up to the vertex and from left to right or anteroposterior without fault, which is possible irrespective of the experience level of the operators. Moreover, Brain Dot Engine starts with an AutoAlign 3D localizer which is mapped to the Tailarach space, and as a result sequence planning is automated according to the reference space independent of patient positioning / habitus.

This is especially convenient in follow-up examinations, such as in this case of demyelinating disease or tumor, resulting in a more reliable and comfortable comparison of the examinations at different time points (Fig. 2).

1. Sequence details of our 20-minute brain evaluation:
   1. T2*w EPI, 23 slices, 5 mm in 9.7 sec, 0.9 x 0.9 x 5 (FOV 185 x 220, matrix 216 x 256) res
   2. T1w sag SE, 4 mm slices in 2:09 min, 0.7 x 0.7 x 4 (FOV 290 x 223, matrix 246 x 320) res
   3. T2w ax TSE, 25 slices, 4 mm in 01:34 min, 0.5 x 0.5 x 4 (FOV 171 x 221, matrix 256 x 384)
   4. T2w FLAIR, 23 slices, 5 mm in 32 sec x 2 0.8 x 0.8 x 5 (FOV 211 x 211, matrix 205 x 256)
   5. DWI EPI b50, b500, b1000, 69 slices in 1:30 min (1.2 x 1.2 x 5, FOV 216 x 231, matrix 174 x 188)
   6. 3D TOF 3 slabs, 116 slices in 2:44 min, 0.4 x 0.4 x 0.5 mm isotropic (FOV 141 x 181, matrix 376 x 512)
   7. T1w cor TSE, 22 4 mm slices in 1.34 min, 0.8 x 0.8 x 4 (FOV 174 x 200, matrix 213 x 256)
   8. T1w ax SE 22 4 mm slices in 2:34 min, 0.9 x 0.9 x 5 (FOV 174 x 200, matrix 213 x 256)
Section 2: 16-channel MSK coils

The new RF system enables the use of 16-channel MSK coils like the Shoulder, Foot/Ankle and Hand/Wrist coils. The new wrist coil gives abundant signal and superb detail. The wrist coil has grown, in fact, to a 16-channel hand-wrist coil (Fig. 3), which is quite convenient for both the patient and the operators and helps faster setup times. Many patients have combined hand/wrist pathology and symptoms, and extended coverage is a huge benefit. Since it is easy to position the hand in the Hand/Wrist coil, examining the fingers has become very straightforward. Figure 4 shows a young butcher who suffered from a deep wound in the index finger. You still can notice the susceptibility artifacts on the coronal STIR and GRE (Figs. 4D, E). One week later the young man can no longer flex the distal interphalangeal joint (DIP) of the index finger. MRI nicely depicts the torn deep flexor retracted to the proximal phalanx in the tendon sheet (Figs. 4H, I). All these images have an in-plane resolution of 0.5 mm, a slice thickness of 2.3 mm or less and scanning times of 1.30 min or less thanks to the higher signal from the high-channel coil.

Since this coil is so successful for fingers, it could also be used for toes. This is the flexibility with Tim. Figure 5 shows images of a middle-aged man, who suffers from a “tingling pain sensation” in the forefoot intermetatarsal space III-IV and numb feeling in digit IV. A T2 hyperintense, T1 hypointense dumbbell shaped lesion bulging between the metatarsal heads III-IV is clearly demonstrated (Figs. 5A, B, C) confirming the clinical suspicion of Morton neuroma.

Section 3: reduction of susceptibility artifacts caused by metal

MRI is challenging in the presence of metal. MAGNETOM Aera came equipped with syngo WARP with high bandwidth TSE and TSE STIR protocols and an
Superb details in a case of trauma to index finger in 1:30 min per sequence.
optional VAT (View Angle Tilting) technique. In Figures 6–8 I share some examples of real day-to-day cases. Figures 7 and 8 show images of a female patient who has had osteosynthesis for tibial plateau fracture following a skiing accident 20 years ago. She had an MRI of the knee, after another skiing accident. WARP helped reduce susceptibility artifacts for better image quality and confidence in diagnosis.

