Imaging of the Lungs with Time-resolved 3D MRA

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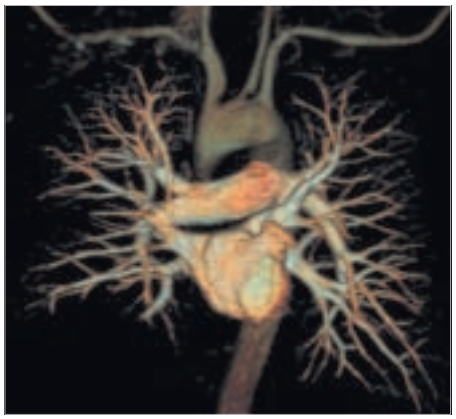
Abstract

Advances in MRI technology have greatly impacted vascular MR applications. Improvements in the image acquisition technique take advantage of combining high temporal resolution with spatial resolution imaging.

A time-resolved 3D MR angiography (MRA) technique, TRICKS™ (Time Resolved Imaging Contrast KineticS) has been proposed as an alternative method for patients with pulmonary disease. TRICKS is a modified 3D fast GRE pulse sequence that combines high temporal and spatial resolution. Compared to conventional MRA, it improves arterial-venous discrimination, reduces sensitivity to motion artifacts and often gives additional information.

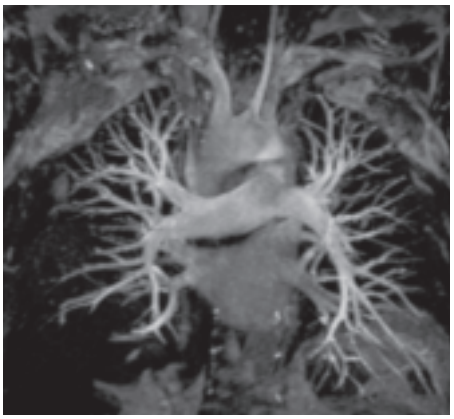
MRI is being increasingly applied in the study of pulmonary vascular anatomy and pathology. The introduction of TRICKS has overcome the limitation of conventional MRA techniques offering the simultaneous assessment of vessels and parenchymal perfusion. Various clinical applications of TRICKS of the chest

Figure 1. Patient A: 58-year-old male

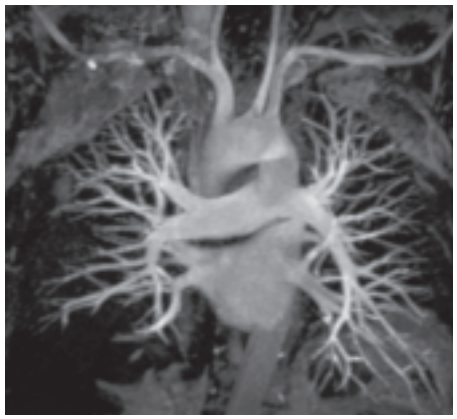


3D volume rendering anterior view

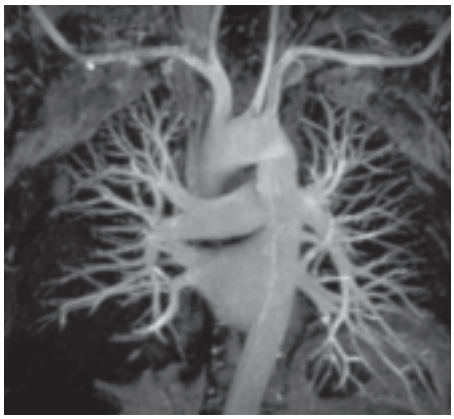
3D volume rendering posterior view



1st phase



2nd phase



3rd phase

can be proposed. Although CT is a popular clinical modality for pulmonary embolism (PE), it has been shown that MRI is able to assess acute PE with high diagnostic accuracy.

In addition, versatility of MR makes it a superior clinical imaging solution for the evaluation of pulmonary transit time in patients with pulmonary hypertension and heart failure.

Clinical Cases

The MR system being used is a GE Healthcare Signa® HDx 1.5T with an 8-channel cardiac phased array coil.

Patients A and B (Figures 1 and 2), were examined to evaluate the anatomy of the left atrium before performing a radiofrequency thermal ablation procedure. The TRICKS 3D data set was then merged with an electroanatomical map obtained by the intracardiac potentials recorded using the catheter during the cardioablation procedure.

In the case of Patient A (Figure 1), an example of normal pulmonary artery studied with TRICKS is shown.

Patient C (Figure 3), has an acute pulmonary embolism. The embolus is in the right inferior pulmonary artery, and it is well depicted on 3D FIESTA Fat Sat and on TRICKS images.

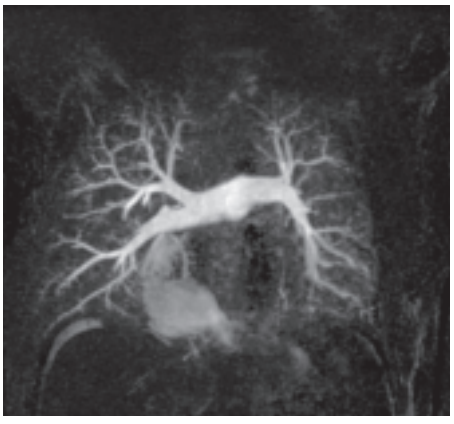
Technique

The patient is positioned supine with a 20-gauge intravenous cannula in the antecubital vein connected to a dedicated MR injector; breath instruction is given before the examination. After a tri-plane scout, a TRICKS sequence is implemented in the coronal plane using the following parameters: TE/TR 1.4/3.5 ms, BW 83 kHz, FOV 43 x 38 cm, matrix 320 x 224, 0.75 NEX, slice thickness 3 mm (overlap 1.5), number of output temporal phases 10, temporal resolution 3.4 s, acquisition time 1.10 min. A mask is acquired before the intravenous contrast injection.

