MAGNETOM Skyra: The Mannheim Perspective

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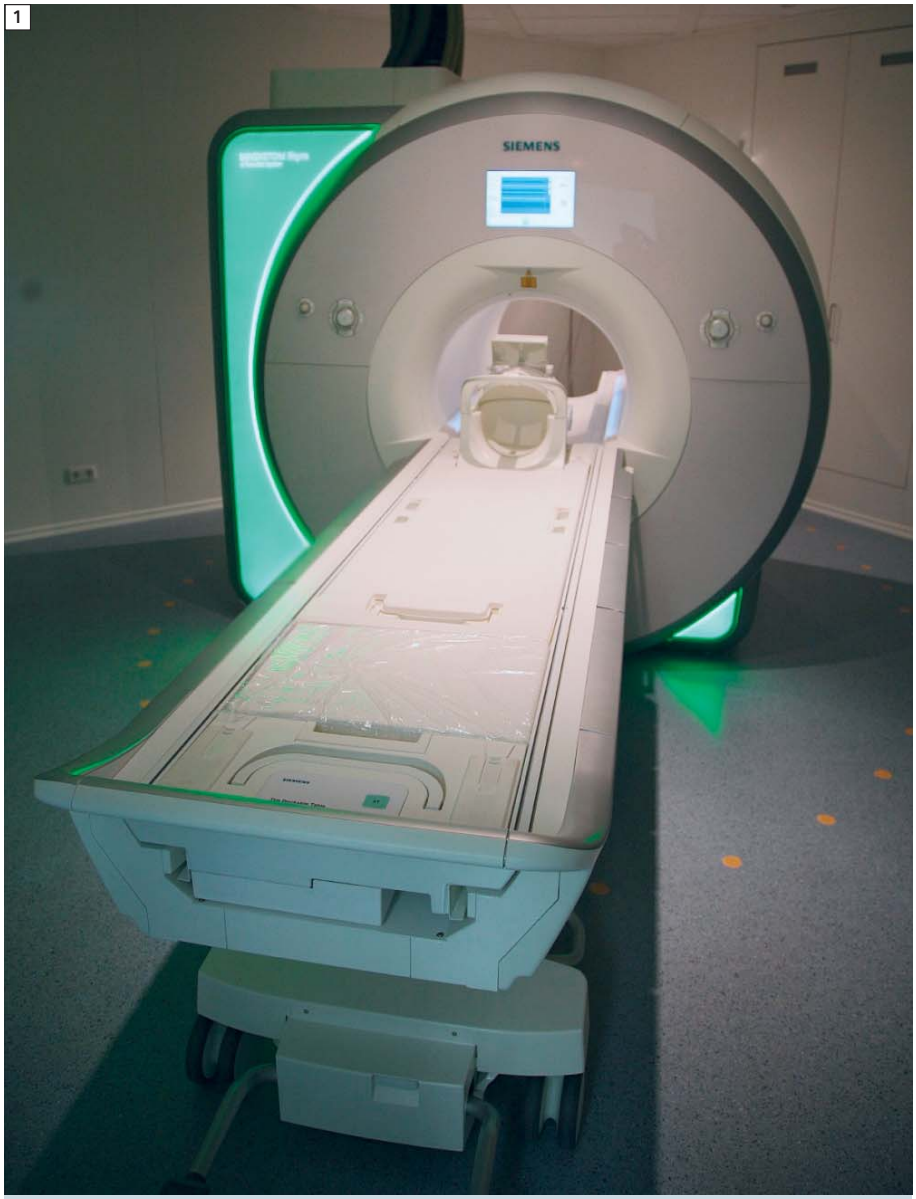
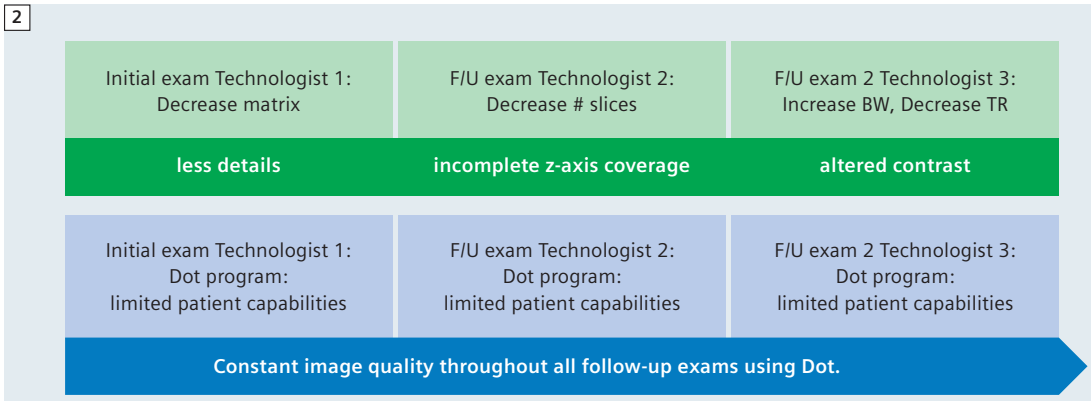
Introduction

