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Let's Dot it. How to Program a Dot Examination of the Liver

Anton S. Quinsten, RT[1]; Samantha Horry, RT[1]; Justine Molinnus, RT[1]; Simone Lohbeck, RT[1]; Dipl. Ing. Karl-Heinz Trümmler[2]

[1]Institute for Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Germany
[2]Siemens AG , Aachen, Germany

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1 First Dot training.

Introduction

The Institute for Diagnostic and Interventional Radiology and Neuroradiology headed by Univ. Prof. Dr. med. M. Forsting at the University Hospital Essen is one of the largest radiology departments in Germany. We work with six MR systems in our institute. These include a 1.5T MAGNETOM Avanto, two 1.5T MAGNETOM Aera systems, one 3T MAGNETOM Skyra, one Biograph mMR and one 7 Tesla system*, all from Siemens. Our department was one of the first clinical users of Dot§ (day optimizing throughput) engines worldwide. After we had applied our basic knowledge in clinical operation, advanced training in Dot was held at our institute by Dipl. Ing. Karl-Heinz Trümmler (an MRI application specialist from Siemens Healthcare). We enjoyed familiarizing ourselves with this software so much that, at the end, we even held a little competition to see who can program best with Dot. If you take a close look at Dot you'll notice that this software is easy to program and will simplify your working life extremely. The following article should give you a better idea of how Dot works and encourage you to create your own examination programs tailored to your wishes.

A brief insight into Dot

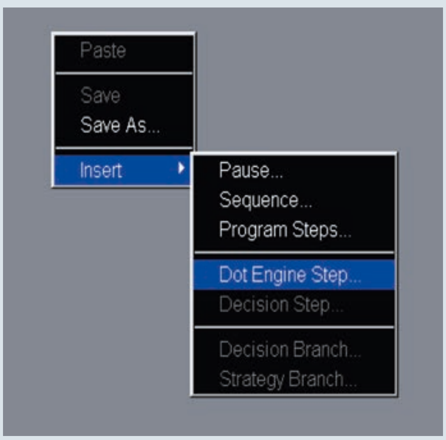
Using Dot, it is possible to optimize examination workflows and shorten examination times, e.g. through automated procedures. An automatic adaptation to the patient and his or her possibilities occurs. The system e.g. adapts the Dot protocol in the area of abdominal measurements to the patient's breath-holding capability while maintaining constant image quality. Furthermore, the field-of-view (FOV), number of slices and slice thickness also are adapted automatically, thus reducing the acquisition time and increasing the efficiency of the examination. With Dot, the user is guided through the examination and made aware of important decision points. Even inexperienced Radiographers are thus able to perform more complex examinations without assistance.

Dot navigates the user through various examinations step-by-step while displaying helpful and practical hints and sample images during each sequence. Sequences can easily be added or removed via integrated decision points at the push of a button. Dot can easily be adapted to our standards with respect to examination routines, exposures and protocols.

Following registration, the patient data and positioning information appear in the Dot display on the scanner and are used to accelerate patient positioning and preparation, since the most important points are already visible on the scanner display in the examination room. Dot ensures optimal timing between breathing and scanning via automatic breath-hold commands. The auto bolus detection ensures that the exposure will be taken at the correct point-of-time during contrast medium examinations. A new Dot engine can be created with an amazingly small number of mouse clicks. Dot constitutes a basic framework of strategies, patient context decisions and clinically decision points. In the following, we will explain some of the most important points that are integrated in a Dot engine.

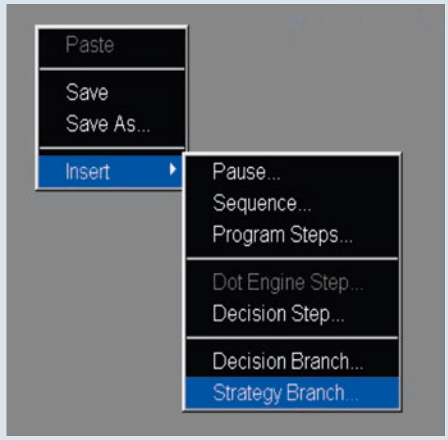
*This product is still under development and not yet commercially available. Its future availability cannot be ensured.
§ Dot is now available for 3T MAGNETOM Skyra and MAGNETOM Verio and for 1.5T MAGNETOM Aera and MAGNETOM Avanto.

Dot engine step: Each Dot engine begins with the Dot engine step. This specifies the kind of Dot involved and contains the exam-related configurations depending on the patient view. Additional functions open along with the different patient views, depending on the body region involved. There is a special patient view for each type of examination. These include Neuro, Onco (Abdomen), Cardio and Angio. During this first step, the entire framework is filled with strategies, patient context decisions and clinical decision points.



Strategy: The strategies employed include the varying tactics required for different patients due to wide variations among the patient population, and may sometimes result in different sequences. This enables us to store the right sequences for each patient under a single Dot engine. Thus for example, a standard protocol can be saved for normal patients and a protocol with correspondingly faster sequences can be stored for restless patients and started during the examination. The user can coordinate the strategies to suit his or her own needs.

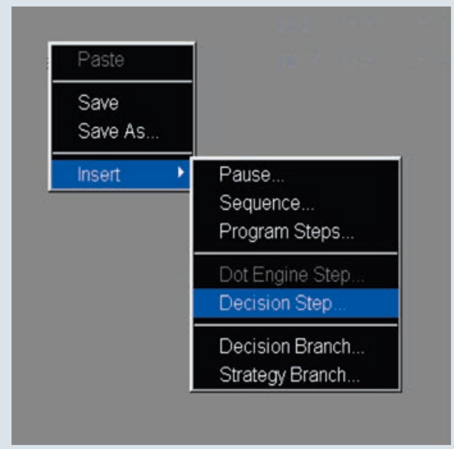
Strategy branch: The strategies previously defined when creating the Dot engine step are listed here. The appropriate strategy is selected while registering the patient and the corresponding sequences then open automatically. The sequences that are suitable for the strategy are already selected and saved while creating the Dot engine.



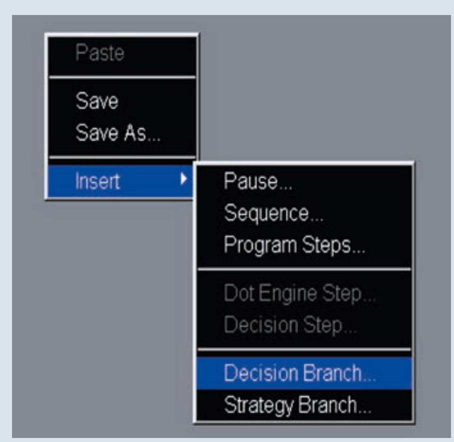
Patient context decision: Patient context decisions involve decisions that already have been made at the beginning of an examination. Like the desired strategy, they also can be selected after registering the patient and changed again during the course of the examination. The patient context decision is integrated in the examination in the form of a decision branch that enables branching of the protocol in two opposite directions. The user can decide for or against a specific patient context decision, e.g. contrast medium. All subsequently desired procedures then open linked to this patient context decision. In contrast to the decision step, a patient context decision is already made in the patient view at the beginning of the examination and does not require any decisions during the further course of the examination.

Clinical decision point: Decisions related to the clinic are initially made during the course of the examination and, as their name implies, are dependent on the patient's clinic. Sequences that are additionally required for clinical reasons are integrated in the examination procedure in the form of a decision step. The sequences desired can be added to the standard examination while it is in progress by selecting a previously defined decision step. The sequences that are run during the corresponding decision are stored in the decision branch.

Decision step: A decision that remains to be made can be selected during the course of the examination. This automatically creates a decision branch under which the corresponding sequence can be found. The sequences are saved in advance here, too, so that they will become available immediately following a corresponding decision. A decision step is required during a Dot engine run only in cases concerning a clinical decision that is initially made while the examination is in progress.



Decision branch: This involves branching of the examination procedure due to a patient context decision or a clinical decision. The user can decide in favor of or against a procedure. Once a decision has been made, the corresponding protocols saved there are made available.



Automatic procedures / additional functions

Auto position: All Dot engines offer the possibility of automatically moving the patient into the isocenter of the respective examination region without previous centering and positioning the patient in the isocenter.

AutoAlign: This function is available only for head, knee and spine examinations and performs automatic positioning of the examination area based on previously set reference points.

AutoFOV: The field-of-view (FOV) is automatically adapted to the structure under examination. The system always selects the FOV with a tolerance range that is slightly larger than necessary to make allowances for patient-related changes, e.g. varying breath-hold phases.

AutoCoilSelect: During examinations, the coils located in the examination area are selected automatically so that the user does not have to select them manually for each sequence. This ensures that the measuring field always remains fully illuminated.

AutoBolus detection: Auto bolus detection promotes optimal timing during dynamic contrast medium examinations. The position where the signal intensity is to be measured in the vessel is determined via a region-of-interest (ROI). The sequence then starts automatically as soon as the previously selected reference value has been reached. Therefore, false starts seldom occur, which is why examinations in which the exposure is to be taken during a specific blood circulation phase (e.g. the aortic arterial phase) often show a better contrast.

AutoVoice commands: The automatic breath-hold commands improve the timing between contrast medium enrichment, the breath-hold command and the scan. A large number of languages can be programmed to simplify examinations without having to rely on an interpreter. In combination with AutoBolus detection, the length of the automatic breath-hold command also must be accounted for in the contrast medium timing.

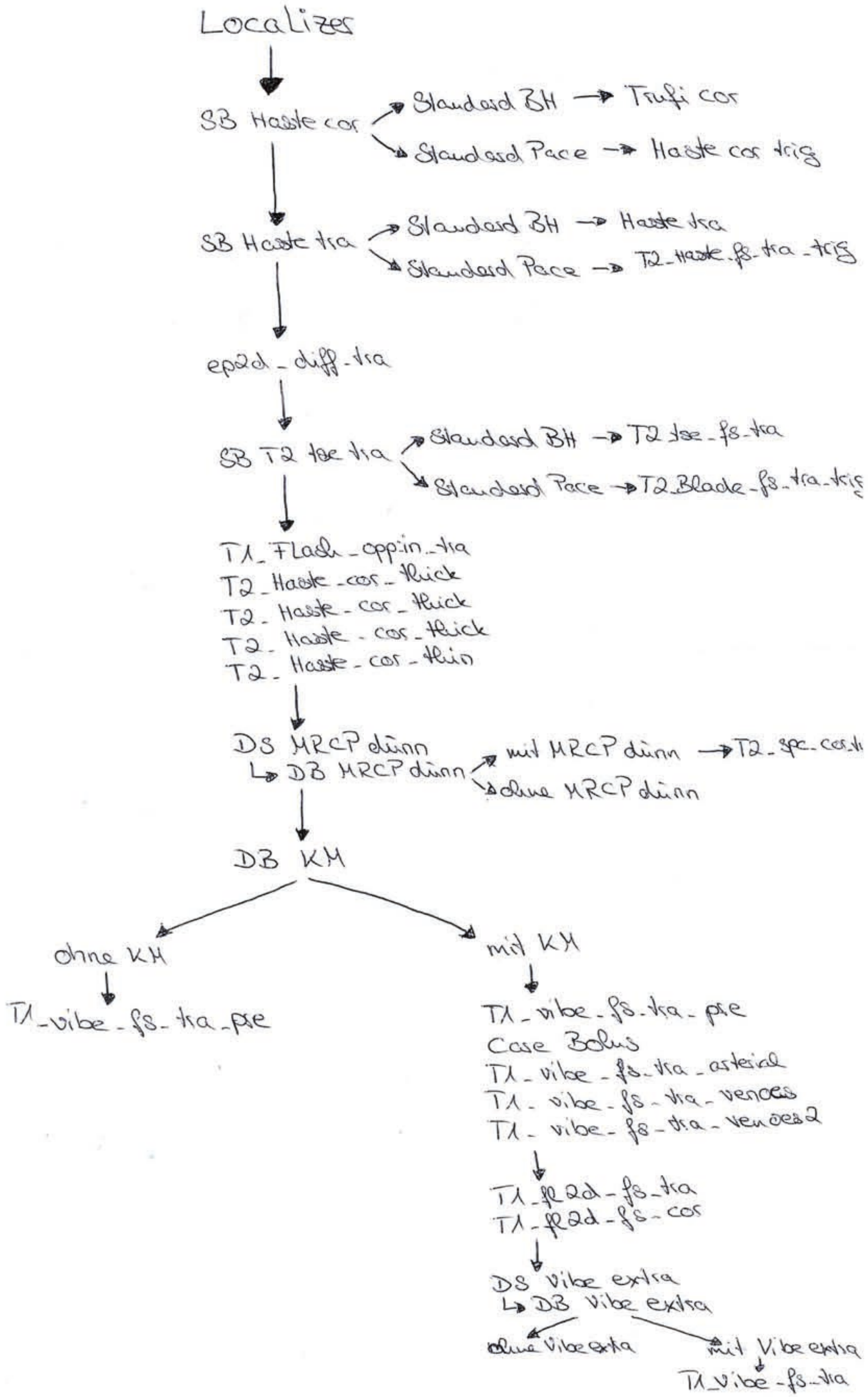
Different patient views:
Only the Neuro patient view is available in the standard package. The patient views specify which additional functions can be accessed during the examination. It is thus for example possible to automate the dynamic 3D VIBE measurements in the liver study and add AutoBolus detection with the help of the Dot add-in ABLE.

- ABLE (abdomen breath-hold liver examination) = Abdomen with contrast medium dynamics, automatic breath-hold commands, automatic start of sequences after contrast medium detection. Delay times can be inserted variably.
- Angio bolus timing = for angiographies with breath-hold command; graphic regions, veins, arteries, automatic arterial time calculation (delay).
- AutoAlign scout = Automatic tilting according to specific reference points.
- Generic views = Guidance images and scope of parameters.
- MPR planning = Planning of multiplanar reconstruction (MPR), can be used only once per Dot engine.
- MPR assignment = Executes the plan, automatic reconstruction.
- Cardiac basic
- Cardiac marker lock = Sets axial points when planning the heart axes.
- Cardiac SAX planning = For planning short axes.
- BOLD = Blood Oxygenation Level Dependent imaging for functional measurement.