Section 4: faster imaging with CAIPIRINHA

CAIPIRINHA (Controlled Aliasing in Parallel Imaging Results in Higher Acceleration) is a new parallel imaging technique from Siemens. The new RF system and high channel coils (Body 18) provide the signal that is needed, whilst the parallel imaging with fourfold acceleration with CAIPIRINHA offers the speed required to maintain short breath-holds even at large coverage in the z-direction and thin slices. The short breath-holds are a real game changer especially in the case of elderly patients, but even young and fit patients benefit. No trade-off between thick slice / large coverage or thin slice / partial coverage is necessary: we always scan full coverage with thin slices. Examination of the abdo-
CAIPRINHA PAT4 in 10 sec compared to PAT2 in 21 sec with same slice thickness and inplane resolution.

With CAIPRINHA no trade-off between thick slice / large coverage or thin slice / partial coverage is necessary: we always scan full coverage with thin slices. The coverage is well seen in this screenshot (yellow dotted box top left, or yellow bold box top middle).
men and thorax benefits greatly from the Aera system. It all fits perfectly together. Here are some examples.

More signal in less scanning time!

Figure 9 demonstrates how, in a liver examination in the same patient examined with CAIPI4, the images with a breath-hold of 10 sec have more signal than the same images (same slice thickness and in-plane resolution) with iPAT2 and 21 sec breath-hold.

MRI examination of the thorax – although more rare – follows the same rules as the abdomen: sequences should be fast enough for the patient to cooperate. Figure 11 gives an example of a metastatic lung carcinoma where PET-CT was not able to exclude or confirm chest wall invasion. MRI was ordered and it turned out to be quite an easy job on MRI, having the short breath-hold CAIPR-INHA PAT 4 VIBE sequences. Even this patient, who clearly is in a bad condition,
cooperated and tolerated the exam well. Invasion in the lateral and dorsal chest wall is readily depicted in both axial and coronal enhanced images. Axial T2w BLADE and free breathing diffusion-weighted imaging (DWI) confirm the chest wall invasion with actual rib invasion and the malignant nature is clearly translated in low ADC values of the lesion (Fig. 12). Maybe we don’t have the fancy colors, like PET does, but we do have the diagnosis! CAIPIRINHA can be used in other regions, too. Figure 13 shows images of a female patient who underwent a brain scan in search of a (post-traumatic?) cause of the headaches. A small mass in the sella was incidentally found. Coronal dynamic VIBE imaging provides a means to assess the perfusion of the sella and pick up smaller lesions e.g. adenomas as demonstrated in this examination. The VIBE sequence is pimped using CAIPIRINHA with 4-fold acceleration, providing 40 high res 1.5 mm slice thickness images every 34 seconds, and dramatically improving detection rate. The acquisition speed makes it possible to complete this examination within the same 20-minute time slot. At our center, shoulder examination is mostly done after arthrogram. This can cause some discomfort and the fast scanning of patients is the best option to avoid movement artifacts. syngo BLADE helps reduce motion artifacts. However CAIPIRINHA is a huge benefit here. We acquire a 3D VIBE Dixon fatsat with CAIPI PAT4 in 1:41 min. The screenshot in Figure 14 shows the details of our shoulder protocol.

**Section 5: the Large Joint Dot Engine for shoulder imaging**

The AutoAlign tool in the Dot Engine helps technologists to plan more quickly and accurately, with reduced operator-depen
Shoulder Dot screenshot showing Inline MPR planning and VIBE CAIPI reformats.

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16 Excellent image quality, fat suppression and coverage in an obese patient in 10.7 sec (breath-hold).

dent variation. Figure 15 shows the sequences used and a total exam time of 11:08 minutes.

Two 3D blocks are scanned: 3D VIBE Dixon fatsat with CAIPI PAT4 (1:41 min) and 3D DESS fatsat (2:41 min) are acquired. These are reconstructed in axial, paracoronal and parasagittal planes inline, rather than in post-processing, thanks to the Inline MPR function of Dot. While still planning the sequences, the technologist already plans the multi-planar reconstruction so that the MPRs are available for reporting without delay as depicted. This produces an incremental benefit in workflow.