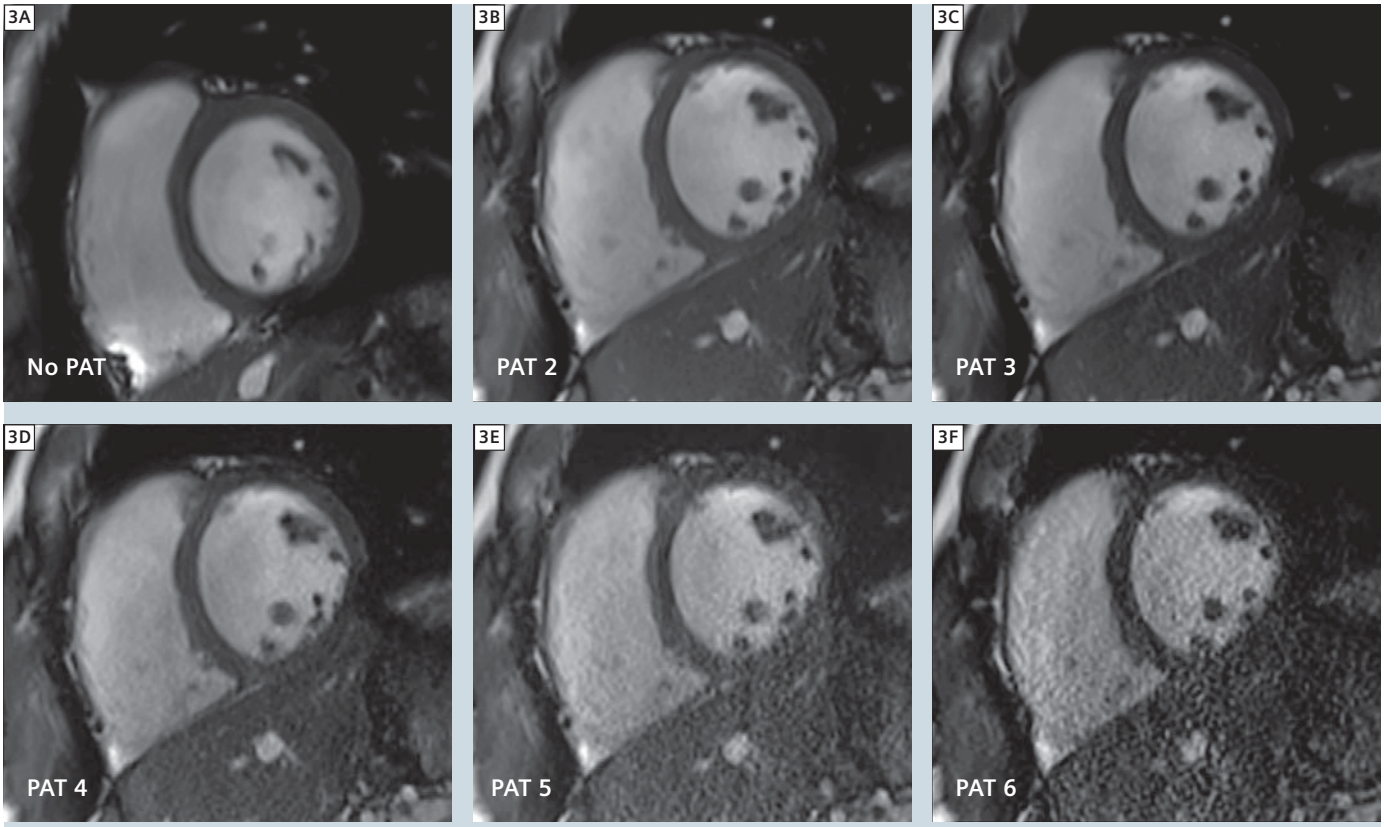
For over one year the 3T MAGNETOM Skyra has been used for scientific projects and clinical imaging at the University Medical Center (UMM) Mannheim. The UMM Mannheim was the first site in the world to install the Skyra. In order to meet the high requirements for state-of-the-art imaging with high spatial resolution and fast scan times, a fully equipped version of the Skyra with XQ gradients and 64 independent receive channels was installed. The small space requirement of the Skyra meant that it could be installed completely within the previous technical cabinet of a former 1T Siemens MAGNETOM Harmony. This enabled us to install the Skyra as the fourth scanner in our MR-facility, alongside a 1.5T MAGNETOM Sonata, a 1.5T MAGNETOM Avanto and a 3T MAGNETOM Trio. This allows us to easily switch patients between the scanners and to run all four scanners with just a small number of technologists. The scanner was installed in such a way that the dockable table can be moved out of the scanner room in the shortest possible way in order to facilitate patient transport into and out of the scanner. All four scanners are operated from 7 am to 8 pm, hence yielding a high patient throughput. The focus of our hospital is translational research in the fields of abdominal imaging and oncologic imaging while all other imaging areas such as musculoskeletal imaging and neurologic imaging are also offered.