Example of application

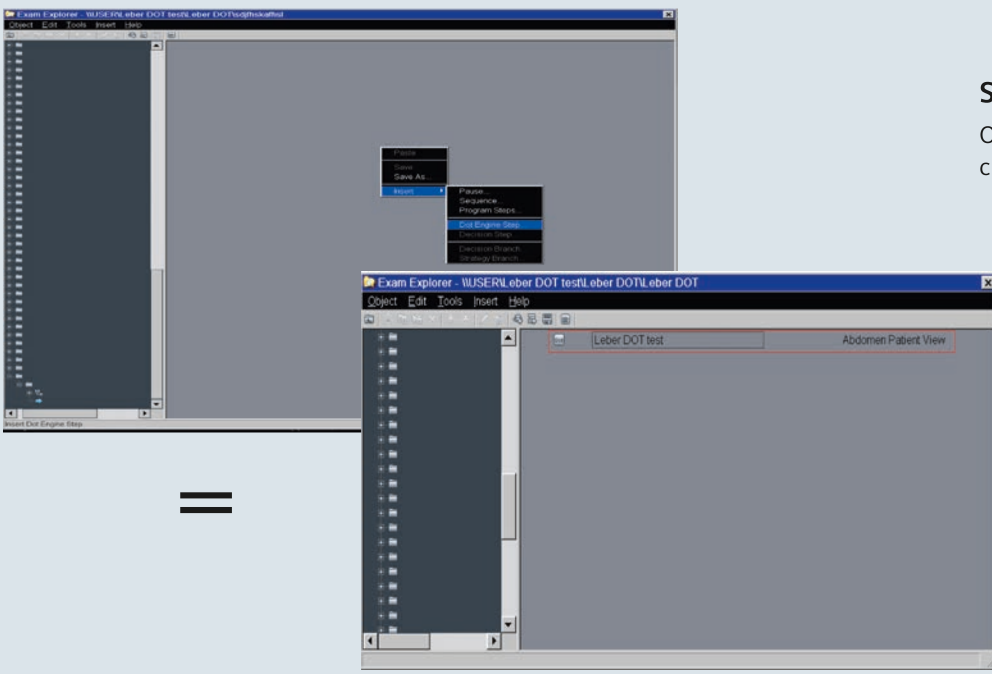
Now we will show you how to create a Dot engine based on the example of a liver study.
It is advisable to make a sketch of the desired protocol before you start creating the Dot engine.

Example of a liver study



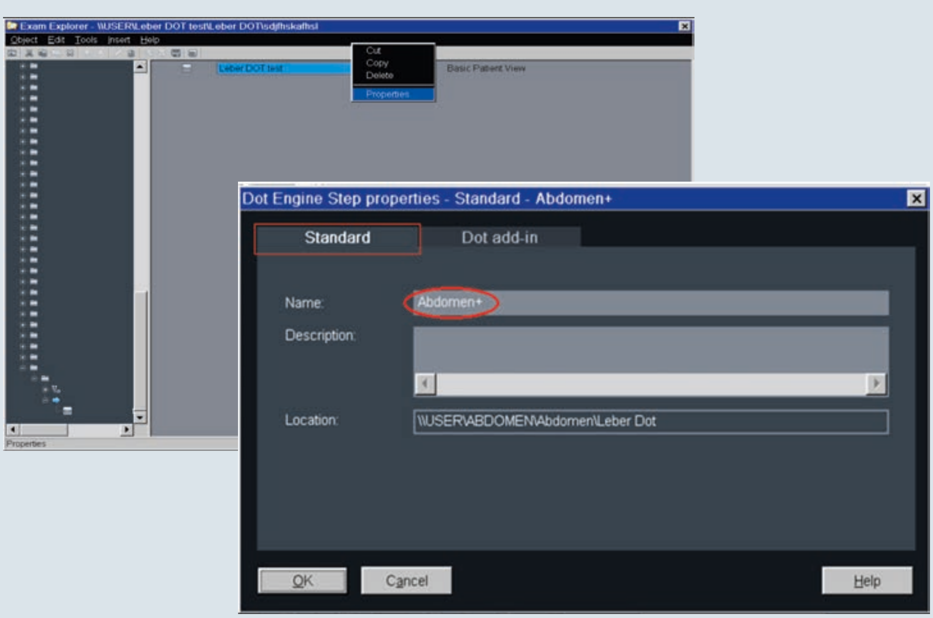
Then the Dot engine is created as shown in this example based on a liver study.

Open the user tree.



Step 1:

Open the subfolder and create a Dot engine.

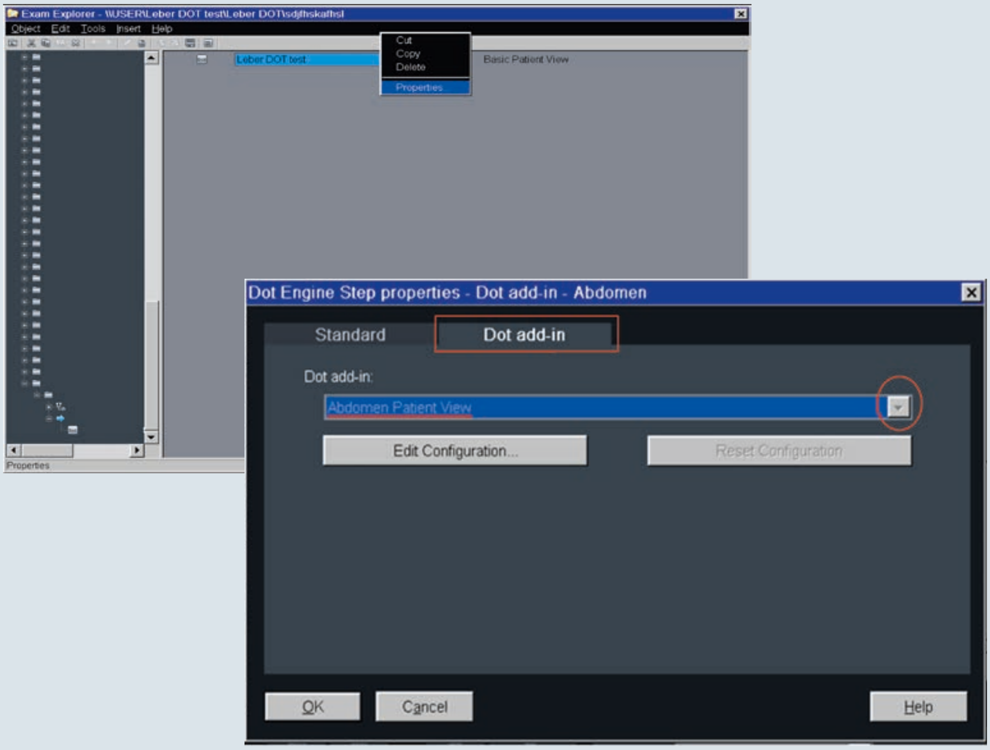


Step 2:

E.g. right-click the Dot engine and select “Properties” or double-click, open and name it.

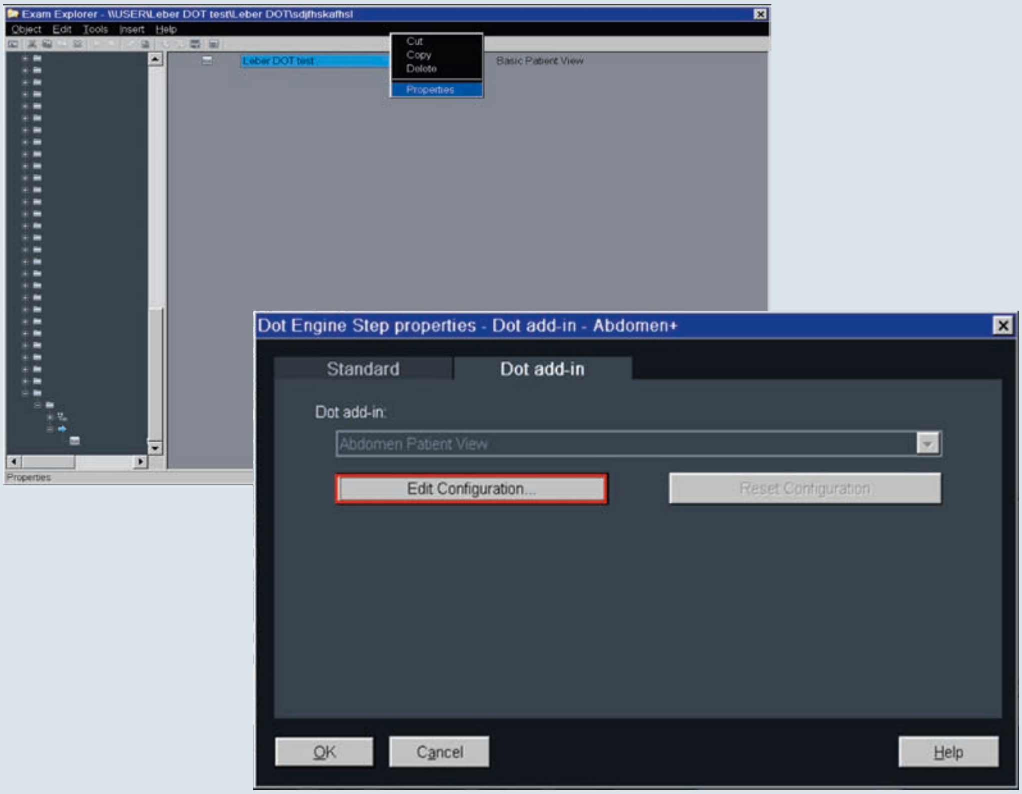
Step 3:

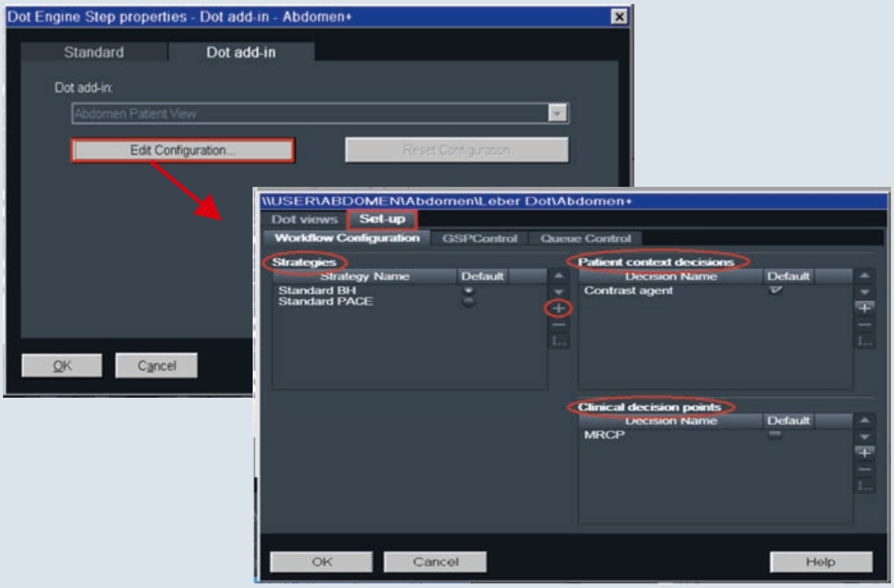
Select the patient view suitable for the examination via Dot add-in.



Step 4:

Select "Edit Configuration" to configure the Dot engine.

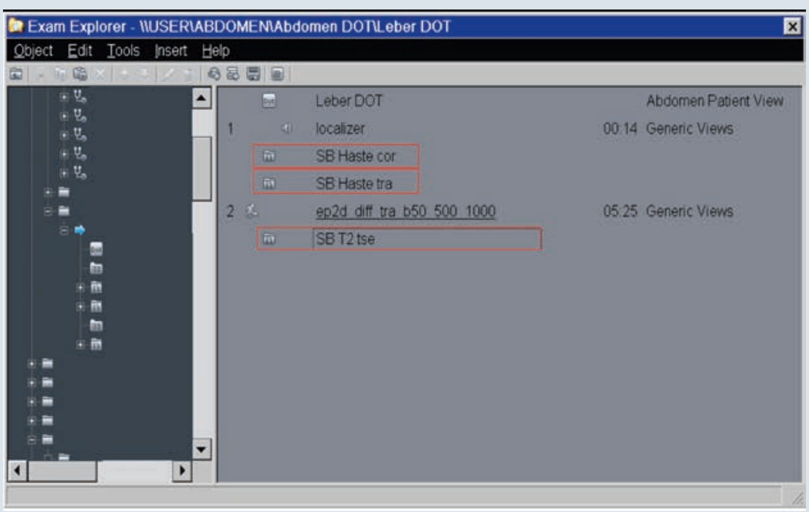




Step 5:

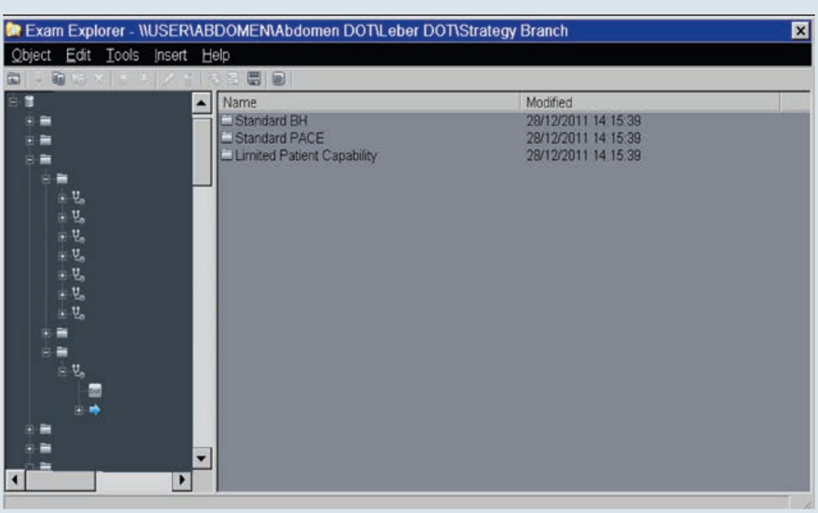
Define the strategies (strategy branch), patient context decisions (decision branch) and clinical decision point (decision step) for the examination by adding them.

Hint: The number of strategies can no longer be changed once the protocol has been put into operation. In order to keep this option open, you might want to insert a placeholder under "Strategies" at the beginning.



