

syngo TimCT – MR Angiography in Clinical Routine

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The University Medical Center Mannheim currently operates five MR units (2x 3T equipped with latest Tim technology and with at least [10x32] channel configuration. 1x 1.5T non-Tim system and 2x 1.5T with [76x32] channel configuration. All scanners equipped with Tim technology are equipped with the *syngo* TimCT-Oncology and *syngo* TimCT-MRA suites.

Background

Due to a very close cooperation with the departments of vascular surgery and angiology, 8–10 patients with suspected or proven peripheral arterial obstructive vascular disease (PAOD) are examined per week. Because of its non-invasiveness and the good depiction of smallest vessels even with heavy calcification, MR Angiography (MRA) of the lower extremity is considered the most appropriate diagnostic imaging technique for PAOD (Fig. 1). Recent data on the accuracy of 3T MRA of the peripheral arteries in patients with PAOD showed a sensitivity of MRA of 95.3% and a specificity of 98.5% when compared to conventional, invasive DSA [1]. A major disadvantage of conventional large field-of-view (FOV) imaging, such

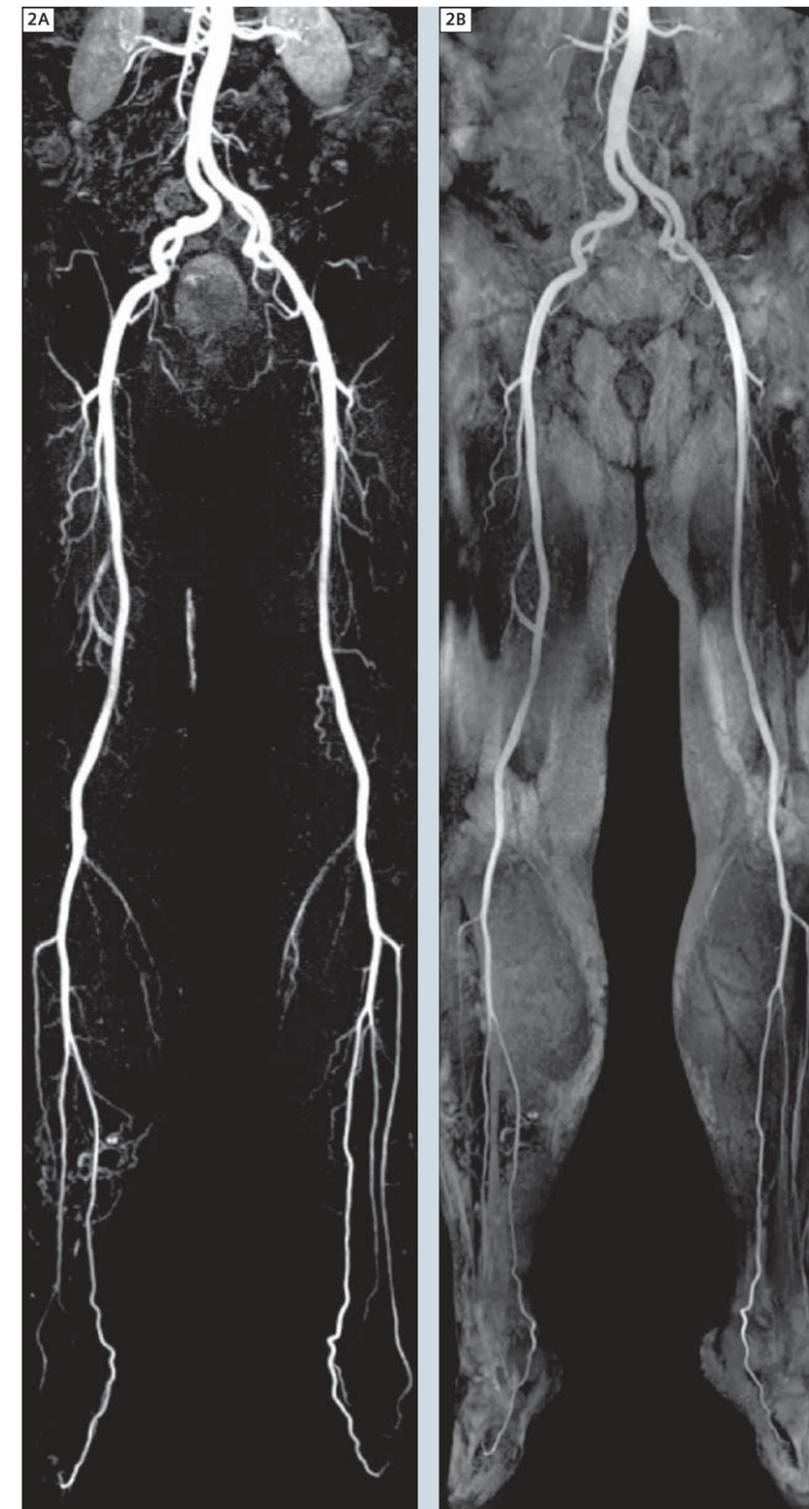
as bolus-chase stepping table MRA, is the complexity of the exam. Three different FOVs have to be planned and examined step-by-step. Thus, images are not acquired as one complete set of data but in several steps. This is error-prone on the one hand and time-consuming on the other hand, in terms of setting up the exam and of actually performing the exam. Afterwards, the images are composed for reading and for demonstration in clinical case conferences. However, the image quality in the overlapping sections of the composed images at the end of the individual FOVs is more likely to be artifact-ridden so that, in the worst case, erroneous interpretation can occur. If MRA images are not composed and are presented as single FOV series, the images are much harder to comprehend for the referring clinical colleagues.