Section 6: liver imaging with Abdomen Dot Engine

Dot has many smart tools that help improve efficiency, consistency, reproducibility and throughput. AutoAlign is one tool I mentioned above in Brain Dot. The Abdomen Dot Engine actually provides several operator-independent tools: with AutoAlign for liver, and AutoCoverage, you always have the complete anatomy covered, ensuring good quality images with fewer incidences requiring repeat scans. This is a significant benefit of Dot and it holds true when we image obese patients, too.
MAGNETOM Aera’s 70 cm open bore enables some larger patients to fit for the first time in their lives inside an MRI machine. But even if we did manage to fit such a patient inside the previous MRI scanner, we still ran into the problems of too much noise and of breath-holds that were too long to cover all the phase encoding steps needed in an obese patient. The increased signal available on the Aera tackles the noise problem and the CAIPRINHA technique gives you a fourfold parallel imaging factor (without additional noise) resulting in acceptable breath-hold times (10.7 sec) even in large patients. Again, it all fits perfectly together!

Abdomen Dot enables easier, faster and more consequent – less operator-dependent – sequence planning and execution with AutoCommand tools where breath-hold commands are given by the system in a language the patient understands. The Abdomen Dot features ABLE (add-in for Automatic Breath-hold Liver Exams) where the system actually triggers on bolus arrival to ensure a pure arterial phase even in cirrhotic liver patients where timing of the bolus could be a challenge for less experienced technologists (Fig. 17).

Non-rigid liver registration of dynamic VIBE series is an automatic step done within the ABLE function to save all phases registered in the database, which enables faster and more accurate reading and reporting. Different contrasts scans (b50 – b800 DWI and ADC map & T2w BLADE) can be in similar anatomical positions as close as possible to the multi-phase dynamic scans due to smart AutoCoverage functionality in Abdomen Dot. The example of a cirrhotic liver in Figure 18 will clearly illustrate the efficiency in reading. This holds true within the scope of a single examination but becomes even more important when comparing examinations at different time points (Fig. 19). Having imaged and sent the images to the PACS in registered series turns out to be of great benefit for reading and reporting in follow-up examinations. This registration process allows for synchronized scrolling up and down simultaneously in the registered series even in a bare bone viewing system used by, for example, the referring physician. Figure 19 shows how convenient it was to reevaluate the liver on MRI in a case of invasive adenocarcinoma of the sigmoid colon. Comparing exams from 2011 and 2013 even on a bare bone viewing system: the Dot registration provides all the synchronization that is needed.

**Section 7: excellent images in the head/neck region**

Whereas in the old days fatsat could be problematic in the cervicothoracic region, TSE Dixon really assists with impeccable fatsat images and having the T2w or T1w TSE images for free. Figure 20 gives a nice example of metastatic melanoma after gadolinium enhancement: no artifacts in the base of the neck! DWI has also improved due to the gradient power enabling short TE thus minimizing artifacts.

The next two examples of DWI in the neck highlight the importance of ADC maps. High signal on the high $b$-value DWI and low ADC value confirm the malignant nature of the metastatic melanoma. DWI can help in determining the nature of lesions, such as in the small benign mixed tumor (BMT) of the right parotid gland with high ADC value depicted in Figure 22.
Section 8: leveraging *syngo.via*

Presenting the roadmap to vascular surgeons has been made easier and better with *syngo.via*. The MIP and composing functionality helps us to integrate three 4D datasets for angiography of the aorta and lower limbs into one dataset and to present the roadmap to the vascular surgeons – something that we do in every case. Cardiac evaluation is done on *syngo.via* and, again, instead of having to leave my reporting system to go to the workstation, I simply push the *syngo.via* button and do my evaluations. Another area where I use *syngo.via* is for volume calculations. Volume calculating helps me out with every acoustic neuroma and for prostate (benign prostate hypertrophy). The inline registration in the Dot engines really helps with the multi timepoint follow up of 90% of cases: it gives me the series synchronized and sends them in that registered way to my non-intelligent, bare bone viewing station (the reporting
system). This synchronization-registration assists in most of the brain and abdomen cases. syngo.via helps in reading difficult cases, where I like to compare, for example, not only the registered axial slices but also coronal slices, the free breathing DWI and other contrasts. When this is required, I simply push the syngo.via button on my viewing station and get my patient opened up in syngo.via. It makes reading and reporting not only faster but also more accurate.

Conclusion

The new RF, high-channel coils, gain in SNR, faster techniques like CAIPIRINHA, new metal implant imaging possibilities, Dot features and syngo.via all are a perfect fit and the MAGNETOM Aera truly combines throughput and highest quality MR imaging in an optimized clinical workflow.