Step 6:

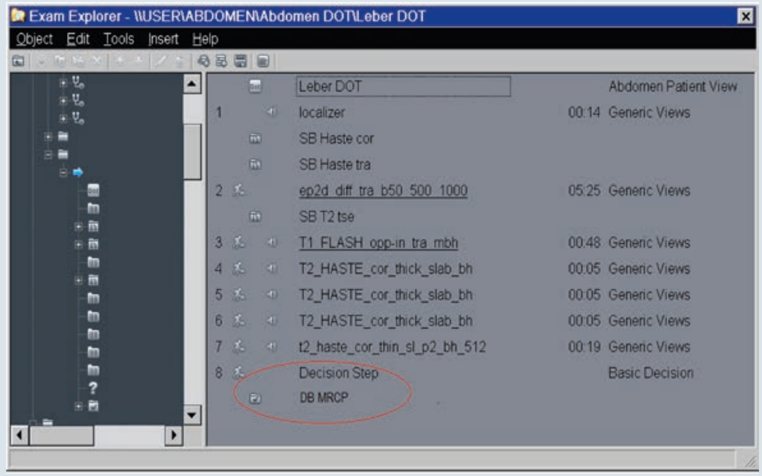
A strategy branch can then be integrated whenever varying sequences are to be used for different strategies. If the sequences are the same for all strategies, they can be inserted directly without generating a branch.

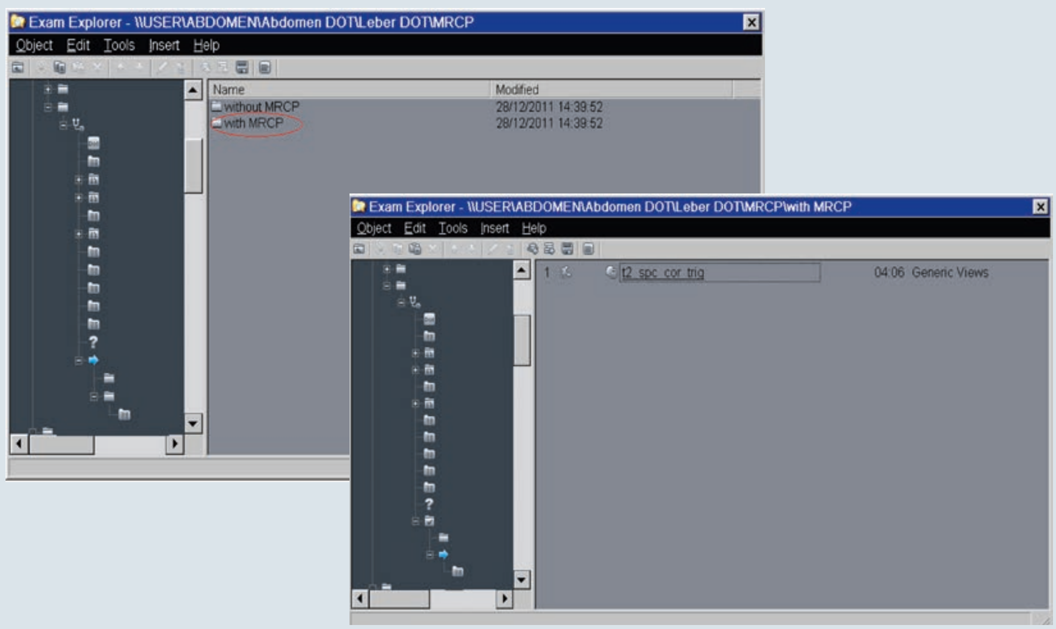


Finally, the correct sequences are saved under the individual strategies.

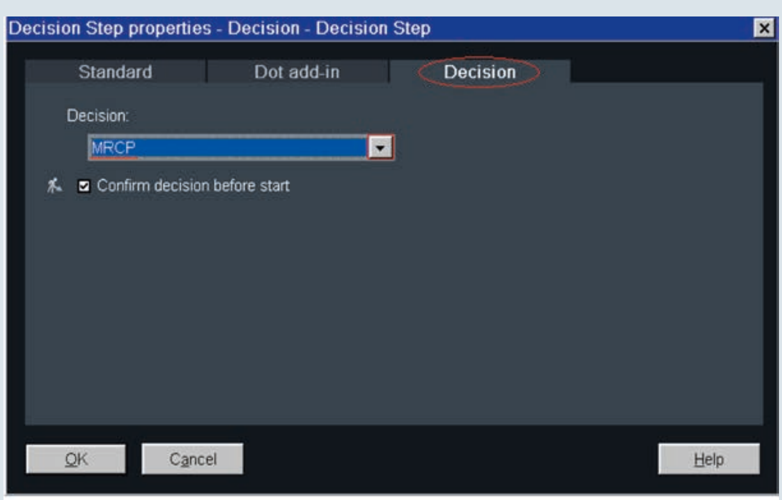
Step 7:

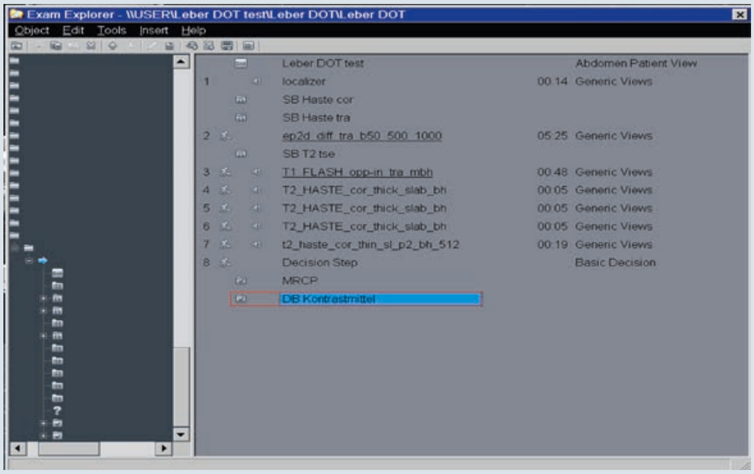
Insert a decision step to enable a decision for a thin MR colangiopankreatography (MRCP) during the course of the examination. The decision step always includes the Dot "basic decision" add-in.





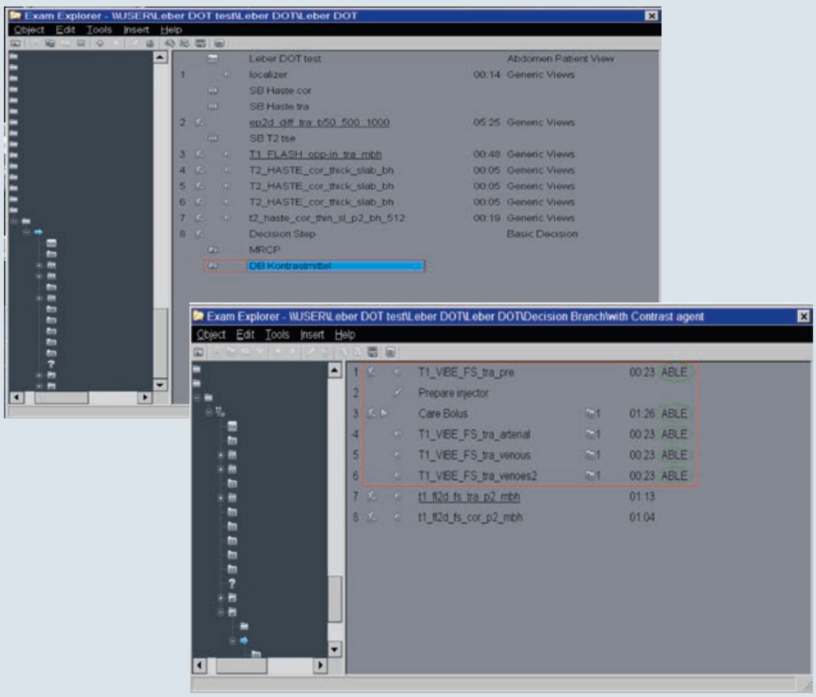
A decision step automatically generates a decision branch. However, a clinical decision point, in this case MRCP, always must be selected under "Decision" for this purpose. The clinical decision point must however already be defined in the patient view.



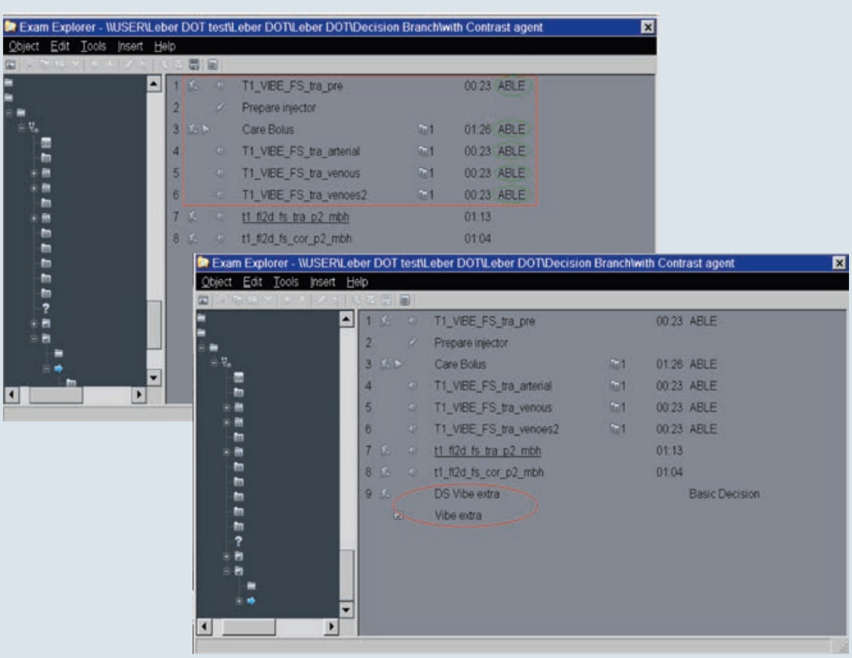


Step 8:

Insert a decision branch for contrast medium administration and save the VIBE protocols for the dynamic contrast medium examination there.



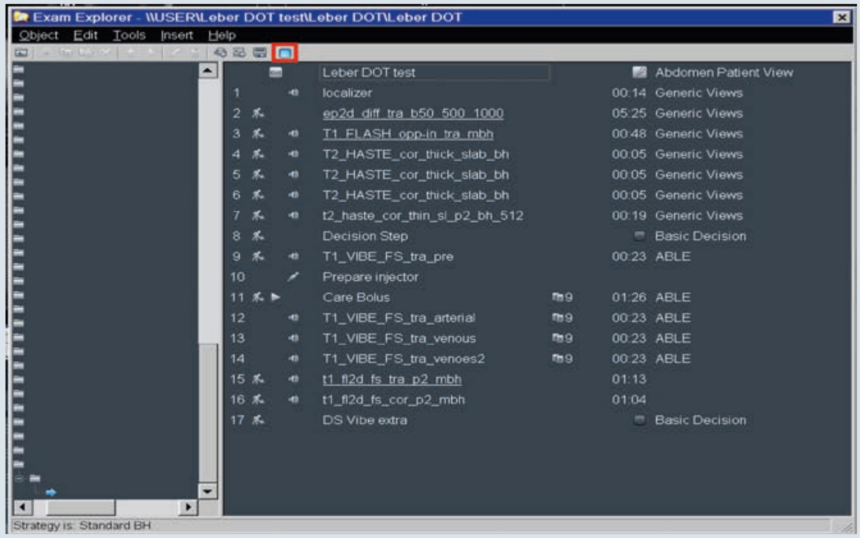
The VIBE is assigned the Dot add-in ABLE. The VIBE always contains 4 measurements (vibe native, vibe arterial, venous and equilibrium). Additional VIBEs cannot be integrated in ABLE.



It is, however, possible to equip additional VIBEs with a generic view add-in and attach them to the examination.

Step 9:

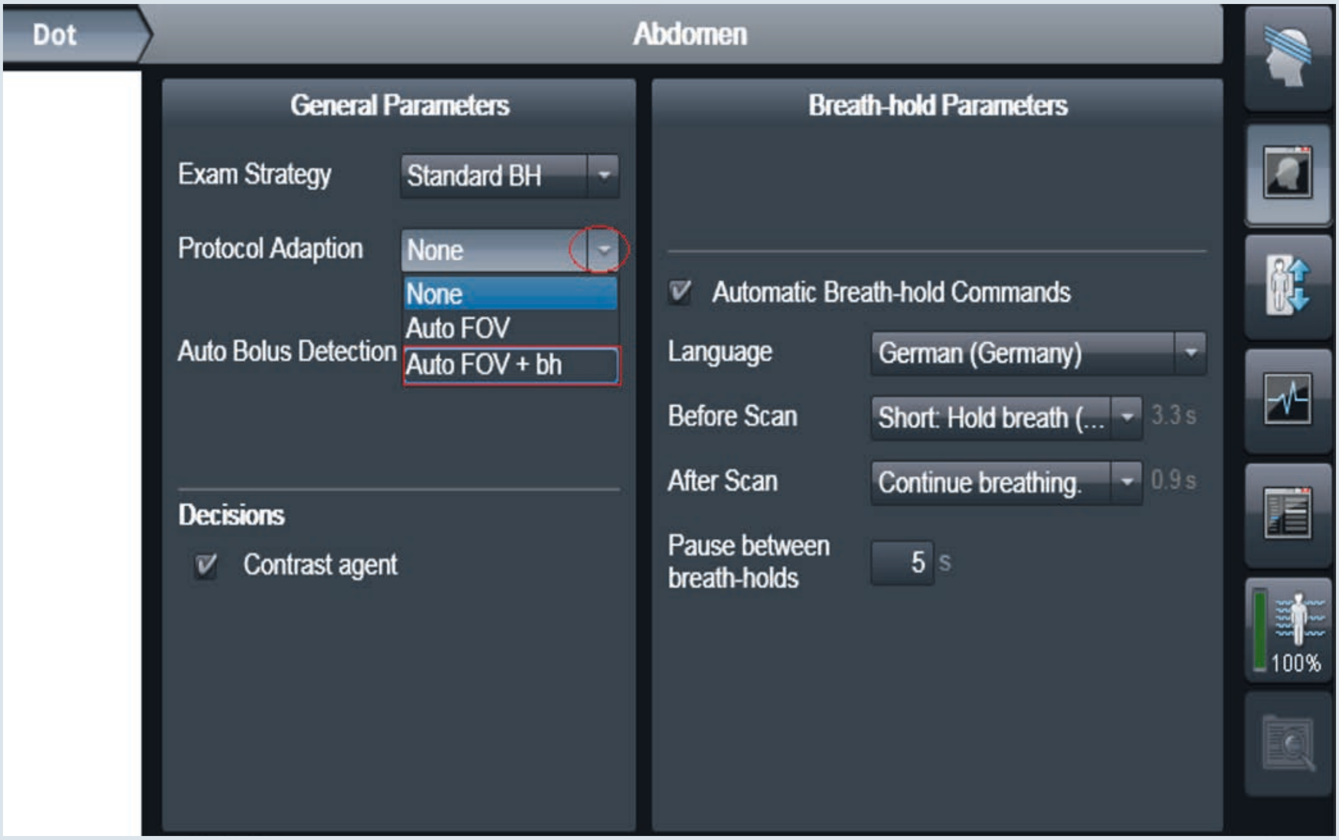
Fill the basic framework with sequences. Measurements which are the same for all strategies and are not subject to any further decisions can be inserted under the Dot engine without a strategy branch.