1 MAGNETOM Skyra with MoodLight illumination installed in Mannheim.



2 Clinical scenario – 80-year-old patient with problems holding her breath with repeated follow-up exams.

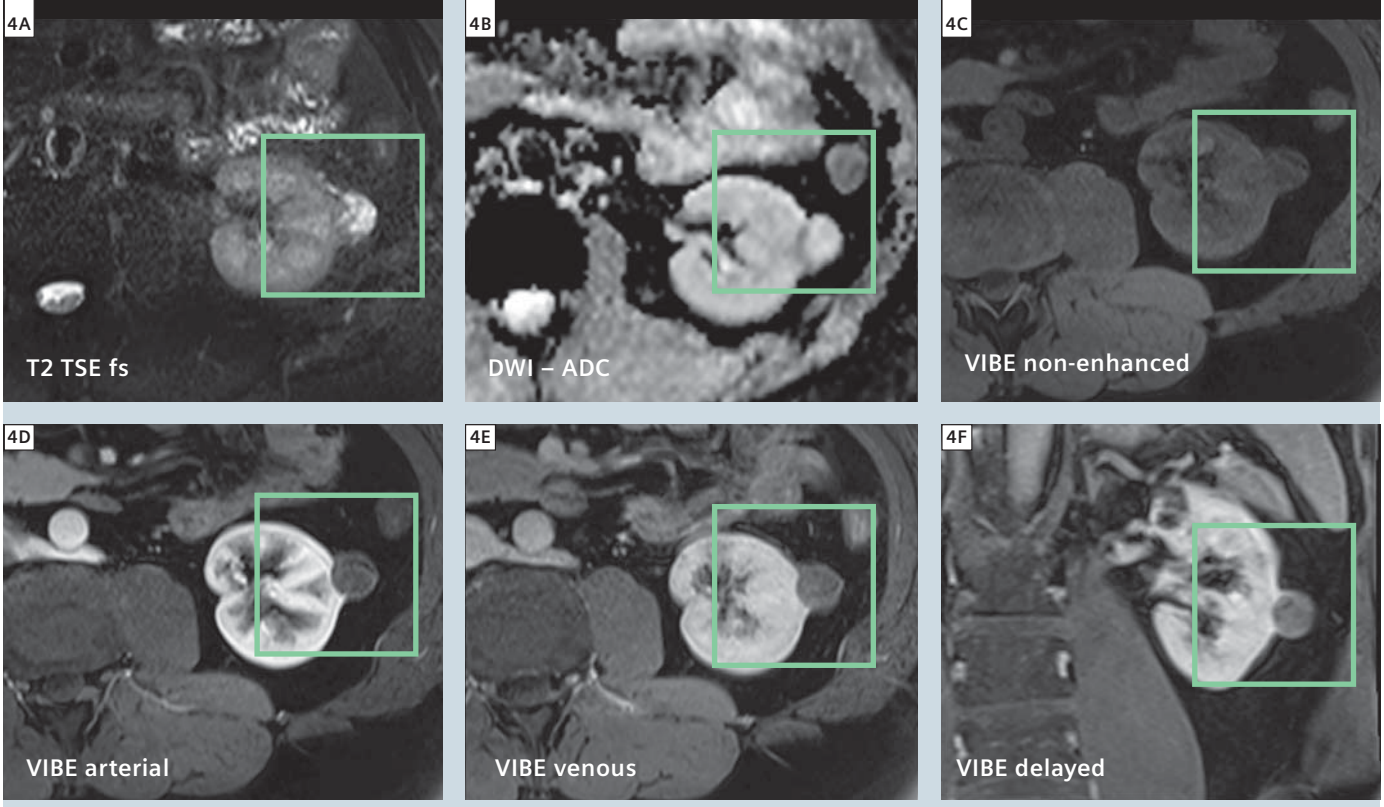


3 Using up to 30 coil elements for cardiac studies (18-element body matrix coil and 12 elements of the 32-element spine matrix coil) allows for high parallel imaging factors (up to 4) in clinical routine applications. With further developments even higher PAT factors of 5–6 will be clinically available.

