4D velocity measurements in an intracranial aneurysm using 3T phase contrast angiography

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Purpose/Introduction

It is believed that hemodynamic parameters in intracranial aneurysms contribute to the understanding of the occurrence of aneurismal rupture [1]. To our knowledge, high resolution accurate velocity measurements in intracranial aneurysms have not yet been performed. In this study, one example is given of velocity measurements in an intracranial aneurysm using 3T phase contrast angiography (PCA).

Materials & Methods

Modulus and phase data were obtained by a fast field echo sequence on a 3T MR system (Philips Medical Systems, Best, The Netherlands). Scan parameters: FOV: 100 x 100 x 10 mm, voxel size: 0.89 x 0.89 x 1 mm, TE/TR: 5.0/9.5 ms, flip angle: 15°, number of averages: 2, venc: 100 x 100 x 100 cm/s. Cardiac phases: 15 (Retrospectively PPU-gated). Phase is measured in three directions: anterior-posterior (AP), right-left (RL) and head-feet (HF). From these measurements velocity magnitude and direction is calculated. The size of the aneurysm is 8 (AP) x 6 (RL) x 5 mm, and located in the left middle cerebral artery. Scan time was ten minutes with the use of parallel imaging.

Results

In figure 1, the five transverse planes are shown in which flow quantification has been performed.

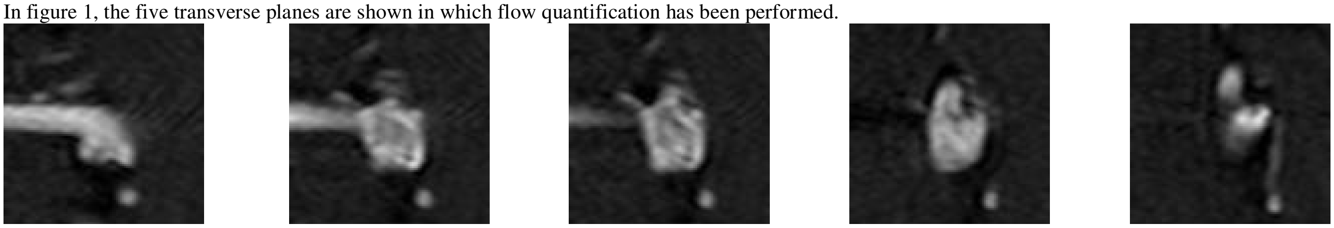

Fig 1a: Plane 1 *b: Plane 2* *c: Plane 3* *d: Plane 4* *e: Plane 5*

In figure 2a, b and c, the three velocity directions at early systole for plane 4 are shown. The calculated magnitude and direction are shown in figure 2c.

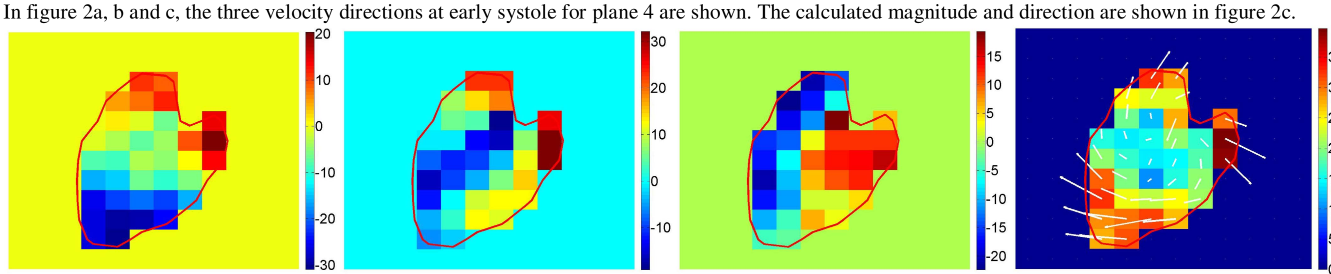

Fig 2a: Velocity RL *b: Velocity HF* *c: Velocity AP* *d: Velocity magnitude and direction*

In figure 3, the velocity and magnitude and direction are shown in time for plane 3.

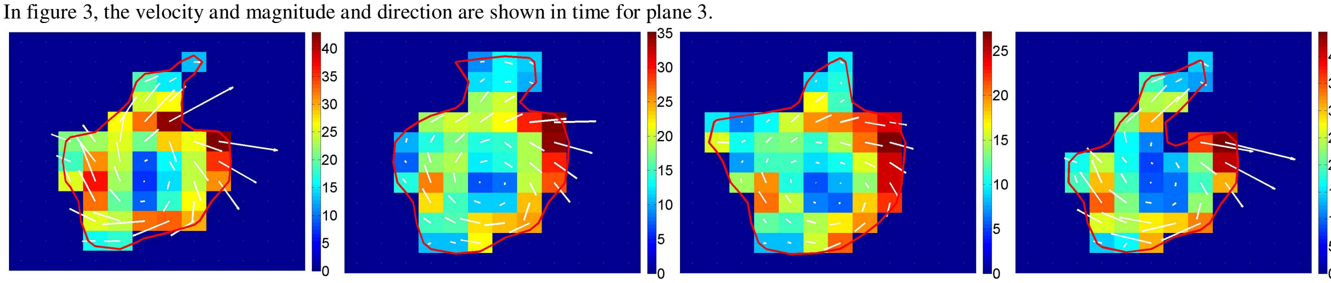

Fig 3a: Late systole *b: Early diastole* *c: Late diastole* *d: Early systole*

In figure 4, the measured velocity for systole and diastole for all planes is displayed.

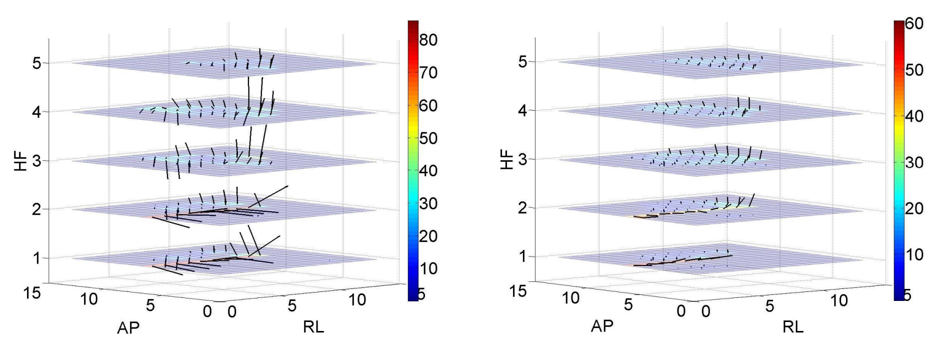

Fig 4a: All planes at early systole *b: All planes at late diastole*

Discussion/Conclusion

From the results, it can be observed that one major in-plane vortex exists as well as a vortex in HF direction. Furthermore, the velocity in the aneurysm is highest on the wall. This indicates that wall shear stress is likely to be high at these positions as well, which may be an important factor for aneurysm rupture. These measurements show that it is possible to globally measure clinically relevant velocity profiles in an intracranial aneurysm when the aneurysm is large and resolution is high enough. This is useful for comparison with or validation of simulated velocity profiles, or for determination of boundary conditions in computational fluid dynamics.

[1] I. Szikora, G. Paal, A. Ugron, F. Nasztanovics et al. *Neuroradiology* (2008) 50:411-421