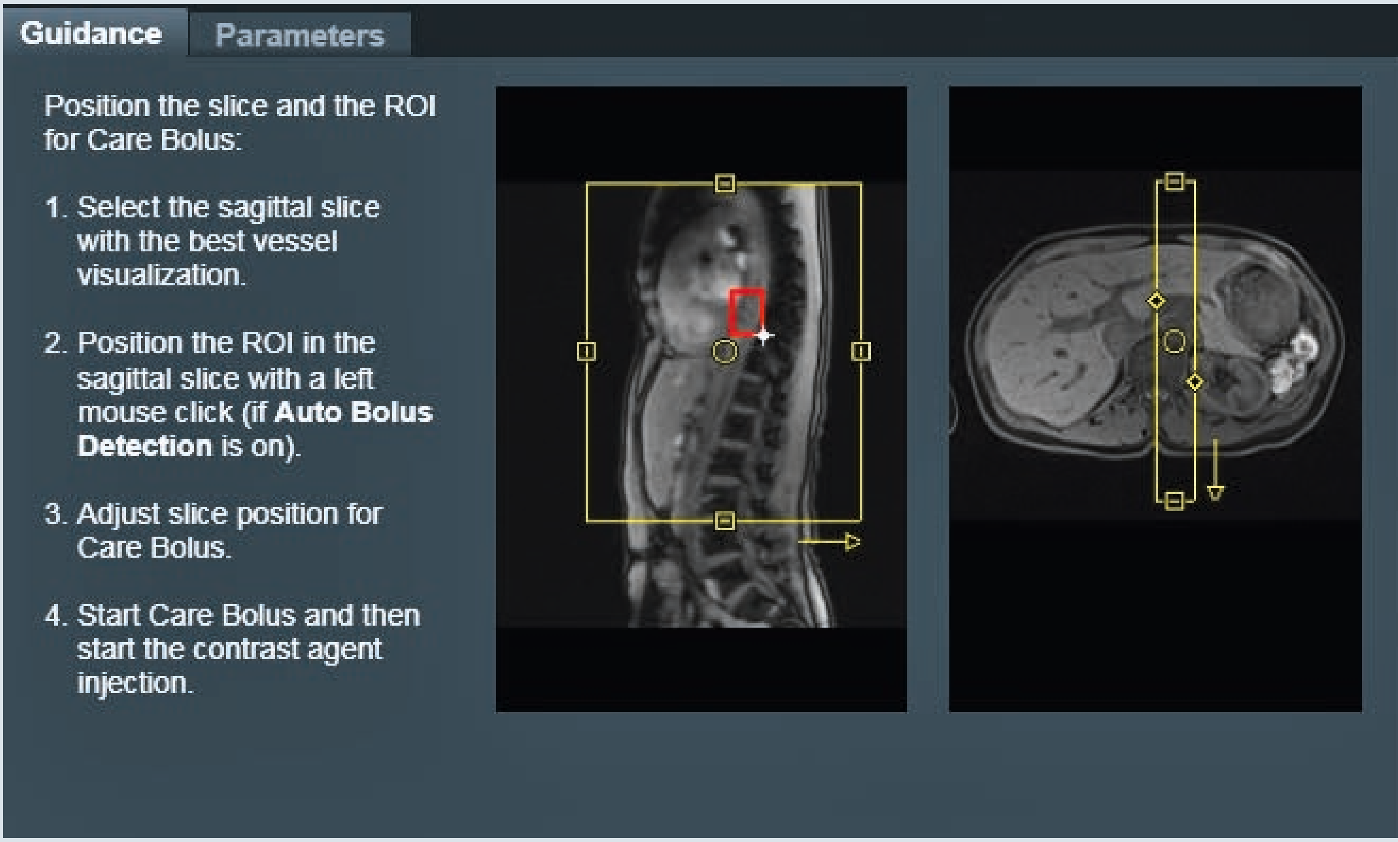


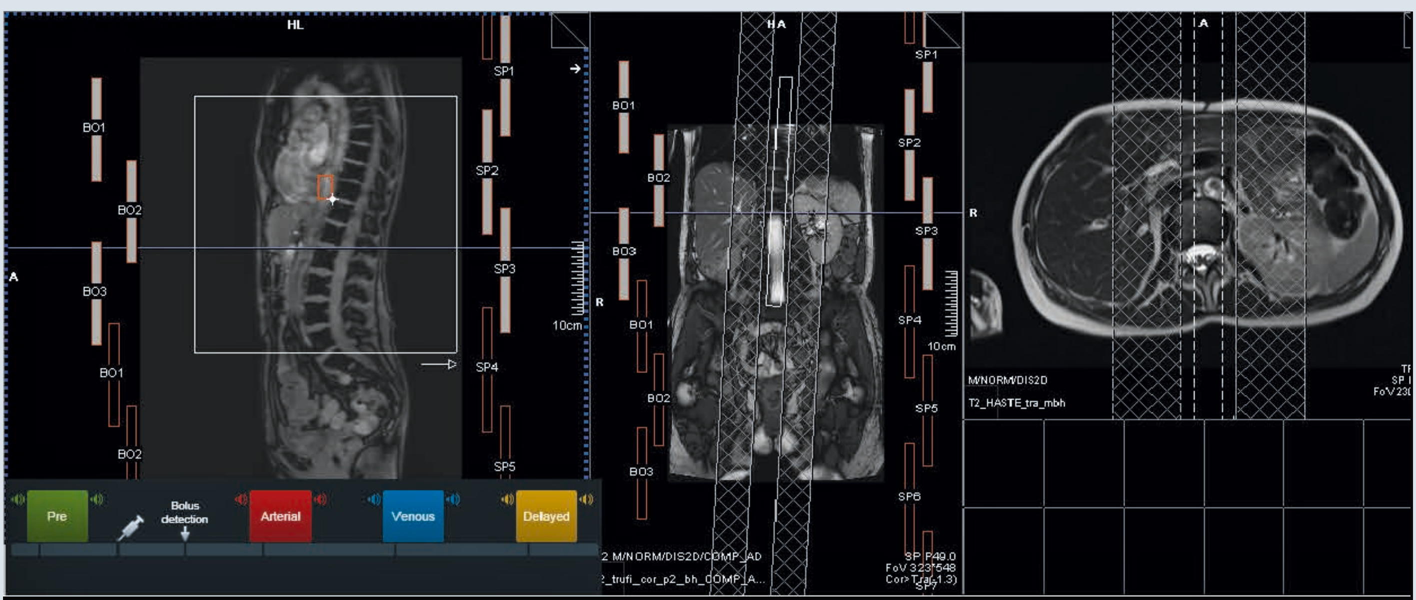
Special features of the liver Dot engine

Automatic adaptation

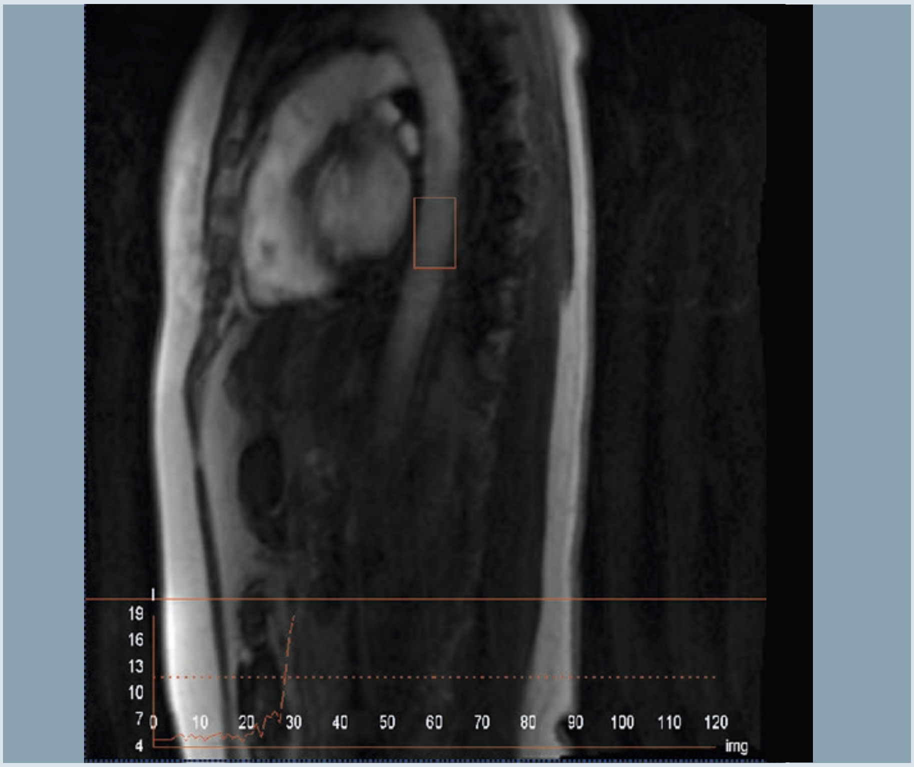
The automatic adaptation can be switched off completely or, as an alternative, either the AutoFOV or the breath-hold command can be used separately. This setting also can be changed during the course of the examination.

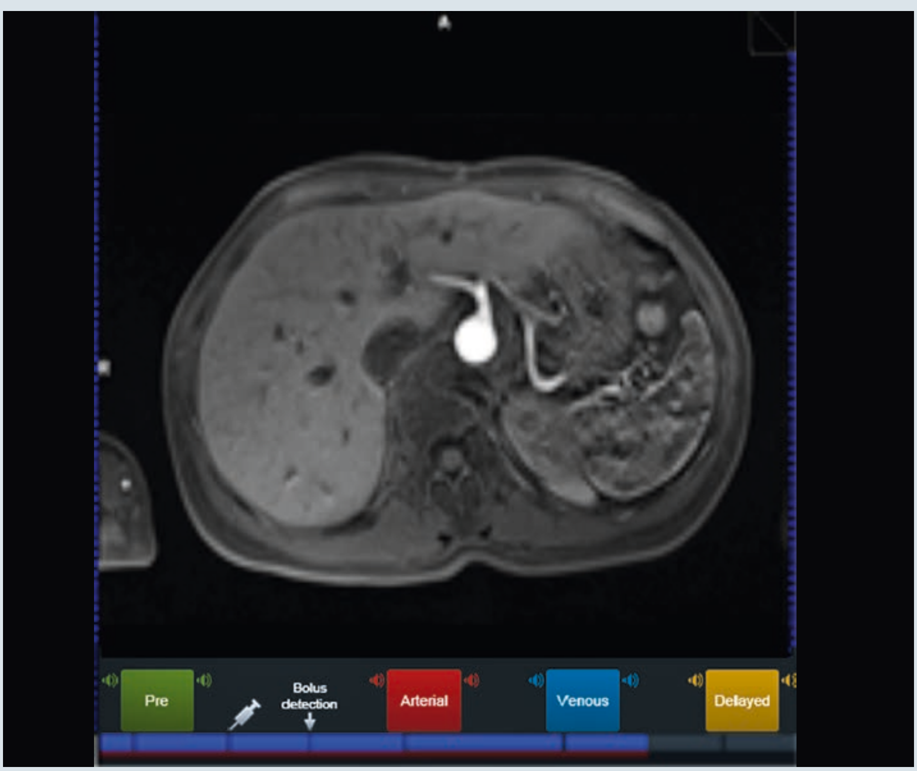






Automatic execution of contrast-medium-supported sequences
The guidance images specify optimal positioning of the ROI. Thus oriented, the ROI on the sagittal image is placed in the ascending aorta.





Once the VIBE has been started, the examination is then executed fully automatically. The enhancement curve displays the increase of the contrast medium and can be used to check that the arterial VIBE starts in time. The rest of the examination is performed automatically and can be followed on the graphic display.

Conclusion

In conclusion it can be said that, from the perspective of the technologists, Dot simplifies examination workflows considerably. And it's even more important to know that you can use Dot to make your work a lot easier. We hope that this introduction marked a first step towards familiarizing you with the Dot application. We hope you will have lots of fun creating your own Dot programs tailored to your own individual standards.

Contact
Anton S. Quinsten
Institute for Diagnostic and Interventional Radiology and Neuroradiology
University Hospital Essen
Hufelandstraße 55
45122 Essen
Germany
Phone: +49 (0)201/723-84506
anton.quinsten@uk-essen.de

Did you know that . . .

You can download SCMR recommended protocols with the Cardiac Dot Engine at

www.siemens.com/SCMR-recommended-protocols

"The Angio Dot Engine is easy, very robust, ultimately foolproof!"

Johan Dehem, M.D., VZW Jan Yperman, Ieper, Belgium

"The Abdomen Dot Engine incorporates various strategies to optimize and standardize a complex abdominal MRI protocol. It allows for automatic detection and positioning of an individualized FOV based on localizer images, can stratify a protocol into patient specific breathing capabilities and provides tools such as automatic bolus timing for dynamic scanning."

Tobias Heye, M.D.[1]; Mustafa R. Bashir, M.D.[2]
[1]Department of Radiology, University Hospital Basel, Switzerland
[2]Department of Radiology, Duke University Medical Center, NC, USA

"In cardiac imaging a single mouse click will change, for example, the cardiac gating of all following sequences."

Stefan Schönberg, Institute of Clinical Radiology and Nuclear Medicine, University Medical Center Mannheim, Germany

"One of the most impressive features of the Cardiac Dot Engine is the fully automated user-independent Inline left ventricular analysis. The software instantaneously delivers all functional parameters without a single mouse click directly after the last acquisition of the cine sequences. This technology enables a complete functional assessment of the heart with all qualitative and quantitative parameters within just 14 minutes!"

Axel McKenna-Küttner, Radiology and Nuclear Medicine, Sportklinik Bad Nauheim, Germany

More clinical articles, tips & tricks, talks on Siemens unique Dot engines at

"The main benefit of the Dot engines is to decrease the complexity of MR and to further standardize MR-examinations. It allows follow-up examinations to be conducted with the same parameter settings and hence with constant image quality over time, which is particularly important for quantitative evaluation of lesions in therapeutic clinical and research studies."

Stefan Schönberg, Institute of Clinical Radiology and Nuclear Medicine, University Medical Center Mannheim, Germany

"A liver MRI protocol can be standardized and partitioned into its typical elements (pre-contrast, multiple arterial, portal venous, and equilibrium phases), so that key settings such as delay times between each element can be configured by the user through an interface that offers an overview of all protocol steps."

