Flow Contrast without Using Exogenous Agent

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1. Who will benefit from this information?

Physicists, radiologists, engineers, and students who are interested in understanding the principles of MR angiography techniques commonly used in clinical settings.

2. How was a problem determined?

Blood flow is a common source of flow artifacts in MRI. Flowing spins introduce additional phase-shift in the MR signal, resulting in spurious signal displacement along the phase-encoding direction. With proper manipulation of the gradient waveforms, this flow-induced phase-shift provides the source of contrast between flow and stationary tissue. The phase-contrast MR angiography (PC-MRA) technique was developed based on this flow phenomenon. The PC-MRA technique has excellent background suppression and can be used for the quantification of flow. The acquisition time of PC-MRA, however, is relatively long, since multiple acquisitions with different flow-sensitizing bipolar gradient waveforms are required to generate the final images.

A more commonly used MRA technique is based on the time-of-flight (TOF) effect of flowing spins. In the imaging slice/slab, the blood flow experiences less number of RF excitation pulses than the background tissue when a short-TR GRE pulse sequence is used. As such, the blood flow has a higher signal than the background tissue due to reduced partial T1 saturation of the flow. The TOF-based MRA is widely used in the diagnosis of vascular diseases, such as vascular occlusion, aneurysm, stenosis, and arteriovenous malformation (AVM).

3. Examples of how this issue have been addressed:

--Flow-induced phase-shift: the relationship between flow velocity and phase-shift will be established.

--Flow-compensation: the compensation of the phase-shift induced by constant flow will be presented.

--Phase-contrast MRA: the imaging sequence and post-processing methods used to generate angiograms will be presented.

--Time-of-flight effect: the flow contrast due to the difference in T1 partial saturation between the blood flow and stationary tissue will be explained.

--2D and 3D TOF MRA of the brain: the pulse sequences of TOF MRA will be demonstrated. The applications of TOF MRA of the brain will be demonstrated. The pros and cons of the 2D and 3D acquisitions will be presented.

4. What will learners be able to do differently because of this information?

--Understand the pros and cons of PC and TOF MRA techniques.

--Determined the most adequate MRA technique for specific clinical applications.

--Properly select the imaging parameters to improve image quality.

--Be able to recognize some basic artifacts in MR angiography and differentiate the artifacts from pathology.