syngo TimCT-MRA advantages

The *syngo* TimCT-MRA application overcomes these problems by offering a continuous table movement during acquisition of a three-dimensional MRA data set with a continuous z-axis FOV of up to 1200 mm. The single steps of conventional MRA are limited to a FOV



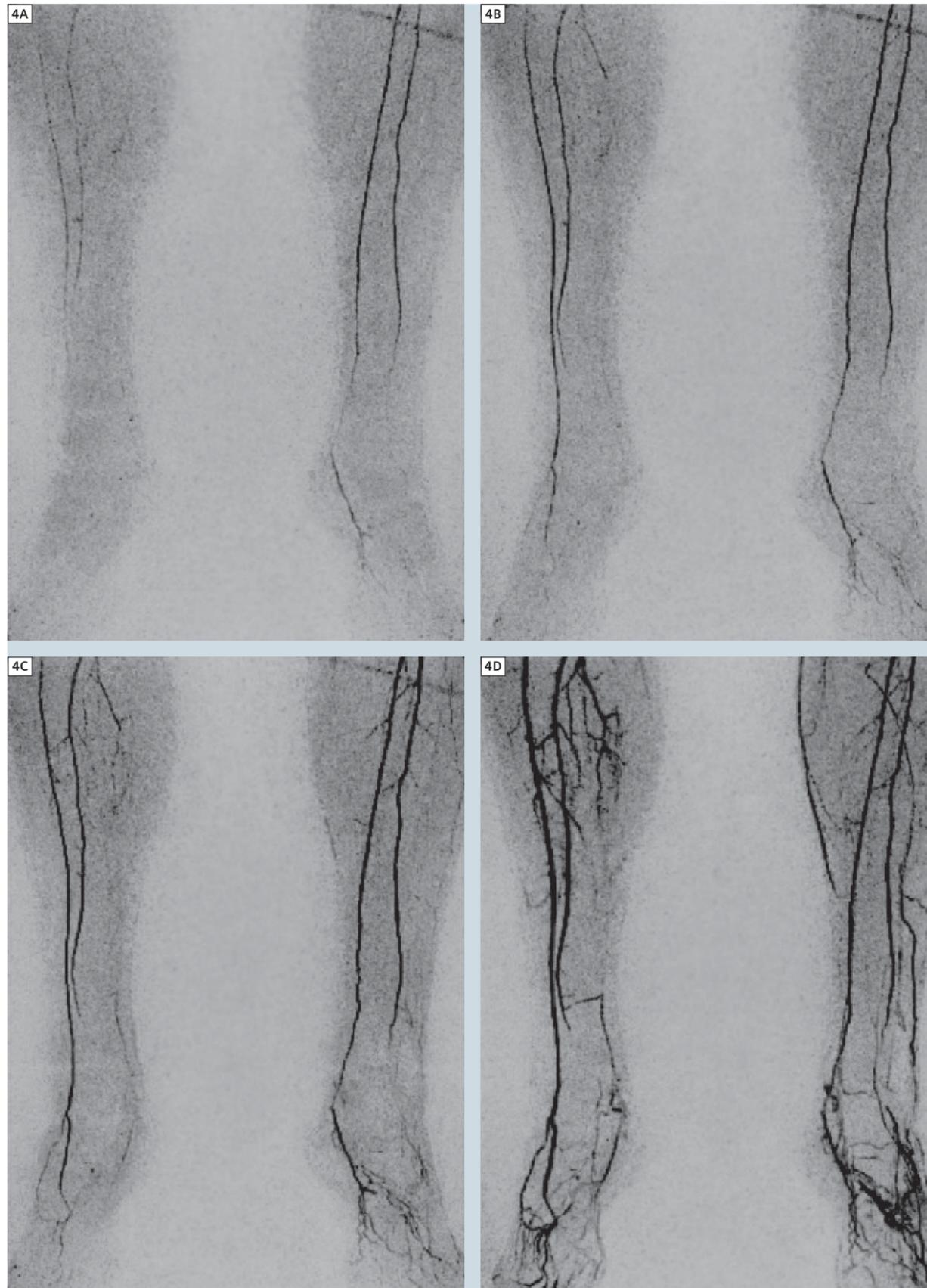
1 Thick slab MIP of a patient with PAOD III-IV showing multiple stenoses in the pelvis, an obliteration of the superficial femoral artery, collateralization by the PFA and extensive soft tissue contrast enhancement due to ischemic inflammation on the left side.