Tobias Heye, M.D.[1]; Mustafa R. Bashir, M.D.[2]
[1]Department of Radiology, University Hospital Basel, Switzerland
[2]Department of Radiology, Duke University Medical Center, NC, USA

"Multiple scan types which differ by only a few minor components (e.g., with or without MRCP, with or without DWI) can be combined into a single, efficient protocol with a few key decision points, reducing redundancy and allowing for simpler base protocol maintenance and modification when necessary."

Tobias Heye, M.D.[1]; Mustafa R. Bashir, M.D.[2]
[1]Department of Radiology, University Hospital Basel, Switzerland
[2]Department of Radiology, Duke University Medical Center, NC, USA

"Whereas test bolus MRA could be tricky in the past (having a piece of paper at hand to calculate your delay), the Angio Dot Engine effectively calculates and updates the delay depending on the planned coverage / resolution."

Johan Dehem, M.D., VZW Jan Yperman, Ieper, Belgium

"In neuro-imaging the Dot engine automatically aligns the images and chooses the appropriate FOV."

Stefan Schönberg, Institute of Clinical Radiology and Nuclear Medicine, University Medical Center Mannheim, Germany

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MAGNETOM Aera – Combining Throughput and Highest Quality MRI in an Optimized Clinical Workflow

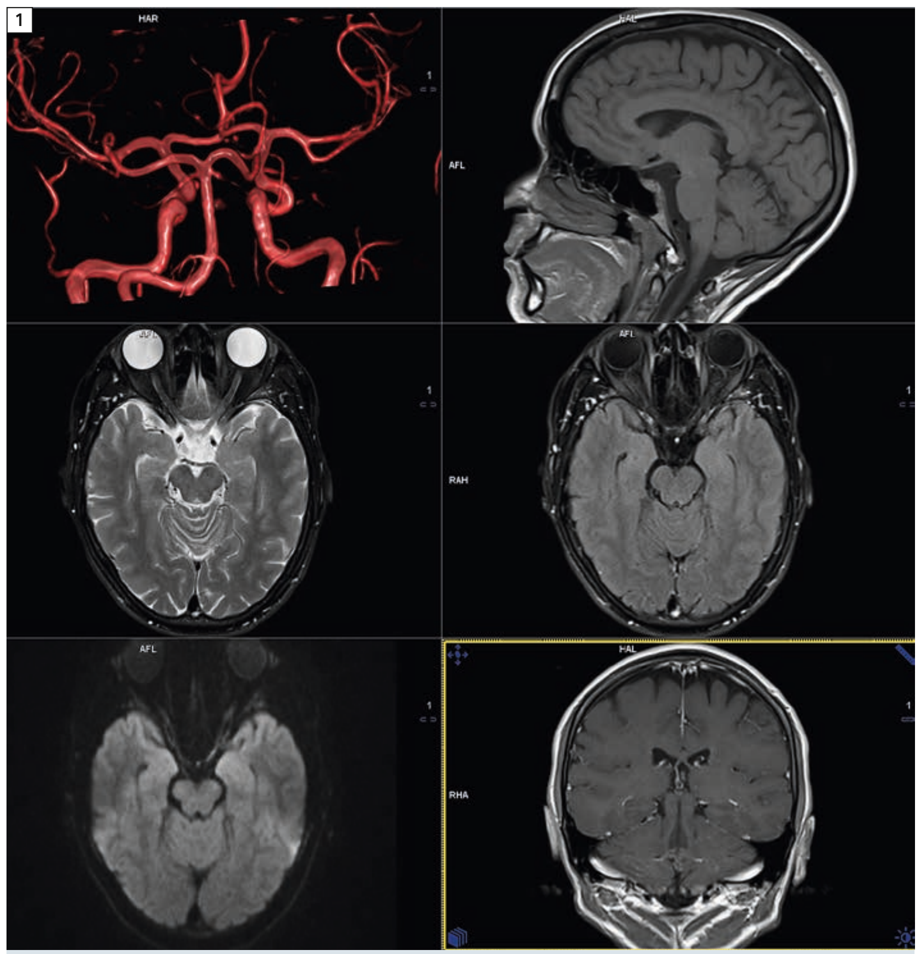
Johan Dehem, M.D.

VZW Jan Yperman, Ieper, Belgium

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.

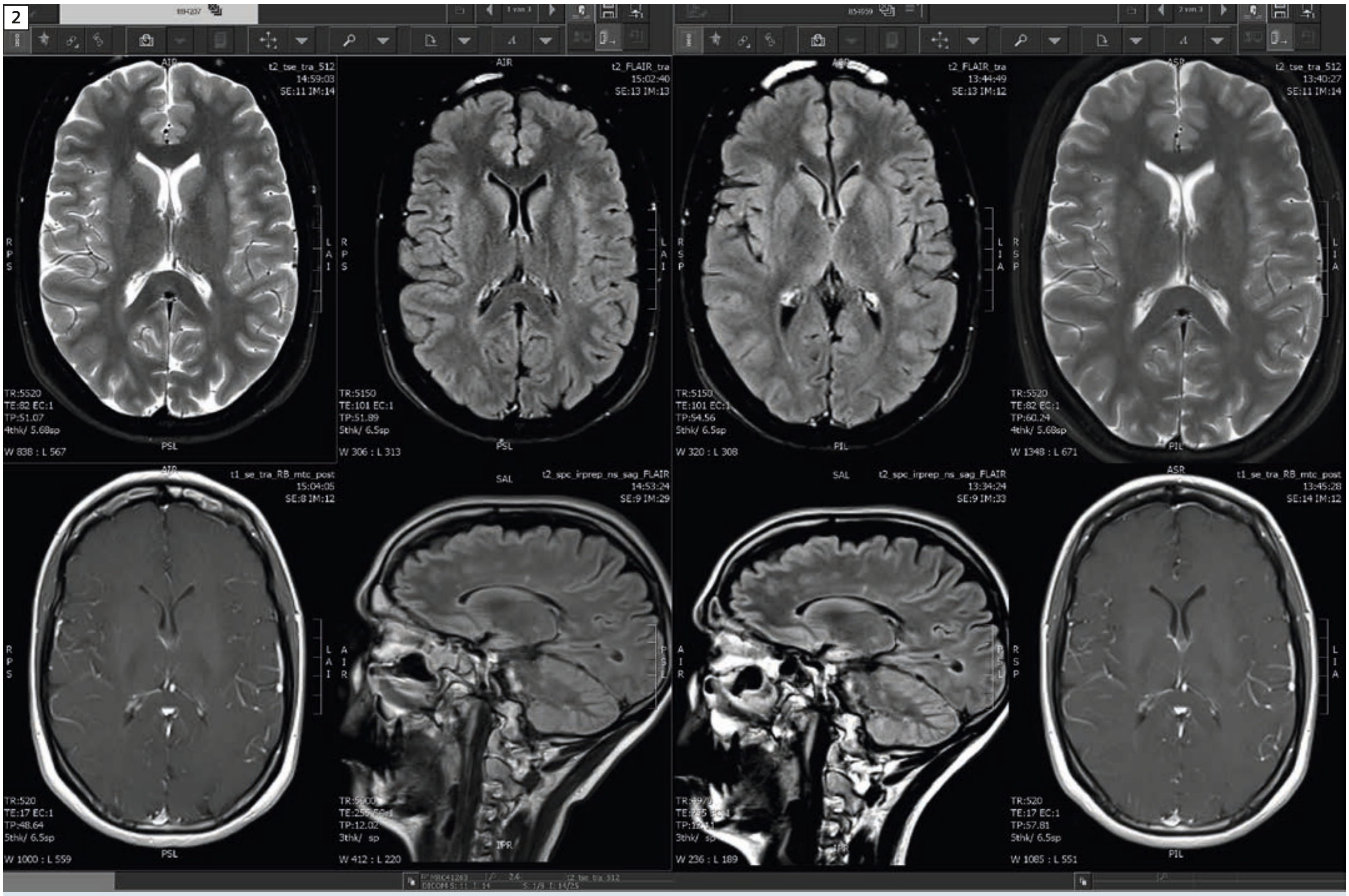
Section 1: fast brain imaging with Tim 4G and Dot

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 *b*50, *b*500, *b*1000, 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)

2



2 Follow-up examination at different time-points in demyelinating disease. Even the small lesions are comparable since anatomy is depicted consistently, independent of operator and patient positions even on a different PACS system and on the viewing system of the referring physician.

Section 2: 16-channel MSK coils

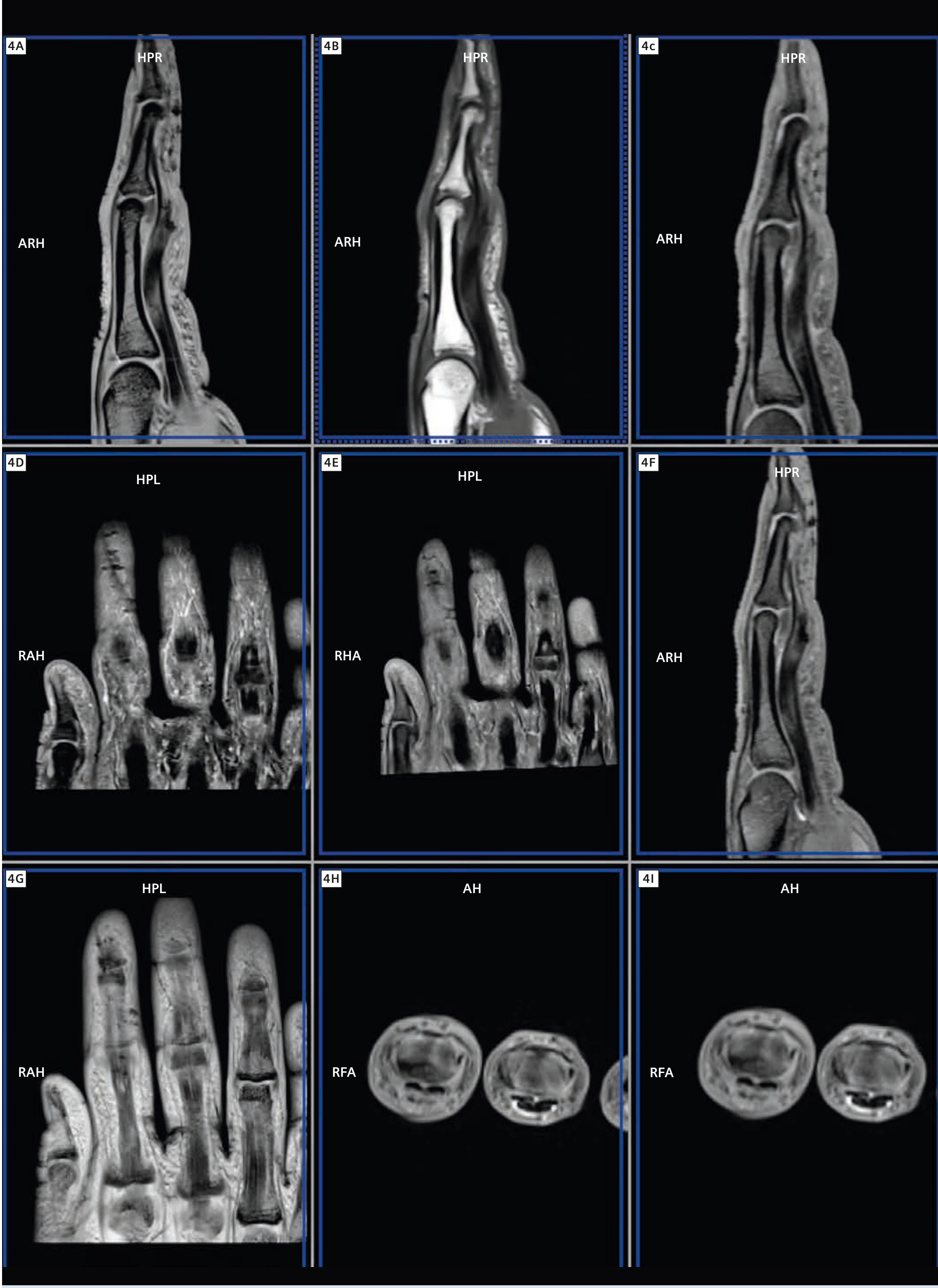
The new RF system enables the use of 16-channel MSK coils like the Shoulder, Foot/Ankle and Hand/Wrist coils.
The new wrist coil gives abundant signal and superb detail. The wrist coil has grown, in fact, to a 16-channel hand-wrist coil (Fig. 3), which is quite convenient for both the patient and the 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.

3

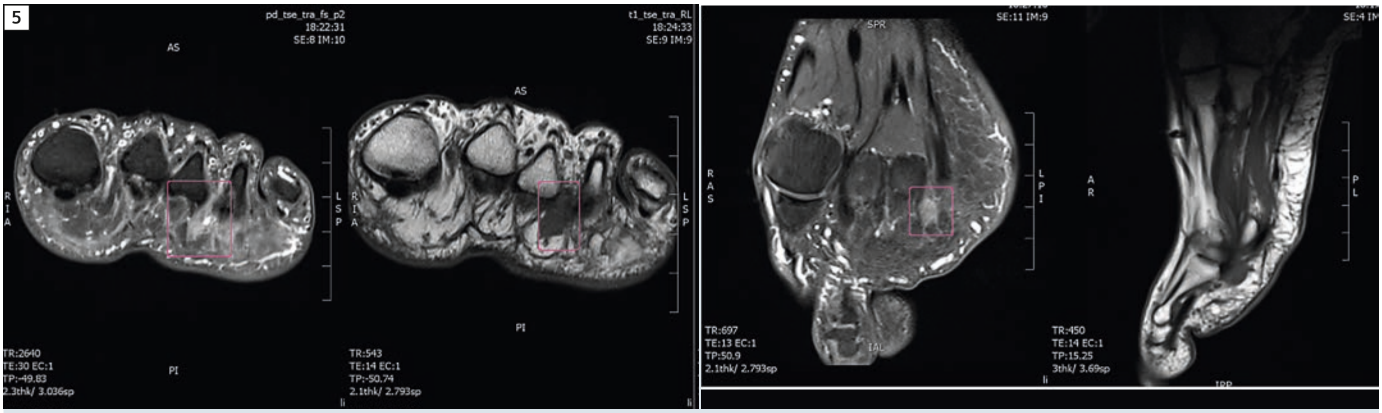
3 16-channel Hand/Wrist coil.