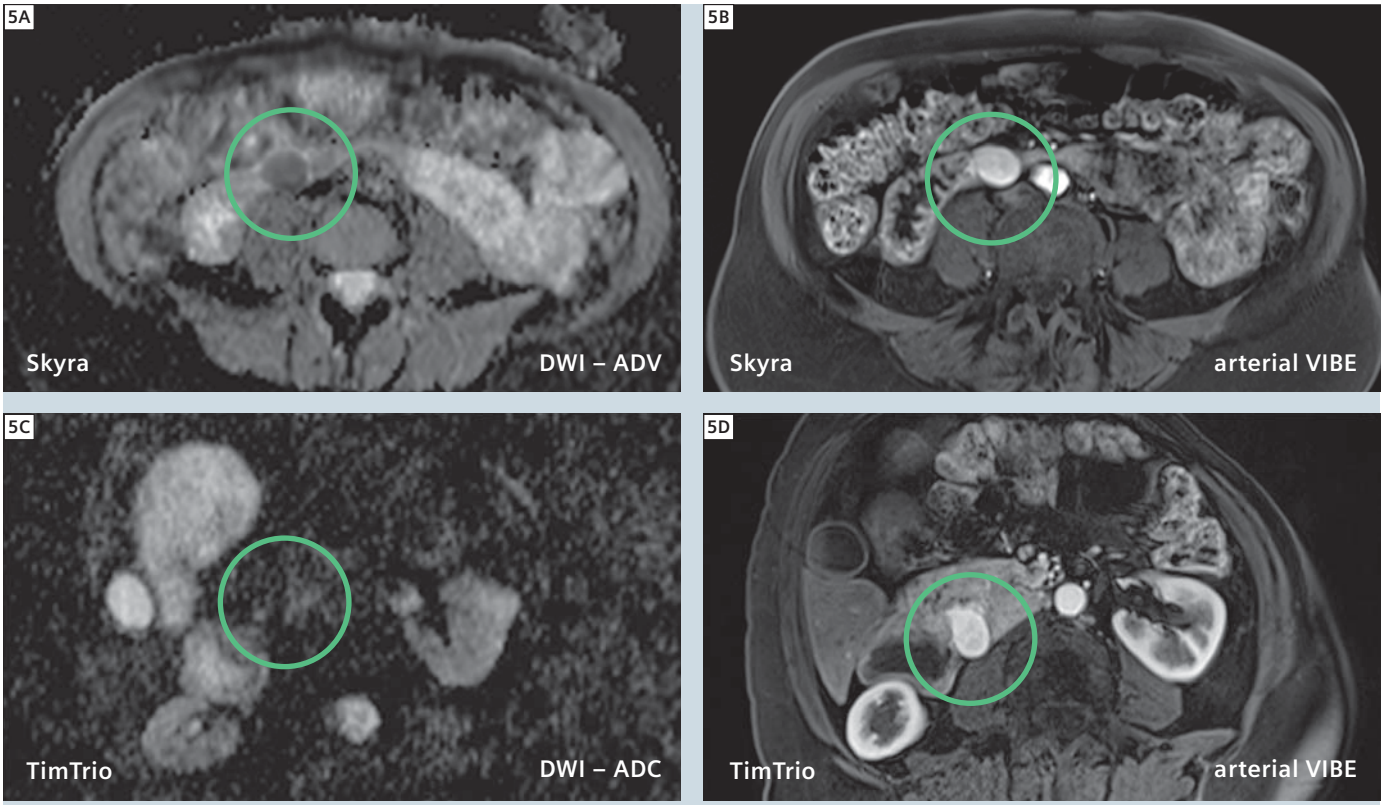
Patient acceptance

Except for the MAGNETOM Skyra all our MR-units are characterized by a 60 cm-wide bore with a length of between 160 cm and 213 cm. So far, 15% of patients have declined an examination because of claustrophobia. Another 5% of our patients could not be examined because of a too big circumference of the abdomen not allowing a positioning of the patients in the conventional MR-scanners. For these two reasons, one of the prerequisites for the fourth scanner to be installed was a wide bore and a maximum of patient comfort.

Patient comfort also included installation of the Illumination MoodLight feature. In summary, the MAGNETOM Skyra combines a 70 cm Open Bore and 173 cm short system design with variable bright outside illumination and light strips inside the bore that further



4 Histologically proven carcinoma of the cyst wall which can only be appreciated in the ADC map where a local restriction of the diffusion can be seen. The contrast-enhanced studies do not allow a delineation of this lesion.

