# High spatial and temporal resolution MRA (TWIST) in acute aortic dissection

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**Introduction:** Endovascular treatment of descending thoracic and abdominal aortic dissection has emerged as an alternative to open surgery. In terms of endovascular aortic stent-graft placement planning, MRI appears to be particularly useful as it can provide a comprehensive pre-interventional diagnostic evaluation of the vascular aortic morphology. However, standard MRA techniques provided no information on flow and tissue perfusion. Therefore, time-resolved MR-angiography (MRA) techniques have recently been introduced to overcome these limitations. Until now sufficient temporal resolution and coverage for the assessment of aortic dissection could only be achieved scarifying special resolution, thus requiring an additional high resolution MR angiography. Our study aimed to evaluate the image quality and the diagnostic accuracy of a recently developed time-resolved 3D MR angiography technique (TWIST) combining high spatial and temporal resolution for the pre-interventional assessment of aortic dissection.

**Methods:** Ten patients (mean age 58y) with acute dissection of the descending thoracic and/or abdominal aorta underwent contrast-enhanced time-resolved 3D MR-angiography. All imaging was performed on a 1.5 T scanner (Avanto, Siemens, Medical Solutions, Erlangen, Germany) equipped with two flexible phased array coils and the integrated spine coils for signal reception. Following automatic injection of 5 ml Gadovist (Schering, Berlin, Germany) at 3ml/sec, 15 consecutive coronal T1w 3D datasets (TR/TE 2.8/1.2 ms; FA 25°; slices 64;matrix 231 x 320; spatial resolution 1.9 x 1.6 x 2.1 mm³, true temporal resolution 3.3 s) were acquired using the TWIST sequence and parallel imaging technique (GRAPPA; R=2). Following the acquisition of an entire non-enhanced dataset (A and B) within one breath hold (23 s), 14 consecutive undersampled datasets were obtained. In the TWIST sequence all k-space points are sorted according to their radial distance in k-space; k-space is divided into A and B. While region A is completely sampled, region B is undersampled by a factor of n. The k-space trajectory within the region B follows a spiral pattern in the ky-kz plain with every trajectory in B being slightly different. The individual trajectories of B are twisted into each other as shown in the snapshots of k-space filling during the execution of the TWIST sequence (Fig.1). After a short pause, a conventional high spatial resolution MRA (0.1 mmol/kg Gadovist®) was acquired (breath hold 25 s) using a 3D spoiled gradient-echo sequence (TR/TE 3/0.97 ms, FA 25°, slices 72,matrix 289 x 384; voxel size 1.4 x 1.3 x 1.8 mm³).



**Fig.1** k-space representation for specific time-points of the TWIST sequence

Both MR data sets were evaluated and compared for image quality and visualization of vascular details. A radiologist and an interventional cardiologist assessed the additional diagnostic information of the TWIST concerning contrast enhancement and tissue perfusion.

**Results:** TWIST MRA could successfully be performed in all patients; no technical or reconstruction problems occurred. Image reconstruction time amounted to 5 minutes for the TWIST sequence. The image quality of the source images of the TWIST protocol was rated comparable to those of the conventional MRA. The presence of artifacts was comparable for both sequences. Due to the dynamic character of the TWIST sequence no venous overlay hampered the assessment of the arterial system. TWIST-MRA characterized true and false lumen as well as the origin of the branch vessels correctly in all patients. The temporal resolution of the TWIST-MRA allowed visualizing the transit of the contrast agent bolus within the true and the false lumen (Fig. 2, 3) and provided additional information compared to the static MRA in 3/10 patients. These finding had impact on therapy planning and the combined morphologic and dynamic imaging of the TWIST MRA provided reliable information for successful planning of endovascular stentgraft repair in all patients.
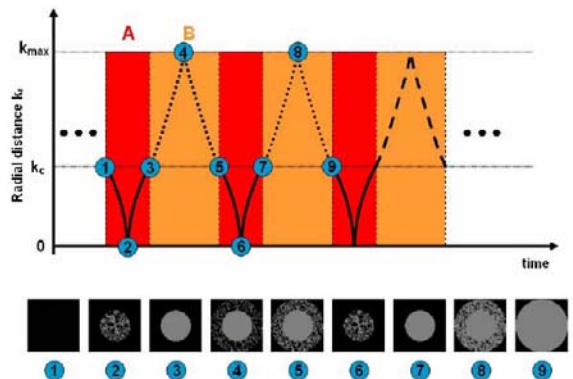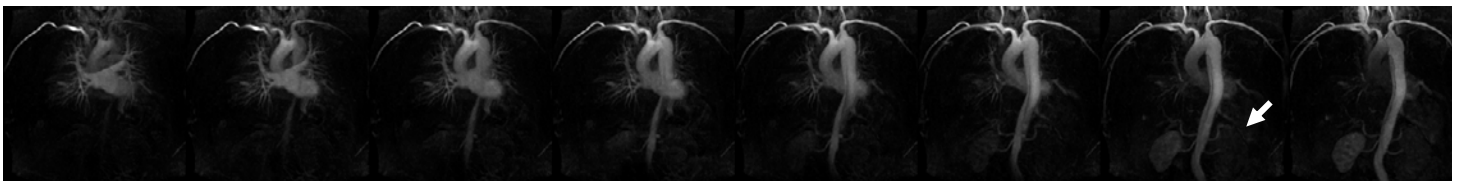


**Fig. 2** Coronal MIPs of subsequent time frames (time delay 3.3 s between single frames) acquired in a 55 y old male patient with acute aortic type B dissection. The high temporal and spatial resolution allows visualization of delayed filling of the false aortic lumen. The left renal artery originating from the false lumen results in a delayed perfusion of the left kidney (arrow).
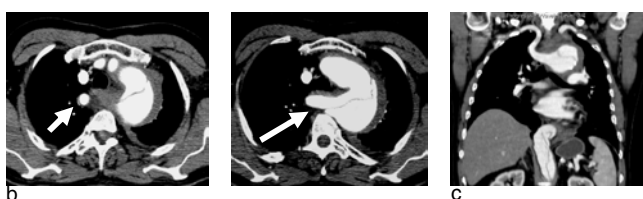


a



b            c

**Fig. 3** 78 y male old patient with aortic dissection of the descending thoracic aorta and aberrant right subclavian artery originating from the false lumen. Coronal MIPs (a) of subsequent time frames show delayed contrast filling of right subclavian artery (arrow). Corresponding axial CT images (b) and coronal MPR (c) confirm aberrant right subclavian artery.

**Discussion:** TWIST MRA is ⪚ obust technique that combining functional and morphological information. Thus the time-resolved TWIST MRA provides all information for treatment planning in patients suffering from acute aortic dissection.