Section 3: reduction of susceptibility artifacts caused by metal

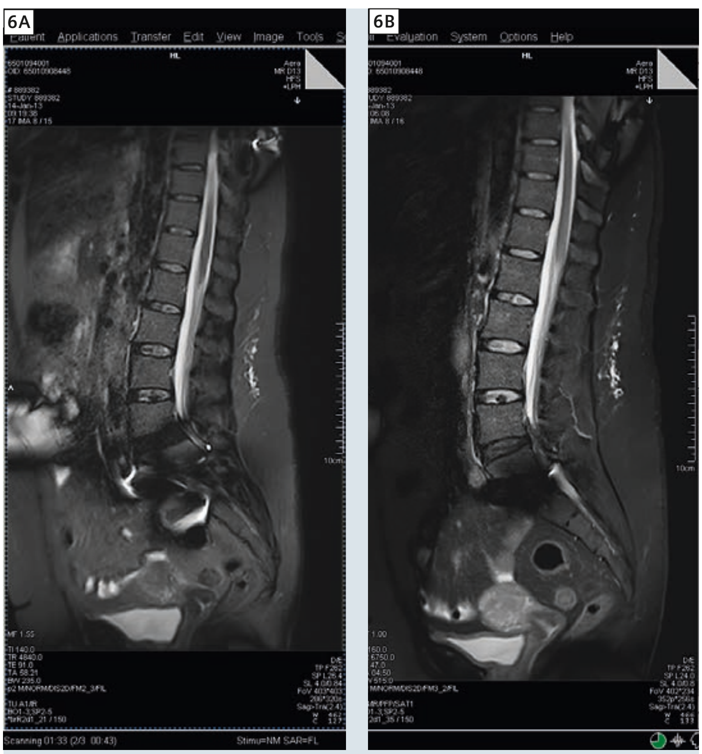
MRI is challenging in the presence of metal. MAGNETOM Aera came equipped with *syngo* WARP with high bandwidth TSE and TSE STIR protocols and an



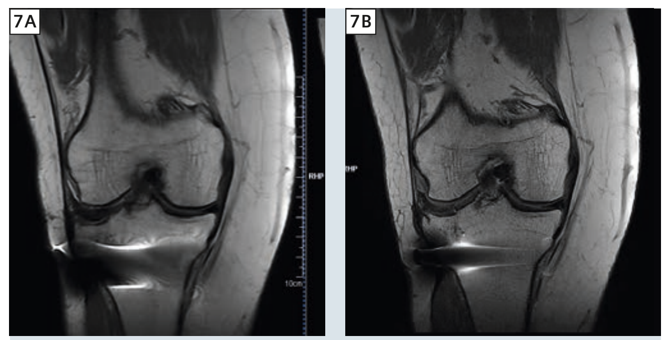
4 Superb details in a case of trauma to index finger in 1:30 min per sequence.



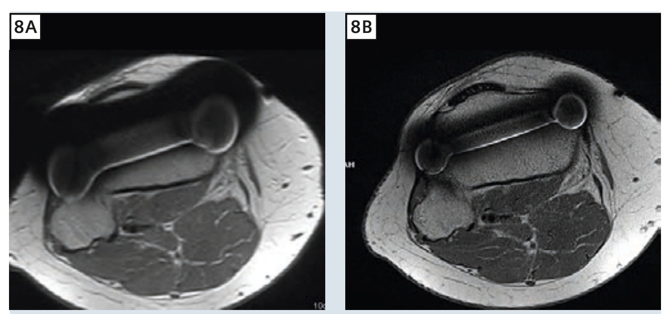
5 Toe imaging using the 16-channel Hand/Wrist coil. Excellent image quality showing Morton neuroma between the metatarsal heads III and IV.



6 T2w TIR versus T2w TIR WARP demonstrates dramatic improvement in image quality with the disc L5-S1 showing up on the WARP images only **(Fig. 6B)**.



7 T1-weighted coronal imaging degraded by artifacts **(7A)**. T1 VAT WARP does the job **(7B)**.

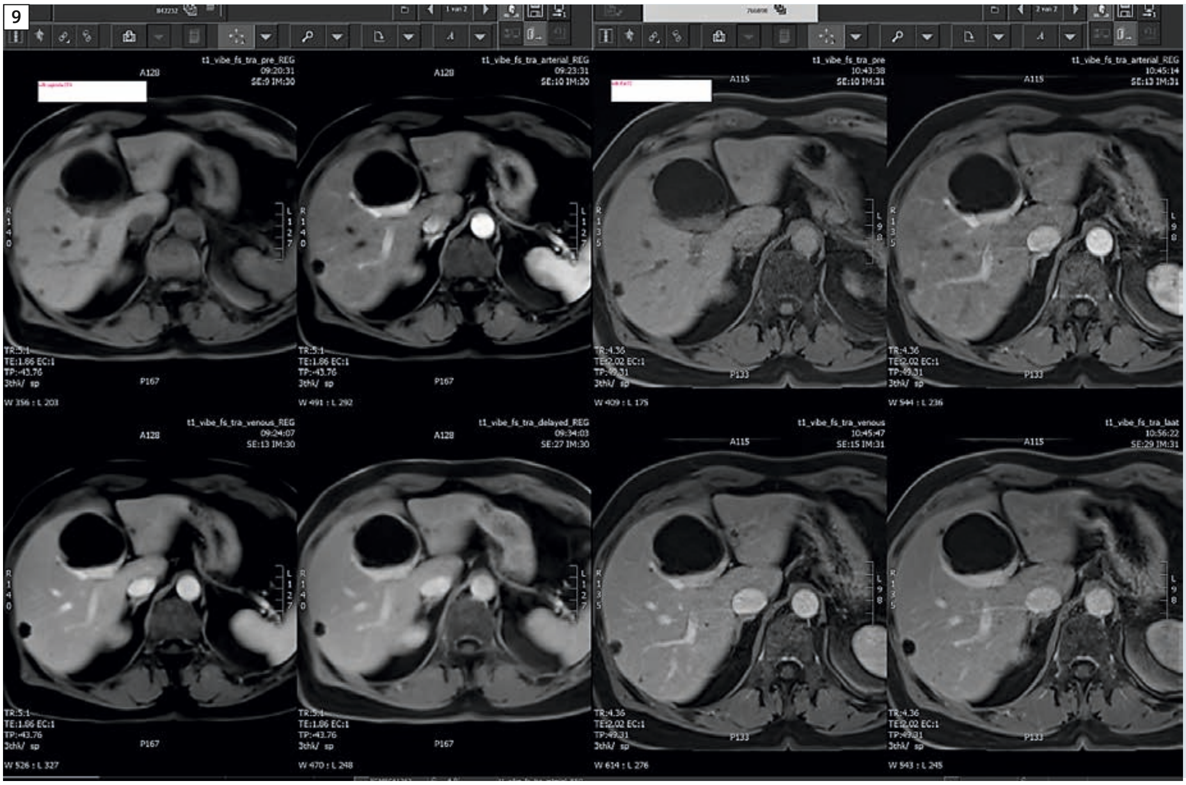


8 Proton density-weighted axial image largely degraded **(8A)**. PD VAT WARP nicely demonstrates the material and recovers the distortion **(8B)**.

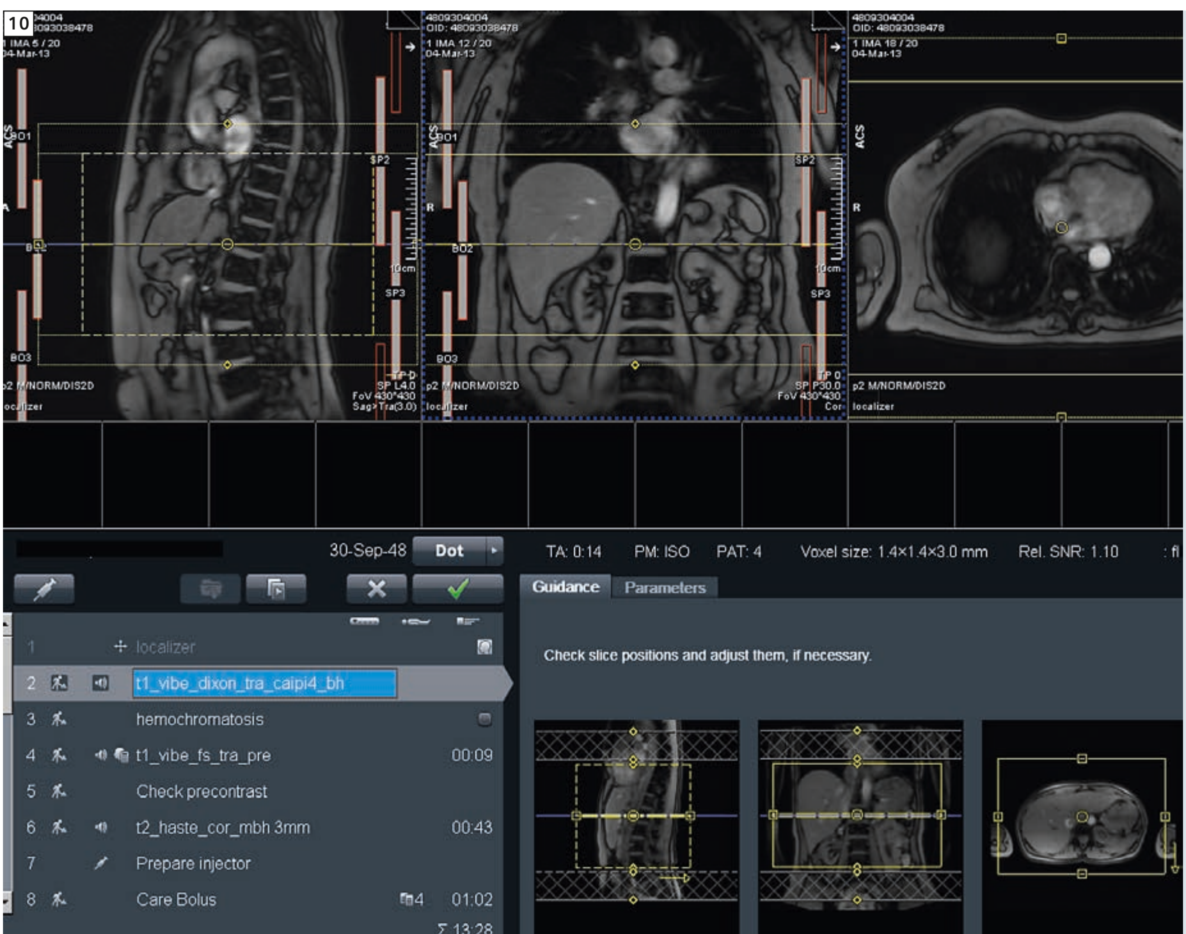
optional VAT (View Angle Tilting) technique. In Figures 6–8 I share some examples of real day-to-day cases.
Figures 7 and 8 show images of a female patient who has had osteosynthesis for tibial plateau fracture following a skiing accident 20 years ago. She had an MRI of the knee, after another skiing 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 CAIPIRINHIA 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-