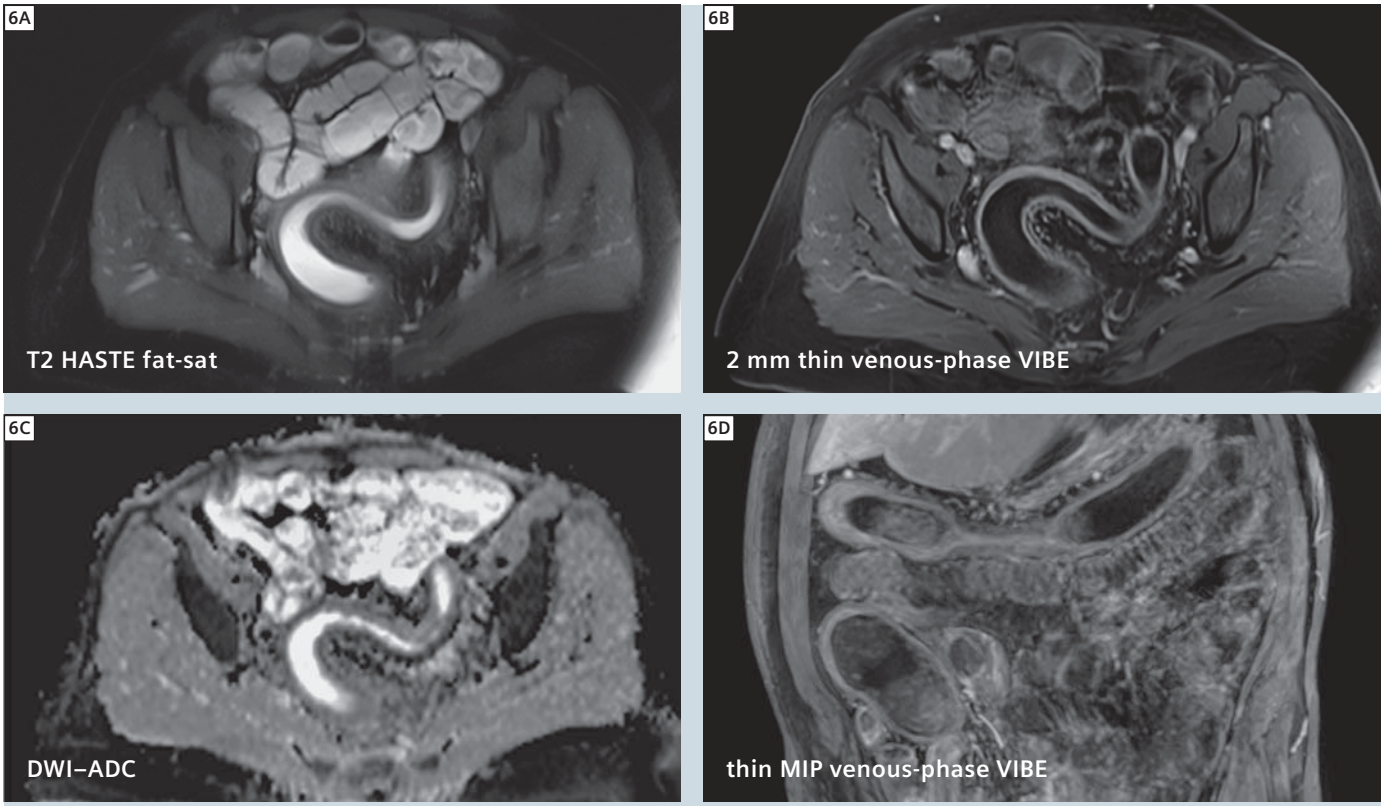


5 Intraindividual comparison study acquired at the 3T MAGNETOM Trio with Tim (lower row) and the 3T MAGNETOM Skyra (upper row, 6 months later). A hypervascular mass can be clearly seen on both arterial phase VIBE images while only the DWI-imaging acquired at the Skyra allows characterizing the mass. Surgery revealed a gastrointestinal stromal tumor (GIST).

decrease patients' anxiety. So far, not a single patient declined an examination in the Skyra due to claustrophobia, which is particularly important for patients in longitudinal research studies. In contrast, a whole new group of patients could be acquired in the meantime: claustrophobic patients and obese patients who could only be examined in low-field open 1T scanners. Approximately 25% of all patients currently examined on the Skyra belong to this latter group. A further potential benefit of the system which has not been fully exploited so far is the imaging of anesthetized patients requiring close medical surveillance. The open and wide bore enables an easy surveillance of the patient with the potential for, e.g., optimal access to a respiratory tube.

User interface

The MAGNETOM Skyra is equipped with a new software platform, *syngo* MR D11 (current version D) that has provided technologists with several positive changes. The MR D11 platform is based on the well-known MR B and MR A *syngo* versions running on all current Siemens MR scanners and hosts various features. The user interface (UI) has been graphically overhauled with unchanged *syngo* functionality so that clinical and research users familiar with *syngo* can immediately start working. Beyond the visible changes in the UI, further technical improvements have been implemented that aim mainly at facilitating and accelerating the actual process of image acquisition. Some well-known features of *syngo* such as AutoCoilSelect have been extended to now include AutoPosition and automated localizers. Based on the registration of the patient (height/weight) and the body part/exam chosen for the examination the Skyra can automatically start the acquisition and hence save time and – furthermore – unnecessary mouse clicks. The most powerful new tools, however, are the so called Dot (Day optimizing throughput) engines. The Dot engines represent a complete customizable system of automatization, standardization and guidance for technologists. In neuro-imaging, for example, the Dot engine automatically aligns the images and chooses the appropriate FOV. Based on the examination strategies as defined by the user, different protocols will be employed: a standard head exam, an exam based on BLADE sequences in the case of non-cooperative patients or dedicated sequences in case of a special exam focus. In cardiac imaging the Dot

