One-Second Temporal Resolution 4D MR DSA with 3D TRICKS, Elliptical Centric View Ordering, and Parallel Imaging

M. Ookawa[1], N. Ichinose[2], M. Miyazaki[2], I. Miyazaki[3], S. Sugiura[2]

[1]Toshiba Medical Systems Engineering co.,LTD., Otawara, Tochigi, Japan, [2]Toshiba Medical Systems R&D Center, Otawara, Tochigi, Japan, [3]Kyorin University, Mitaka, Tokyo, Japan

Abstract

A technique combining 3D TRICKS, elliptical centric view ordering and parallel imaging was developed and applied to contrast enhanced MR angiography. Four volunteer studies were performed on a 1.5 T superconductive imager (EXCELART, Toshiba, Japan) equipped with a 16-element 8-ch QD Torso SPEEDER coil. Speeding up factor of both TRICKS and parallel imaging were 3 and 3, respectively. As a result, 9 times increased temporal resolution was achieved. With this technique, temporal resolution of one second is achieved while keeping the spatial resolution of regular 3D MR DSA, which provides clear observation of dynamics for contrast media passage.

Introduction

In contrast enhanced MR angiography, several approaches such as 3D-TRICKS [1] and parallel imaging [2] have been reported in order to increase temporal and/or spatial resolution. An elliptical centric view ordering technique [3] enables enhancement of the image contrast at the onset of data acquisition. Recently, combination of TRICKS and elliptical centric view ordering in contrast enhanced MRA has been reported [4]. In this study, an additional application of parallel imaging to this technique is applied to improve further efficiency in temporal resolution. Our technique, combining TRICKS, elliptical centric view ordering and parallel imaging, was developed in order to achieve 4D MR DSA with the temporal resolution in a one-second order.

Methods

Four volunteer studies were performed on a 1.5-T superconductive imager (EXCELART, Toshiba, Japan), equipped with a 16-element 8-ch QD Torso SPEEDER coil as a receiver. Dynamic images were acquired with a 3D fast field echo sequence using the following parameters;
TR/TE/FA=3.1msec/0.9msec/20 degree, 40x40cm FOV, 128x256 matrix, and 22 partitions with 4.2mm slice thickness. Images were interpolated the matrix size and intensity correction was performed.
The speeding-up factor of both TRICKS and parallel imaging were 3 and 3, respectively. As a result, 9 times increased temporal resolution was totally achieved.
Using a power injector, 9.8 ml Gd-DTPA was injected intravenously at 2.5ml/sec, which was then flushed with 20 ml of physiological saline solution.

Results

In obtained cine images, a 1.2-second temporal resolution allows observation of complete separation of pulmonary arteries from veins in 3 phases. In addition, the renal arteries were enough temporal resolution to permit us to find in 4 to 5 phases.
On the images acquired at the timing of contrast media inflow, some ringing artifacts were seen probably due to the discontinuity of the contrast media concentration or signal intensity of the vessels. However using parallel imaging, this artifact is highly reduced since the time distance between each data acquisition is decreased and results in less signal intensity difference. As a result, this artifact can be hardly observed in the MIP images when using parallel imaging technique.

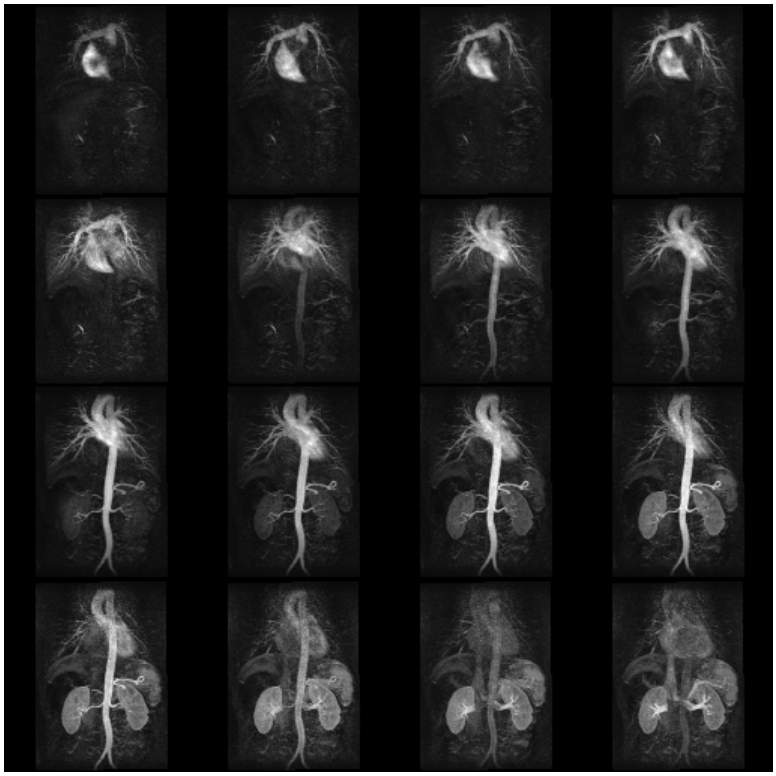

Figure 1 Arterial phase views of a normal volunteer

Conclusion

With the combination of TRICKS and parallel imaging, temporal resolution of one second is achieved while keeping the spatial resolution comparable to regular 3D MR DSA, which provides clear observation of dynamics for contrast media passage from various viewing directions.

References

[1] Korosec FR, et al. MRM 36(3):345-351, 1996
[2] Carlson JW, Minemura T. Magn Reson Med 1993; 29: 681-688.
[3] Wilman AH, et al. Radiology 205:137-146, 1997
[4] Zhou Y, et al. Proc ISMRM 9 1948, 2001