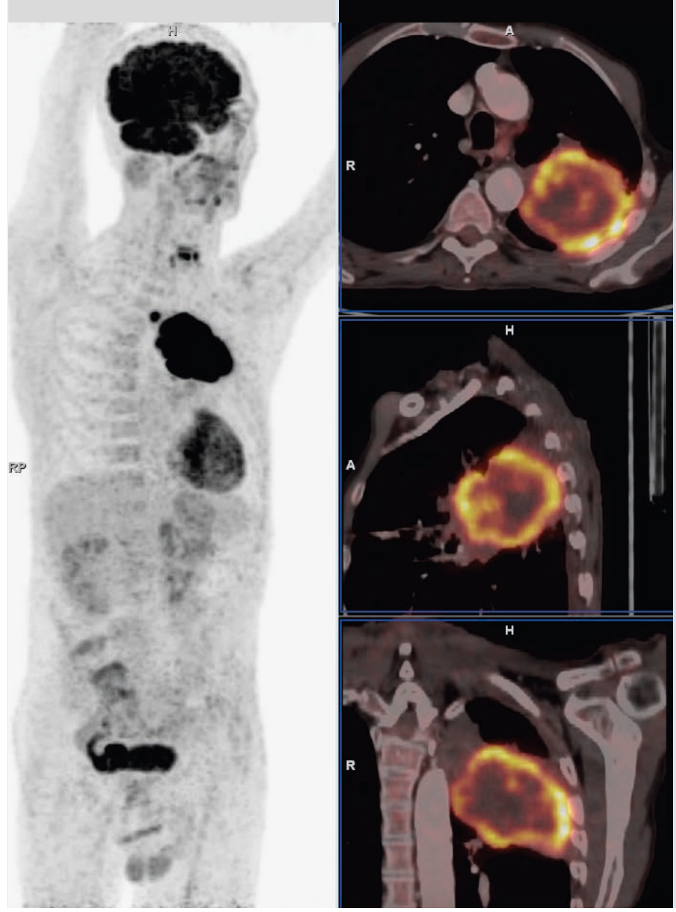


9 CAIPIRINHA PAT4 in 10 sec compared to PAT2 in 21 sec with same slice thickness and in-plane resolution.

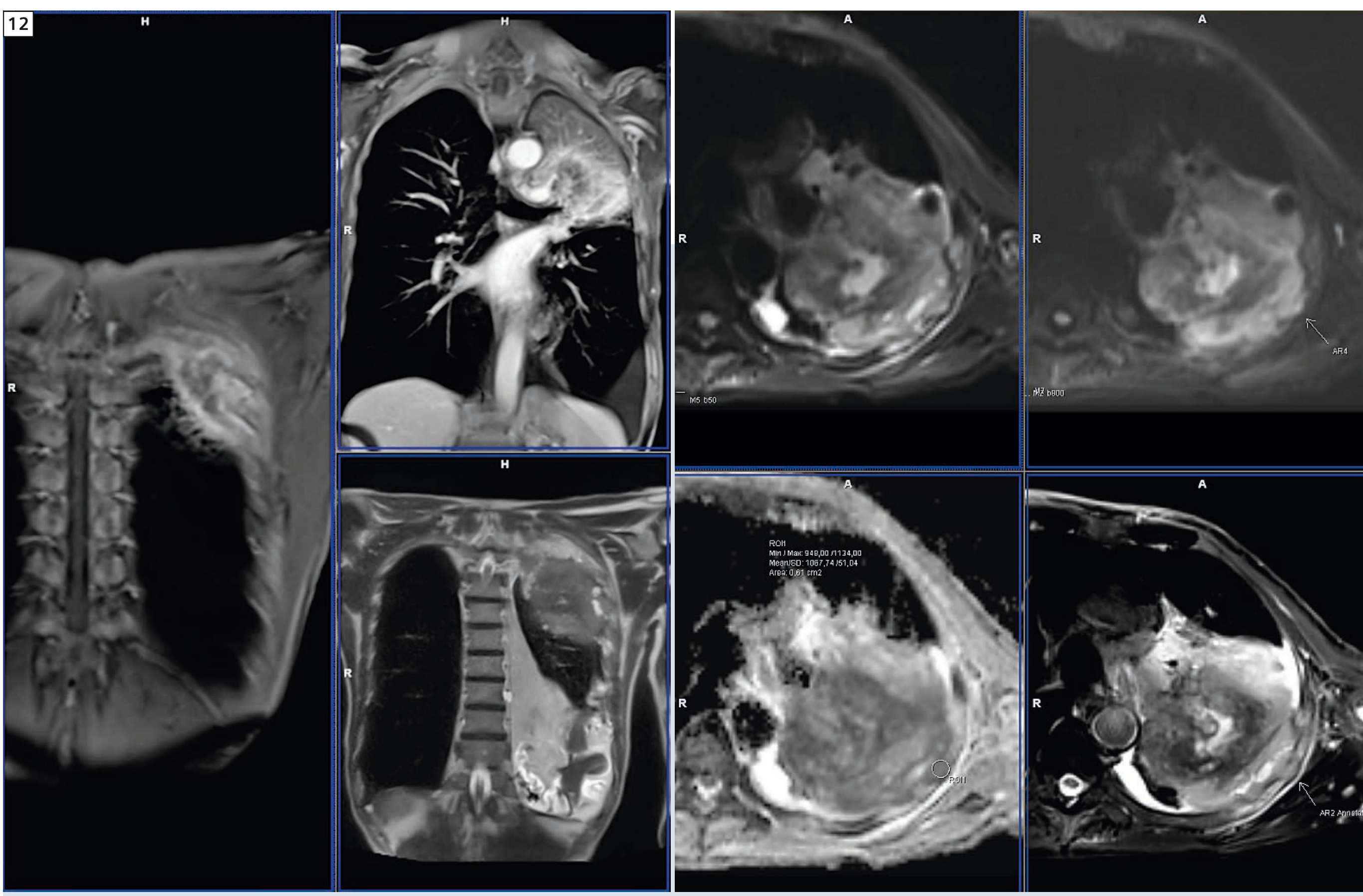


10 With CAIPIRINHA no trade-off between thick slice / large coverage or thin slice / partial coverage is necessary: we always scan full coverage with thin slices. The coverage is well seen in this screenshot (yellow dotted box top left, or yellow bold box top middle).

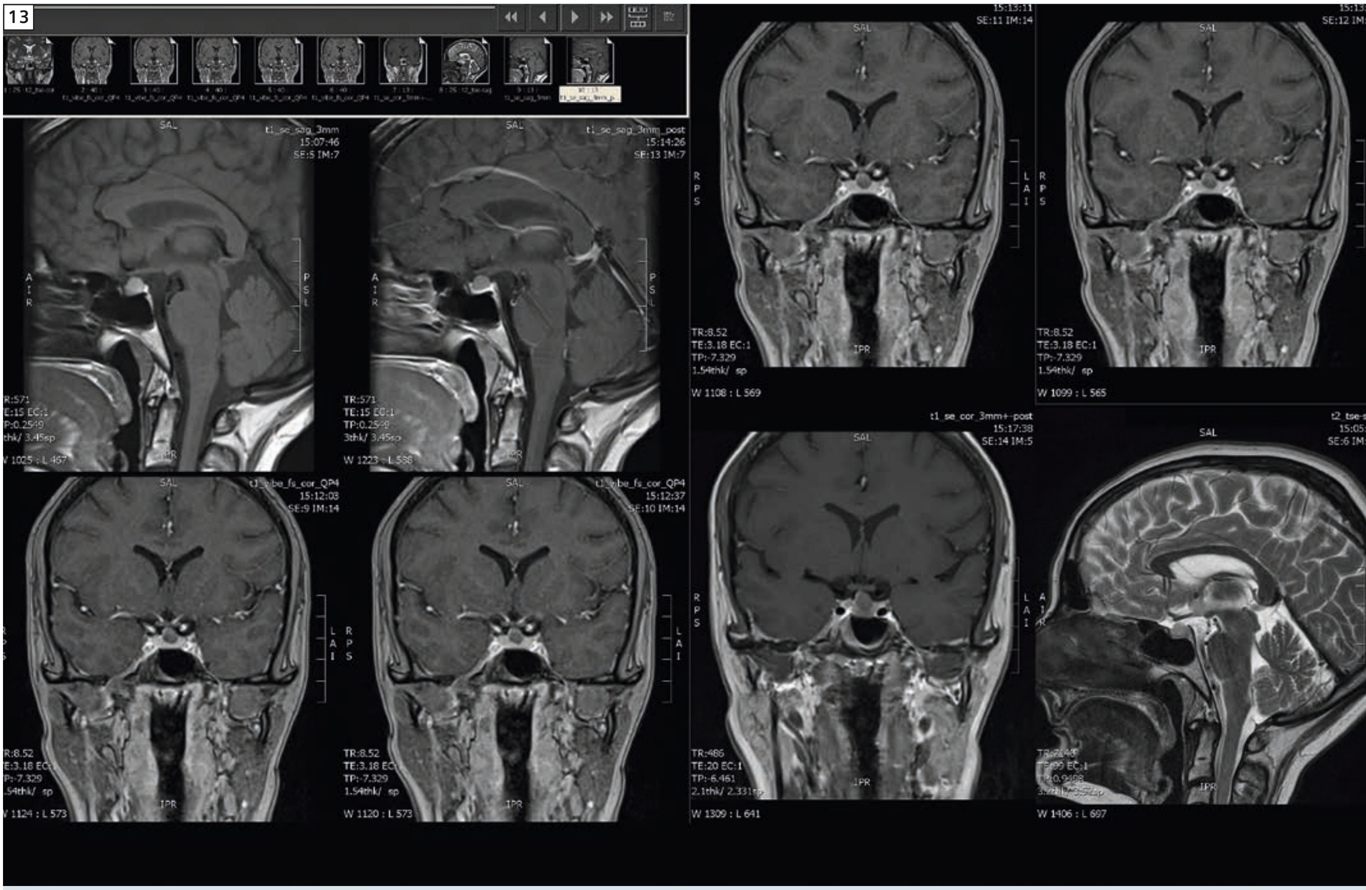
men and thorax benefits greatly from the Aera system. It all fits perfectly together. Here are some examples.
More signal in less scanning time! Figure 9 demonstrates how, in a liver examination in the same patient examined with CAIPI4, the images with a breath-hold of 10 sec have more signal than the 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 CAIPIRINHA PAT 4 VIBE sequences. Even this patient, who clearly is in a bad condition,



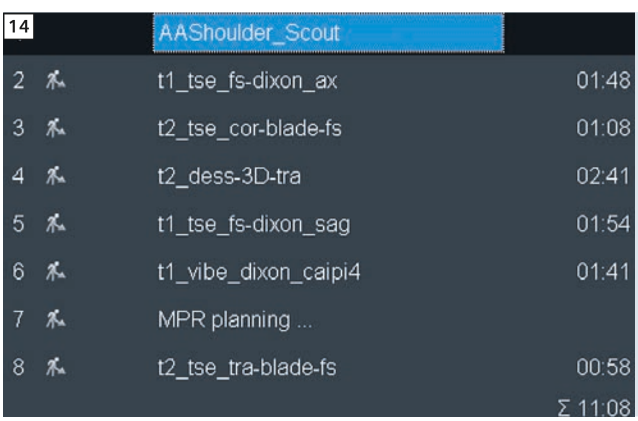
11 A case of a metastatic lung carcinoma where PET-CT was not able to exclude or confirm chest wall invasion.



12 CAIPIRINHA PAT4 VIBE post-contrast coronal showing the tumor (arrow) and lateral and dorsal chest wall invasion (small arrows). Axial T2w BLADE and free breathing DWI show the chest wall invasion with actual rib invasion.



13 Coronal dynamic sella imaging with CAIPI PAT4 VIBE in 34 seconds.



14 Screenshot showing 1.41 min CAIPI VIBE Dixon for 3D shoulder imaging. High SNR due to the 16-channel MSK coils allows us to use these fast sequences.

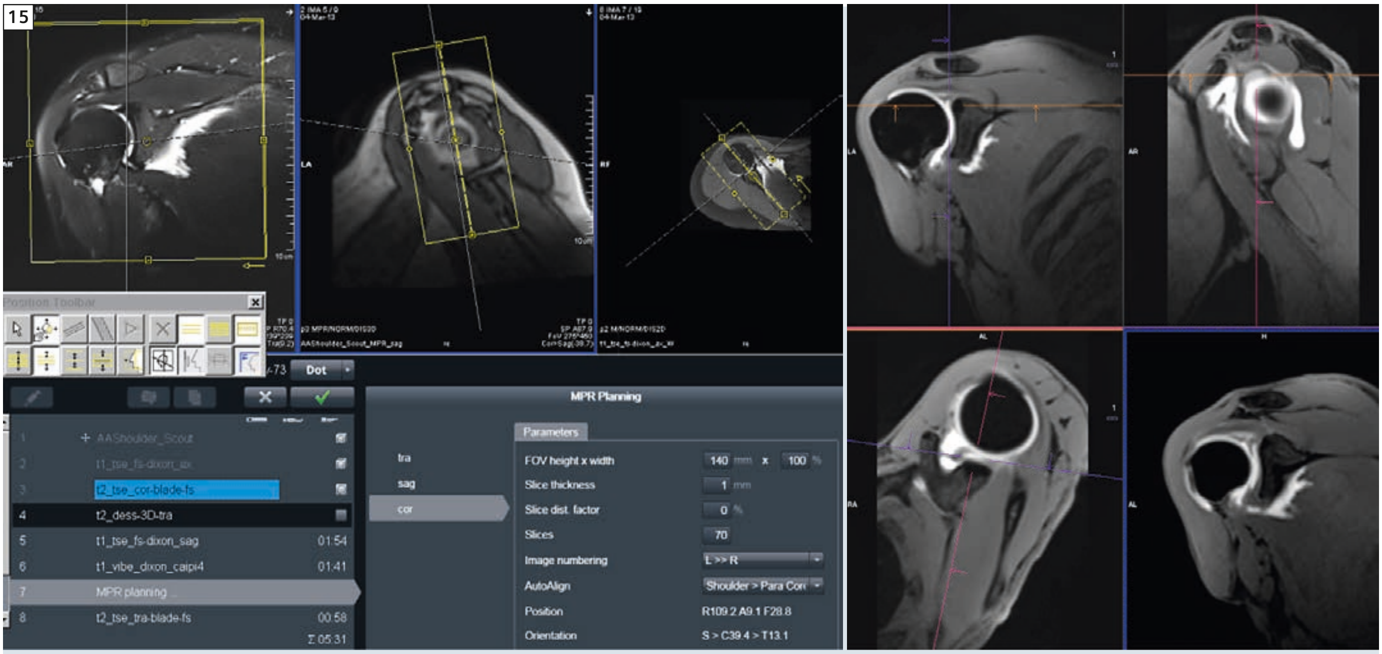
cooperated and tolerated the exam well. Invasion in the lateral and dorsal chest wall is readily depicted in both axial and coronal enhanced images. Axial T2w BLADE and free breathing diffusion-weighted imaging (DWI) confirm the chest wall invasion with actual rib invasion and the malignant nature is 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



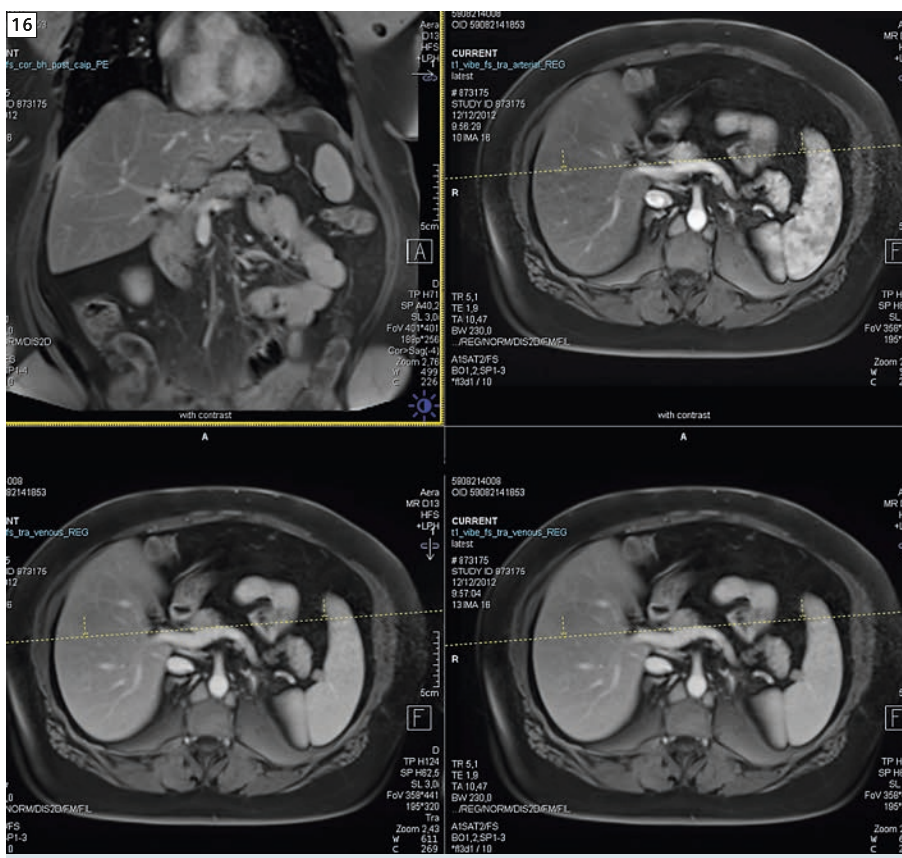
15 Shoulder Dot screenshot showing Inline MPR planning and VIBE CIAPI reformats.

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.



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

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 CAIPIRINHA 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 (*b*50 – *b*800 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.