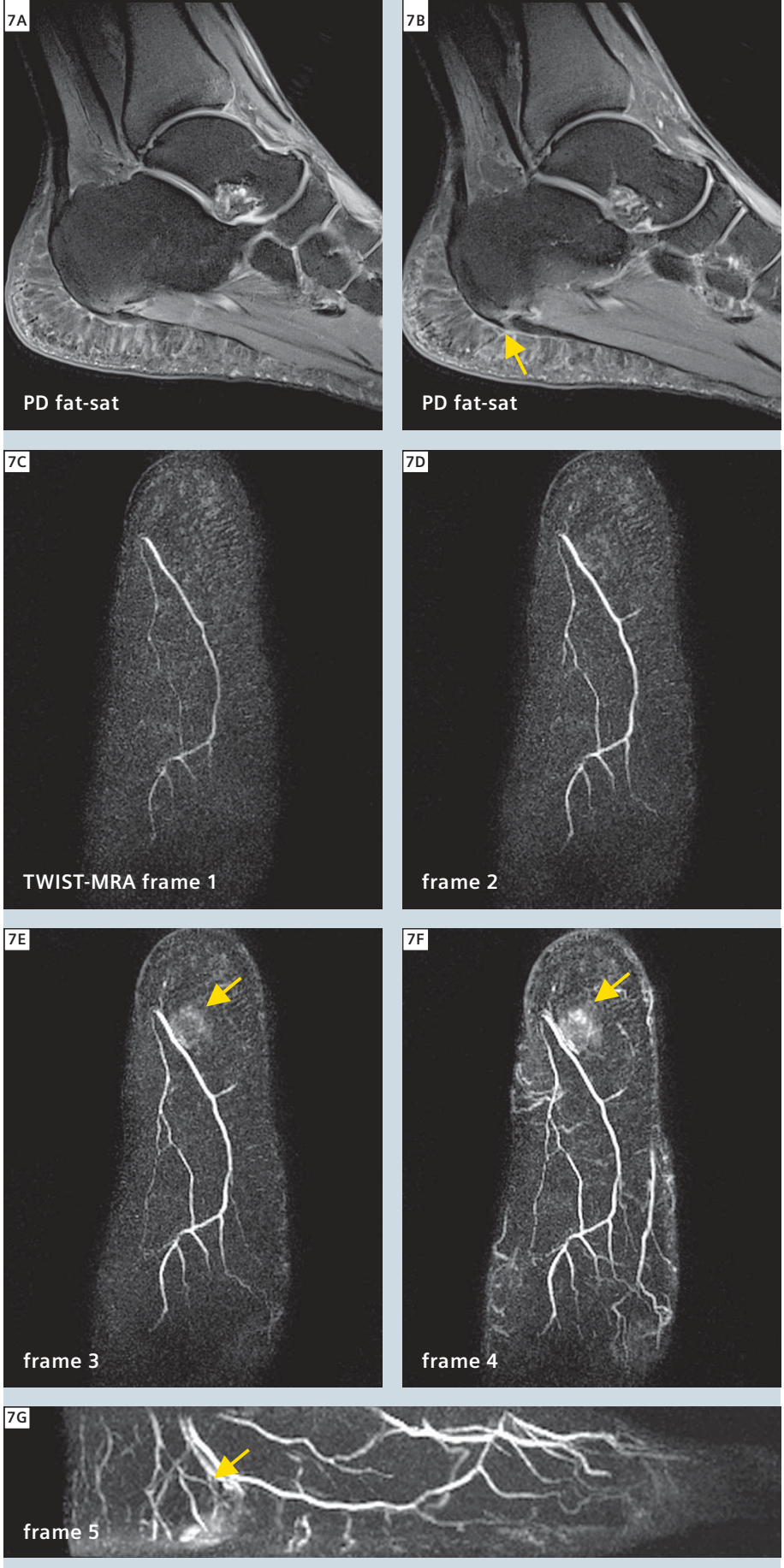


6 Long-segment inflammatory changes in the entire colon of a patient suffering from ulcerative colitis. Bowel wall thickening can be seen in the T2w-images as well as in the T1w-images post contrast but also in the DWI-sequence where a restriction of the diffusion can clearly be seen. Please note the normal appearance of the small bowel.

engines provide special guidance images that support less experienced technologists in the complex positioning for cardiac exams. Also, a single mouse click will change, for example, the cardiac gating of all following sequences. Overall, the main benefit of the Dot engines is not to obviate the need for technologists but 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.