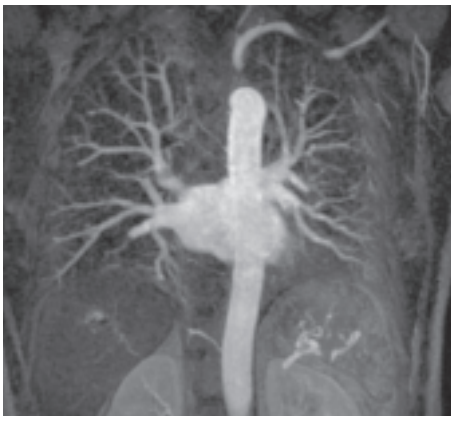
The TRICKS sequence is the first acquisition technique combining K-space segmentation and the elliptic centric view ordering. High temporal resolution is achieved by dividing the K-space into a number of segments from the center of K-space out. Views are acquired in an elliptic centric order and the rate of sampling is varied, so that the center of K-space is sampled more often than the outer regions and the time period from one phase to the next is shortened.

The start of the acquisition coincides with the start of a bolus injection of 10 ml of paramagnetic contrast media at a flow 2 ml/s. Data was processed obtaining pulmonary arteriograms and venograms.

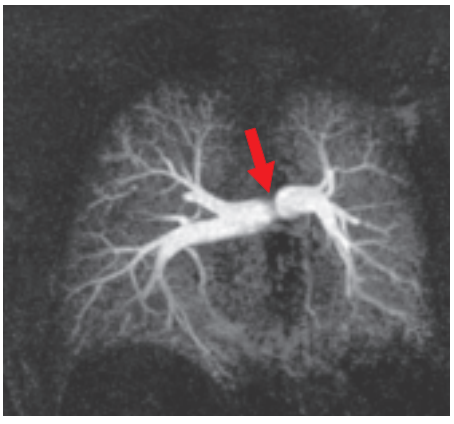
Figure 2. Patient B: 48-year-old male



Pulmonary arteries

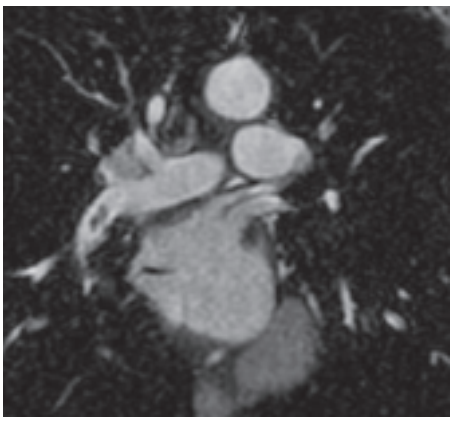


Pulmonary veins

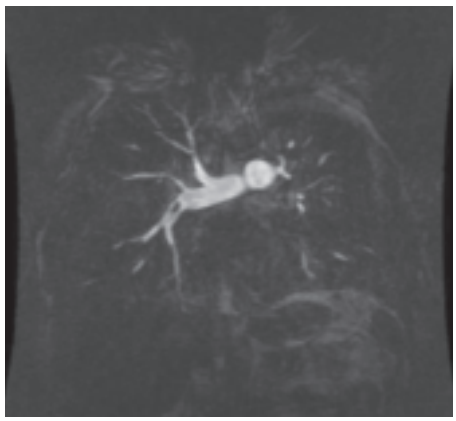


Pulmonary arteries and parenchyma

Figure 3. Patient C: 47-year-old female



Coronal 3D FIESTA Fat Sat



TRICKS acquisition: embolus in the right inferior pulmonary artery

TRICKS acquisition: oblique reconstruction

TRICKS acquisition: oblique reconstruction

Findings

The different phases of TRICKS MRA clearly delineate vascular and cardiac structures due to the high temporal resolution, while optimized spatial resolution allows to appreciate the anatomic details.

Conclusion

Using the TRICKS technique, a good visualization of the pulmonary artery can be obtained. Despite the widespread use of CT for studying the pulmonary artery, the availability of the time-resolved technique makes MRI an alternative and fascinating tool in the evaluation of this anatomic region. ■

About the University of Pisa, Italy

The Department of Interventional and Diagnostic Radiology, chaired by Professor Carlo Bartolozzi, is an academic department of the University of Pisa, Italy. Equipped with the latest technology, the department provides services at Pisa's Cisanello and Santa Chiara teaching hospitals.

With nearly 100,000 imaging examinations performed annually, there is a broad array of diagnostic imaging and interventions that offer an excellent foundation for graduate medical education. The Department is built upon a system of competence, teamwork, innovation and service as a major referral and teaching center for diagnostic and interventional radiology within Tuscany, Italy and beyond.

Our commitment is to provide excellence in medical imaging, responsive service and the responsible use of our resources in clinical care, education and research.