

Contrast-Enhanced MRA with Elliptic-Centric View Ordering and View Sharing: Theoretical Considerations and Application in Patients with Cardiopulmonary Disease

C. Fink¹, M. Bock², R. Kroeker³, M. Requardt³, S. Ley¹, H-U. Kauczor¹

¹Radiology, DKFZ, Heidelberg, Germany, ²Medical Physics in Radiology, DKFZ, Heidelberg, Germany, ³Siemens Medical Solutions, Erlangen, Germany

Introduction

Time-resolved contrast-enhanced 3D MRA of the pulmonary vasculature remains challenging due to the large volume to be imaged and the rapid washout of the administered contrast agent. At the required temporal resolution often only a limited image resolution is available. In this study an acquisition protocol is evaluated that is based on a time-resolved 3D MRA sequence with elliptic-centric view order in combination with parallel imaging and a temporal interpolation scheme (TRICKS).

Materials and Methods

The TRICKS view sharing technique splits k-space into different regions (A,B,C,...) which are updated less frequently with increasing distance from the k-space center. Since rapid signal intensity changes occur during time-resolved contrast-enhanced MRA, we assessed the possible influences of these signal variations on the temporal interpolation in TRICKS MRA. In a simulation the point spread function for TRICKS MRA was computed taking into account the special k-space trajectories of elliptic centric view ordering in phase and partition encoding direction. Using parameters from prior pulmonary MRA scans, simulations revealed, that a k-space segmentation in 3 regions should provide acceptable artefacts at an increased in temporal resolution by 33 %. In a clinical study, 36 patients (mean age: 50±17 years) with cardiopulmonary disease were examined with the optimised TRICKS protocol using the following image parameters: TE/TR/α=0.8 ms/1.9 ms/40°, reconstruction algorithm GRAPPA, acceleration factor: 2, 20 reference lines, spiral-radial reorder mode, FOV=480 mm, 256x110 matrix, 44 partitions, voxel size: 1.9x3.5x4 mm³, Gd-DTPA @ 0.1 mmol kg b.w.. Images were compared to those acquired with a time-resolved MRA sequence without TRICKS in a similar patient group (31 patients, mean age: 47±18 years). Blinded to the used pulse sequence, two radiologists assessed the image quality and presence of artefacts in consensus.

Results

The high temporal and spatial resolution of TRICKS allowed an accurate assessment of the vascular anatomy and functional analysis of shunts and lung perfusion (Fig. 1). The image quality of TRICKS-MRA was rated superior to MRA data without TRICKS ("excellent" image quality 77% vs. 58%). No artefacts were observed with the used reconstruction mode.

Conclusion

Time-resolved contrast-enhanced 3D MRA with view-sharing (TRICKS) allows the clinical assessment of cardiopulmonary disease with a high temporal and spatial resolution, if the imaging parameters are chosen carefully with respect to the desired quality of the point spread function.

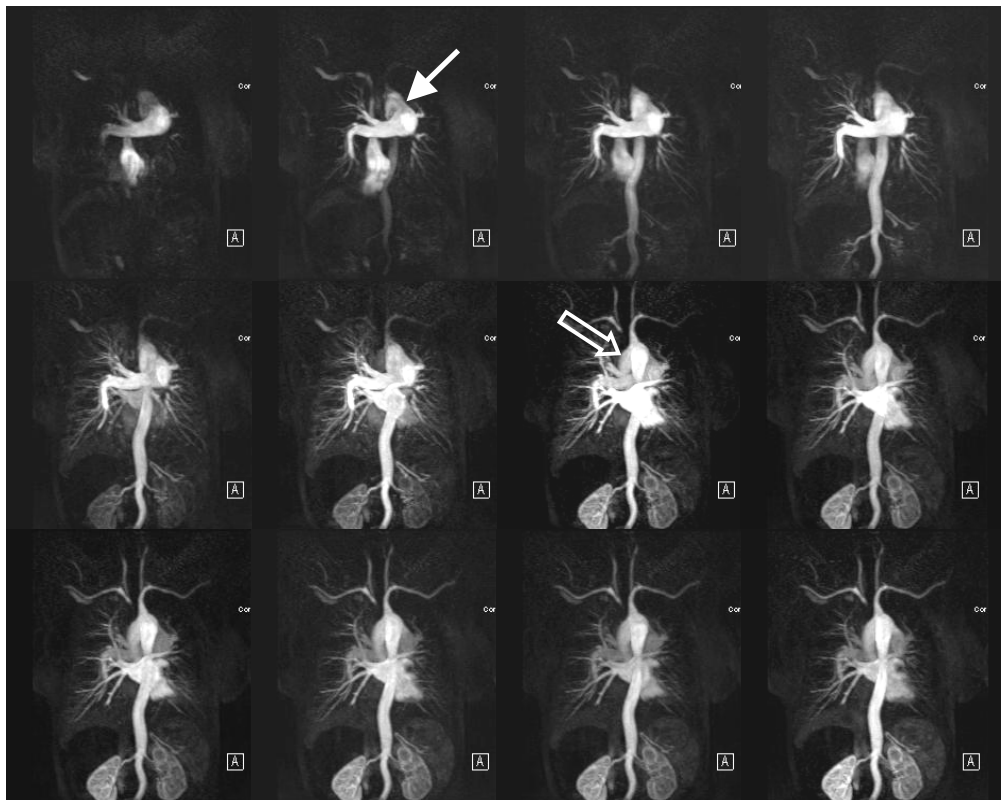


Fig.1:

40 year-old female with patent ductus arteriosus (PDA).

The high temporal and spatial resolution of the time-resolved 3D MRA with TRICKS allows the visualization of the shunt from the main pulmonary artery to the descending aorta (solid arrow). The ascending aorta (open arrow) only shows an enhancement in later phases.