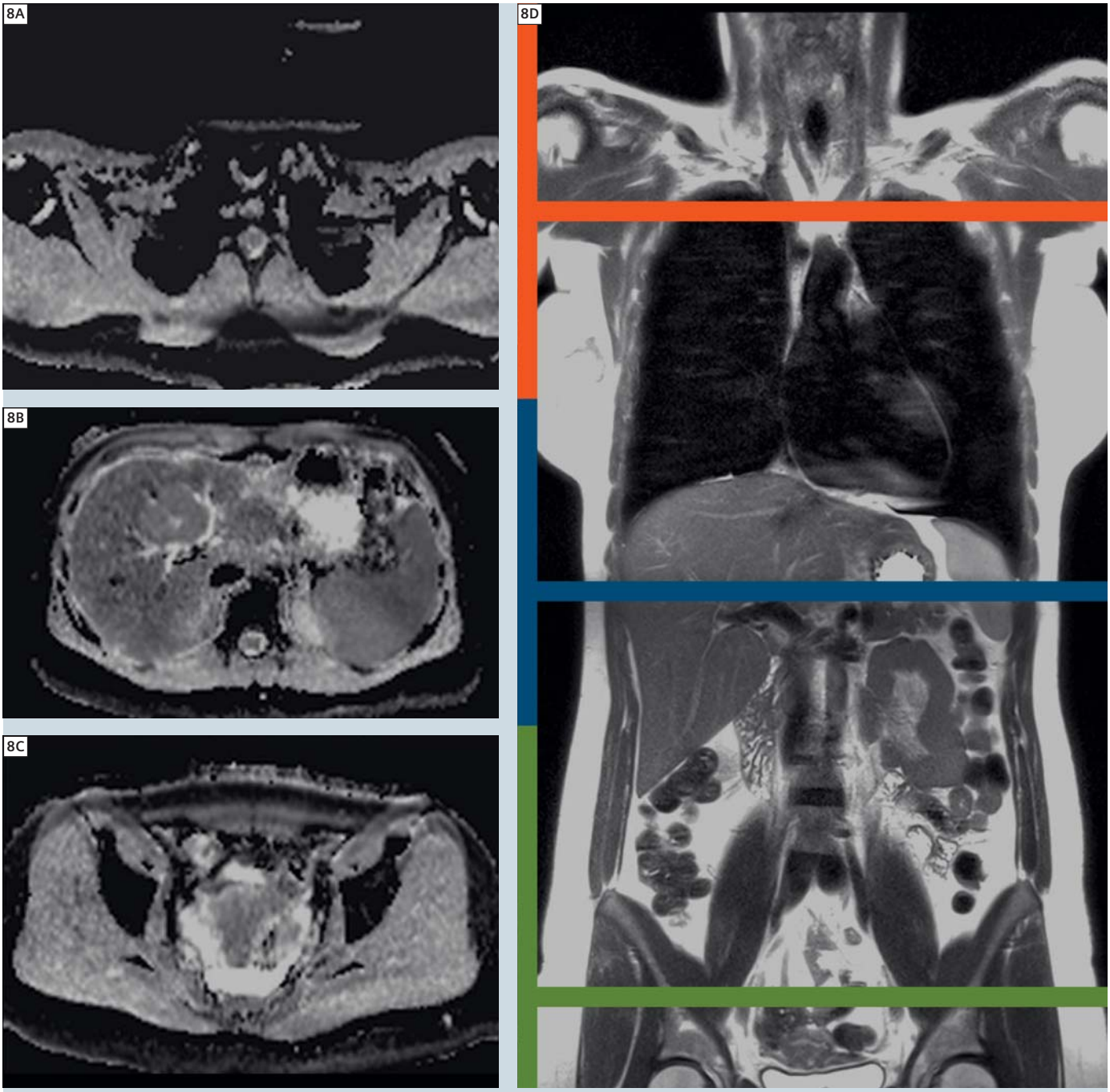
Imaging capabilities

The MAGNETOM Skyra overcomes typical B_1-imhogeneities that used to degrade image quality in the spine, abdomen or neck region by a two-way RF-transmission, the TimTX TrueForm technology. Compared to conventional 3T MR-scanners the number of non-diagnostic MR-examinations of the upper abdomen or of the neck could be reduced to virtually zero. While T1w-imaging is less affected by field inhomogeneities (if no fat-sat is applied) T2w-sequences and diffusion-weighted imaging (DWI) massively profit from the two-way excitation in the abdomen. Non-diagnostic image quality of abdominal T2w-sequences has not occurred on our system so far. DWI is notorious for ghosting artifacts in the presence of field inhomogeneities.