2 Thick slab coronary view of the vessels of the lower extremity in a patient with PAOD II with and without subtraction.



3 3D reformation of an MR-angiography of the same patient as in figure 2. The high signal-to-noise ratio (SNR) allows for superb depiction of the vessels.



4 Dynamic imaging of the calf vessels ($1.1 \times 1.1 \times 1.1 \text{ mm}^3$, 5 s temporal resolution) with low dose *syngo* TWIST-Angiography in a patient with PAOD III showing obliterations of the posterior tibial artery on the right and of the distal anterior tibial artery on the left side.

of 400 to 500 mm depending on the equipment used, which have to be composed manually after the exam. Beyond the easy visualization, TimCT-MRA is beneficial in two other ways. Firstly, due to the ease of planning of the exam without angulation of different slabs and without the need to optimize the overlapping segments. Secondly, whilst the conventional step-by-step approach requires two periods of dead-time (for the table to move without acquiring images and for the contrast agent bolus to travel further through the body), by contrast *syngo* TimCT is very time-effective since it eliminates these dead-times. The more effective use of the contrast agent enables a reduction in the dose of contrast agent of 20–40%.

***syngo* TWIST dynamic information**

Characteristically, up to 50% of patients with PAOD III-IV show venous overlay in the calves due to inflammatory hyperemia and side-different flow [1]. Therefore, our protocol is supplemented by an additional dynamic TWIST angiography of the critical calf station after the TimCT-MRA. The *syngo* TWIST-MRA allows dynamic depiction of the small run-off vessels and collateral vessels. Due to the dynamic nature of the TWIST-MRA purely arterial images of the calf vessels can be acquired even in patients with severe inflammation or those with side-different flow.

TimCT-MRA and TWIST in clinical routine

The protocol is very simple and – at our institution – includes a *syngo* TimCT localizer, a vessel scout, the T1w FLASH angiography sequence before and after contrast administration (TR 2.42 ms, TE 1.02 ms, spatial resolution $1.2 \times 1.2 \times 1.2 \text{ mm}^3$) and the TWIST-angiography of the lower legs (TR 2.75 ms, TE 1.02 ms, spatial resolution $1.1 \times 1.1 \times 1.1 \text{ mm}^3$) 1–2 minutes after the TimCT-MRA. The examination is performed with a sub-single dose of contrast media (Gadobutrol) for the TimCT-MRA, and with

a second administration of a reduced dose of contrast media for the dynamic TWIST-angiography. In order to increase the injected volume and to save on contrast media, at our institution Gadobutrol is diluted with saline 1:1. The dosage of contrast media does not exceed that of a traditional single-dose multi-step MRA.

The images acquired in patients with the *syngo* TimCT-MRA technique show consistently good image quality (Figs. 2 and 3). In a feasibility study on the image quality of low-dose TimCT-MRA, 393 out of 397 vessel segments showed diagnostic image quality and 213 vessel segments were scored with excellent image quality. Non-assessable segments were only encountered in 4 out of 397 vessel segments (1%). A slight venous overlay occurred in 27% in the lower leg station, not interfering with diagnostic reading, whereas no venous overlay occurred in the pelvis or the thighs [2, 3]. Additional relevant information was found in 64% of the patients with the *syngo* TWIST-MRA, such as collateral vessels not detectable in the TimCT-MRA due to venous overlay or tissue contrast media enhancement (Fig. 4) [2]. Although the spatial resolution of the *syngo* TimCT-MRA suite (1.2 mm isotropic at 3T with software version *syngo* MR B15) is currently inferior to the conventional DSA exams (0.3 mm in-plane) and slightly inferior to CT angiography, evaluation of pathologies is nearly equivalent in our experience. A further improvement is the introduction of a higher spatial resolution in the calf station which is available with the latest software version *syngo* MR B17 allowing 0.7 mm isotropic resolution in the calves.

Conclusion

Overall, the *syngo* TimCT-MRA suite is a huge improvement in imaging the lower extremities in a clinical setting as it combines an easy, fast and robust workflow with good clinical results and is applicable to a broad range of patients.

References

- 1 Berg F, Bangard C, Bovenschulte H, Hellmich M, Nijenhuis M, Lackner K, Gossmann A: Feasibility of Peripheral Contrast-Enhanced Magnetic Resonance Angiography at 3.0 Tesla With a Hybrid Technique. Comparison With Digital Subtraction Angiography. *Invest Radiol*. 2008;43: 642–649
- 2 Voth M, Haneder S, Huck K, Gutfleisch A, Schoenberg SO, Michaely HJ: Peripheral Magnetic Resonance Angiography With Continuous Table Movement in Combination With High Spatial and Temporal Resolution Time-Resolved MRA With a Total Single Dose (0.1 mmol/kg) of Gadobutrol at 3.0T. *Invest Radiol* 2009;44: 627–633
- 3 Kramer K, Zenge M, Schmitt P, Glaser C, Reiser MF, Herrmann KA: Peripheral Magnetic Resonance Angiography (MRA) With Continuous Table Movement at 3.0 T. Initial Experience Compared With Step-by-Step MRA. *Invest Radiol* 2008;43: 627–634

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