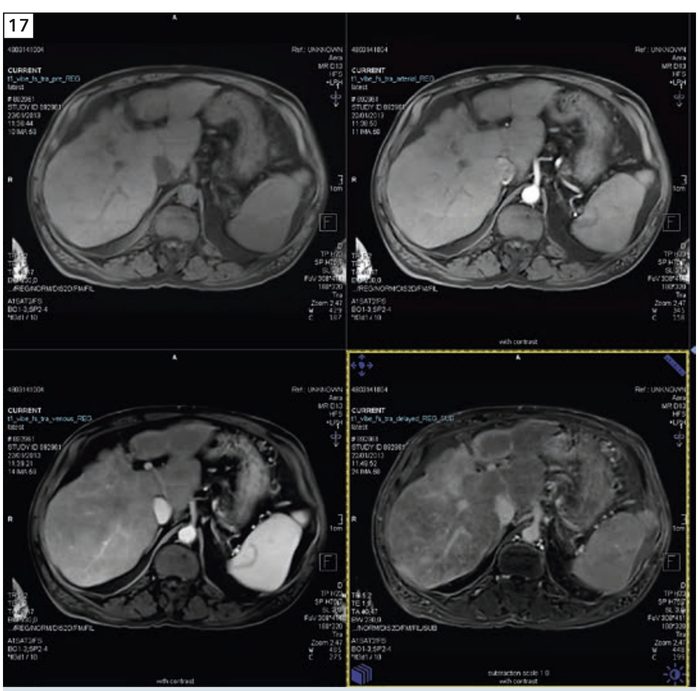
Section 7: excellent images in the head/neck region

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.

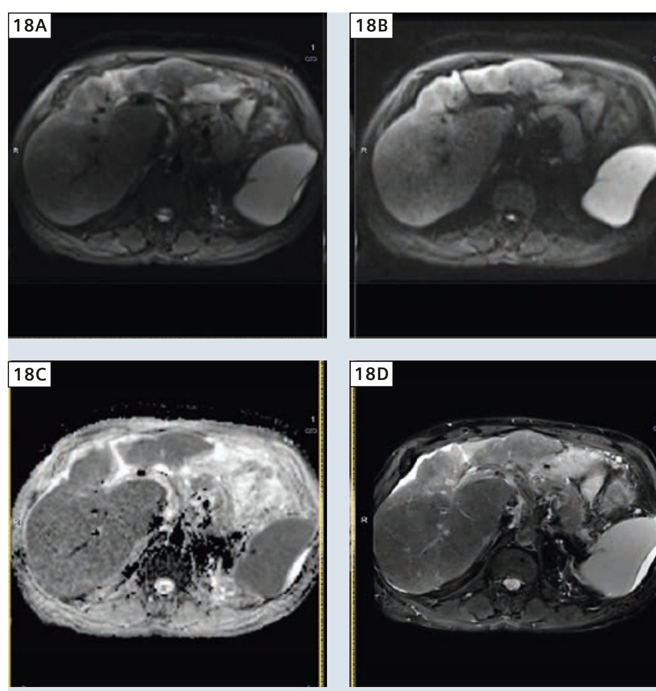
Figure 20 gives a nice example of metastatic melanoma after gadolinium enhancement: no artifacts in the base of the neck! DWI has also improved due to the gradient power enabling short TE thus minimizing artifacts.

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.

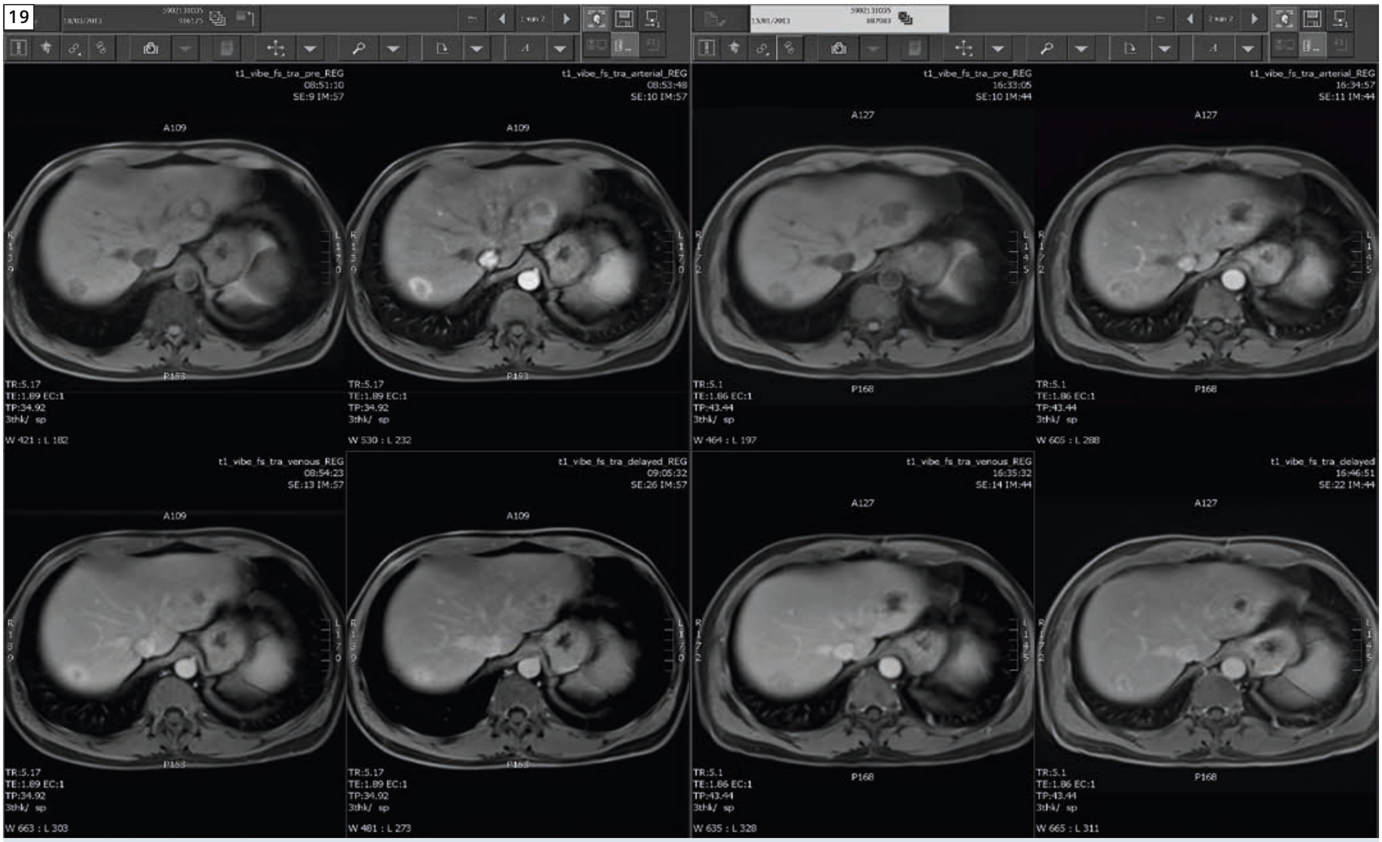
DWI can help in determining the nature of lesions, such as in the small benign mixed tumor (BMT) of the right parotid gland with high ADC value depicted in Figure 22.



17 Abdomen Dot ABLE technique helps ensure accurate dynamic liver phases even in cirrhotic livers.



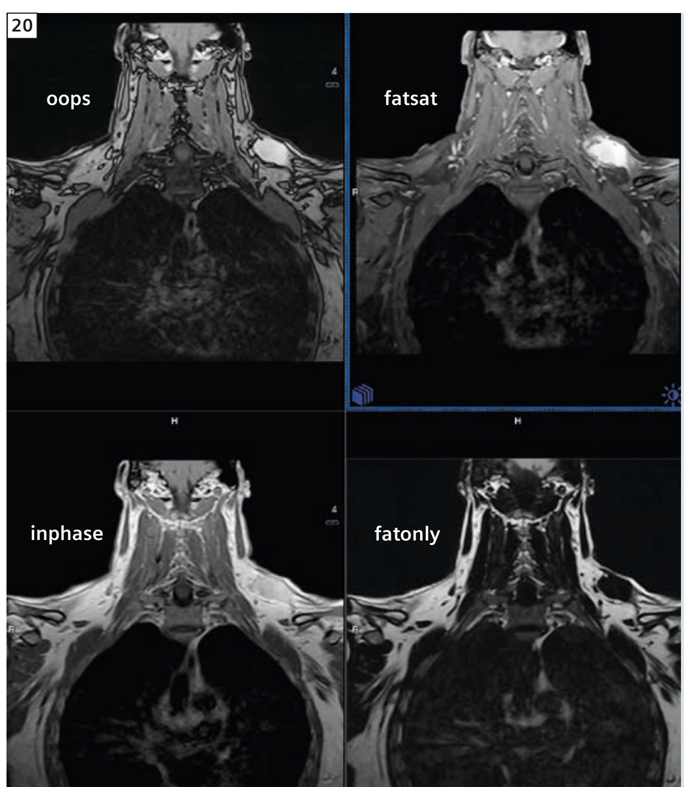
18 **(18A)** VIBE, **(18B)** DWI, **(18C)** ADC map and **(18D)** T2w BLADE all at almost similar slice positions. This helps in faster and more accurate reading and reporting.



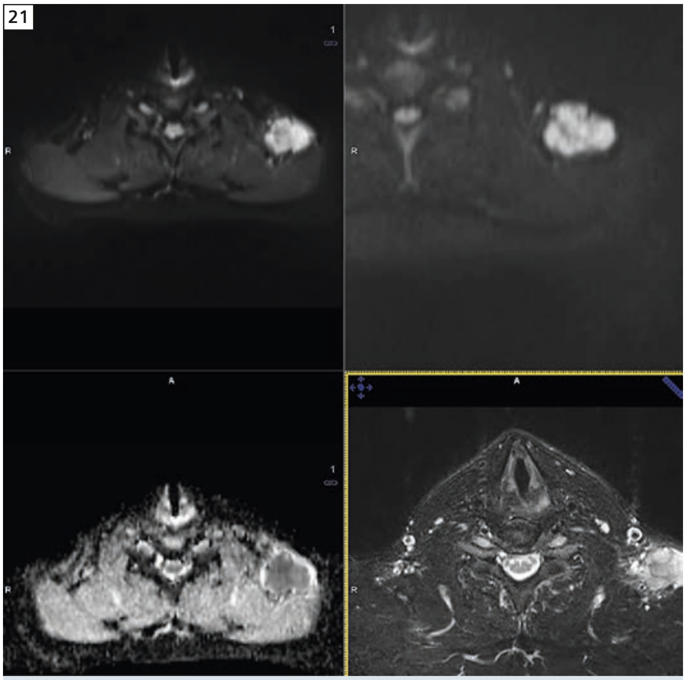
19 Shows the relevance of liver registration and synchronized viewing for efficiency.

Section 8: leveraging *syngo*.via

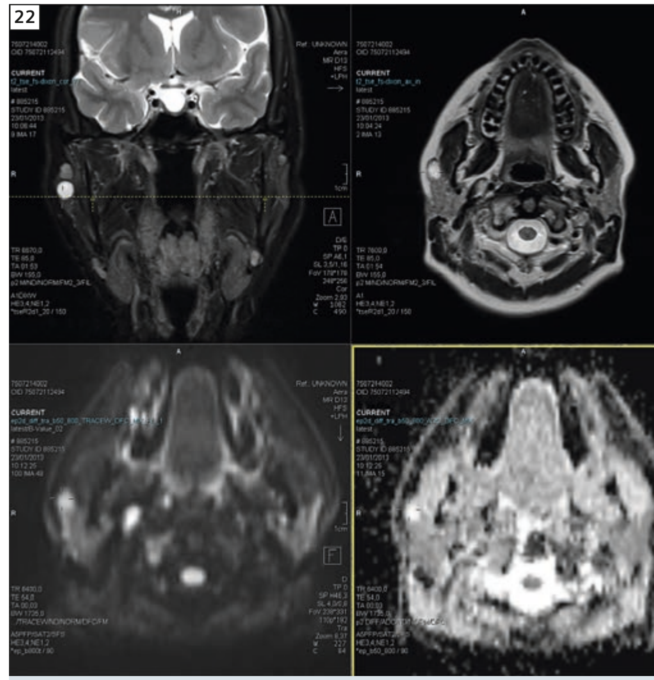
Presenting the roadmap to vascular surgeons has been made easier and better with *syngo*.via. The MIP and composing functionality helps us to integrate three 4D datasets for angiography of the aorta and lower limbs into one dataset and to present the roadmap to the vascular surgeons – something that 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



20 TSE Dixon showing In-phase, Out-of-phase, fat and water coronal in a case of metastatic melanoma post-contrast.)



21 CAIPIRINHA, axial, DWI, ADC map and Fatsat T2w axial?? Showing low ADC (arrow) metastatic melonoma.



22 Coronal T2w TSE, T2w axial showing hyperintense lesion. DWI and ADC map with high ADC (arrow) help confirm benign mixed tumor diagnosis.

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.

Contact
Johan Dehem, M.D
VZW Jan Yperman
Ieper
Belgium
johan.dehem@gmail.com

Further information

Visit us at
www.siemens.com/magnetom-world
to listen to Dr. Dehem's talk on **Highest Quality Imaging in an Optimized Clinical Workflow** given during the lunch symposium at the 15th International MRI Symposium MR 2013 in Garmisch-Partenkirchen, Germany.

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Johan Dehem, M.D.
VZW Jan Yperman
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Global Business Unit

Siemens AG
Medical Solutions
Magnetic Resonance
Henkestraße 127
DE-91052 Erlangen
Germany
Phone: +49 9131 84-0
www.siemens.com/healthcare

Local Contact Information

Asia/Pacific:
Siemens Medical Solutions
Asia Pacific Headquarters
The Siemens Center
60 MacPherson Road
Singapore 348615
Phone: +65 6490 6000

Canada:
Siemens Canada Limited
Healthcare Sector
1550 Appleby Lane
Burlington, ON L7L 6X7, Canada
Phone +1 905 315-6868

Europe/Africa/Middle East:
Siemens AG, Healthcare Sector
Henkestr. 127
91052 Erlangen, Germany
Phone: +49 9131 84-0

Latin America:
Siemens S.A., Medical Solutions
Avenida de Pte. Julio A. Roca No 516, Piso
C1067 ABN Buenos Aires, Argentina
Phone: +54 11 4340-8400

USA:
Siemens Medical Solutions USA, Inc.
51 Valley Stream Parkway
Malvern, PA 19355-1406, USA
Phone: +1 888 826-9702

Global Siemens Headquarters

Siemens AG
Wittelsbacherplatz 2
80333 Muenchen
Germany

Global Siemens Healthcare Headquarters

Siemens AG
Healthcare Sector
Henkestraße 127
91052 Erlangen
Germany
Phone: +49 9131 84-0
www.siemens.com/healthcare

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