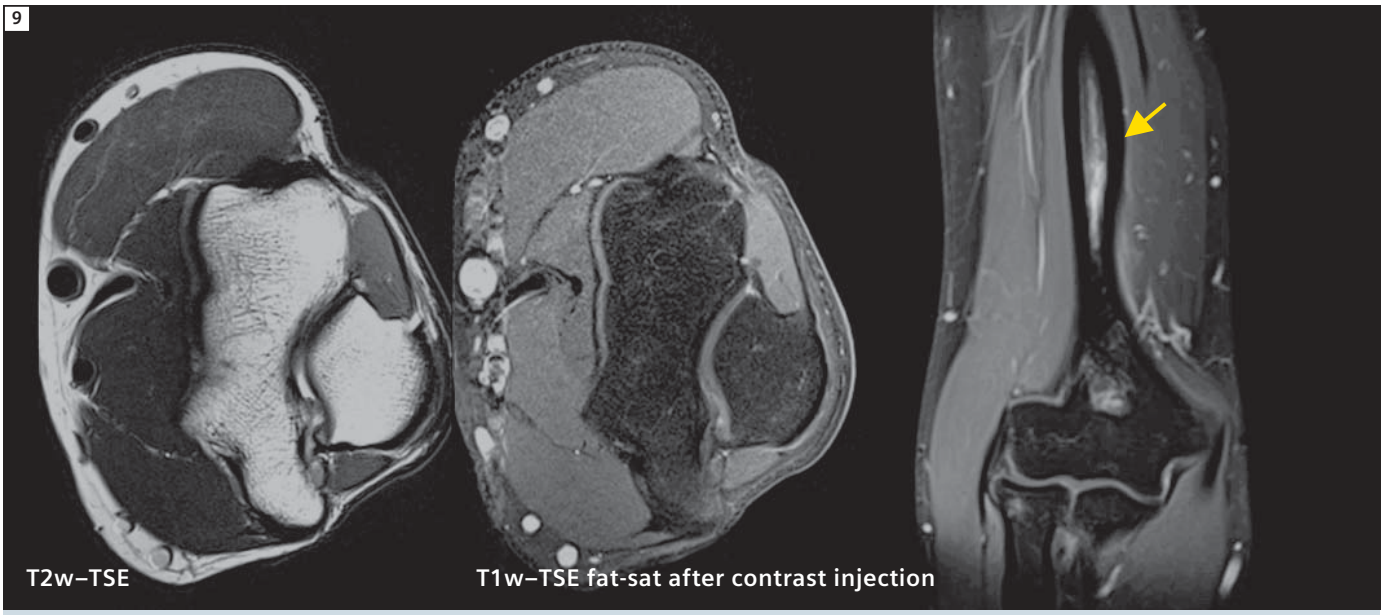


7 Bony spur of the calcaneus barely seen on the 2 mm thin sagital PDw-images (small arrow) but clearly seen as focus of intense, inflammatory contrast enhancement in the time-resolved TWIST MR angiography (arrows).

With conventional 3T MR-scanners only 30–40% of all examinations yielded robust image quality – whereas Skyra has sustainably increased robustness, leading to a technical success rate of more than 85%. The robustness of abdominal DWI with MAGNETOM Skyra can now be compared to the robustness of 1.5T acquisitions – yet higher b-values of up to 1200 of good quality can be acquired with Skyra. The high SNR achieved with Skyra can also be accounted for by the newly designed multi-element coils ranging, for example, from an 18-channel body matrix coil over a 20-element head and neck



8 Coronal composed large z-axis (45 cm) field-of-view T2-HASTE sequence that shows homogenous image quality throughout. Due to the 2-way RF-excitation homogenous DWI-imaging can be acquired in the upper thorax (red), the abdomen (blue) or the pelvis (green) with minimal artifacts.



9 2 mm thin slices acquired off-center in this young patient with elbow pain demonstrate homogenous image quality. The homogenous fat sat shows a contrast-uptake in the humeral diaphysis (arrow).

coil to dedicated 16-element extremity coils. The two 18-element body matrix coils mean that large-field-of-view imaging of the abdomen with isotropic voxel size of 1.3–1.7 mm (depending on patient size) has become the clinical standard. The 45 cm z-axis FOV enables depiction of the entire abdomen in patients with, for example, Crohn's disease. While the dynamic T1w-VIBE sequences perfectly demonstrate the anatomy of the organs and vessels as well as the pathologic enhancement areas, DWI sequences can be added to further assess the bowel wall and to characterize potential inter-enteric abscesses. As a matter of course the higher robustness and SNR of DWI with Skyra is a valuable tool for the detection and characterization of complex renal masses such as complex renal cysts. The new extremity coils e.g. allow the acquisition of high-resolution images of the knee or the shoulder with an acquired slice thickness of 2 mm and inplane resolutions of 0.3–0.5 mm². In imaging of the wrist even 1.5 mm thin slices can be acquired with excellent image quality. Imaging of the shoulder, elbow and wrist reveal a homogenous fat-saturation even though they have to be positioned off-center, which clearly differentiates the MAGNETOM Skyra from conventional 3T MR-scanners. Overall, this excellent quality of DWI studies in the body opens the field for 3T MRI as the leading tool for cancer diagnosis and response evaluation of innovative therapies.

Summary

MAGNETOM Skyra is a well-balanced MR-system with the highest technical standards that allows imaging with high reliability and highest image quality throughout the body, thanks mainly to the new coil design in combination with the TimTX TrueForm technology. The new UI in combination with the Dot engines elevate also the user performance to a higher level and allow for better image consistence with less user-interference. As successful image acquisition is ultimately dependent on patients' corporation, the wide and short bore with internal and exterior illumination takes patients' fear away and guarantees in combination with the fast protocols high patient satisfaction. Its unique image quality, versatility and standardization of complex exams make it particularly attractive as a state-of-the-art system for both research and clinical studies.

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