

AbstractID: 2267 Title: High resolution MRA

Magnetic Resonance Angiography (MRA) is the process of using Magnetic Resonance Imaging (MRI) to generate images of the blood vessels in the body. Analogous to X-ray Angiography, MRA is primarily concerned with imaging the blood vessel lumen. Disease in the blood vessel wall can also be of importance and can be imaged with MRI techniques. Unlike X-ray imaging, MRI and MRA techniques are very flexible and can be designed to yield images where blood is bright and background soft-tissues are dark, or where blood is dark and background soft tissues are bright. Both techniques can be effective at demonstrating vessel lumen and wall detail.

Imaging of vascular lumen anatomy presents an interesting challenge because of the range of sizes and flow velocities encountered. The blood vessels form a branching network in which the vessel diameters range over 3 orders of magnitude in diameter from as large as 10 mm down to less than 10 microns. Further, the cross-section of the vessel lumen is generally larger than that of the vessel wall. Although MRI and MRA techniques are effective at imaging large vascular detail, it is much more difficult to create high resolution images of fine vessel detail. In the absence of injected contrast media, the image signal is generally a function of the motion of the blood itself where faster flow results in a larger signal. In general flow is slow in small arteries and arterioles and near the edges of larger arteries, resulting in a non-uniform signal throughout the vascular bed. Because blood flow is faster in arteries than in veins, the arteries are more clearly seen in white blood (time-of-flight) images. The slower flow in small arteries greatly reduces the signal and visibility of these small vessels. Contrast agents can be used to shorten the blood relaxation rates and thereby increase the relative signal strength from blood, improve the homogeneity of the signal across the vessel lumen, and increase the signal and visibility of small arteries. At the same time, contrast agents cause a tremendous increase in the signal strength and visibility of veins of comparable sizes, making it hard to distinguish between arteries and veins.

In this presentation we consider the challenges faced in using MR to generate images of blood vessel lumen and wall anatomy. The ability to visualize high resolution vessel detail can be described in terms of a contrast/detail diagram and depends upon many factors including vessel properties (dimensions, location, orientation, flow, relative relaxation rates) and imaging parameters (voxel dimensions, imaging geometry, pulse sequence parameters, and coil geometry and arrangement). We investigate practical limits on resolution, scan time, and other imaging factors.

Educational objectives

The attendee should understand

1. the mechanisms of blood vessel signal enhancement in magnetic resonance angiography
2. the dependence of SNR on vessel and imaging parameters
3. the concept of visibility in terms of the contrast/detail diagram.
4. the most important factors that affect attainable spatial resolution of blood vessel detail