

Development and evaluation of acquisition and reprojection techniques for magnetic resonance angiography

Frank R. Korosec

Currently, the most widely used means of diagnosing vascular disease are x-ray angiography and ultrasound. X-ray angiography offers high contrast, high resolution images of vasculature, but it is an invasive technique. Ultrasound is non-invasive but its utility is limited. Recently, it has been demonstrated that magnetic resonance imaging (MRI), a non-invasive imaging modality, is able to provide images of vasculature. MR already provides excellent images of soft tissues, and it possesses the potential to provide functional information regarding the cardiovascular system. Thus, MR promises to be a very powerful tool for diagnosing vascular disease. Magnetic resonance angiography (MRA) is, however, in its infancy, and many improvements in image quality are necessary before it becomes widely accepted.

The purpose of this study was to evaluate the characteristics of existing MRA techniques with the intent of increasing their capabilities. Time-of-flight and phase-contrast techniques were evaluated. An understanding of the strengths and weaknesses associated with these techniques led to the development of a phase-contrast line-scan imaging sequence.

This phase-contrast line-scan imaging sequence offers immunity to ghost artifacts, rapid data acquisition capabilities, enhanced vascular signal due to both in-flow enhancement and the use of a large tip angle, elimination of unwanted vascular signal through the use of a traveling saturation pulse, the ability to demonstrate hemodynamic information, and excellent background suppression.

In evaluating MRA techniques, it was realized that the current means of converting a volume of angiographic image data into a presentable two-dimensional image has some drawbacks. A data-adaptive ray-tracing reprojection technique that addresses some of these limitations was developed. The data-adaptive reprojection technique provides a projection image similar to that provided by conventional x-ray techniques in which both vessel thickness and vessel crossing information in the projection dimension are revealed; neither of which are revealed when the currently used technique is implemented. The data-adaptive reprojection technique also represents vessel diameter more accurately than the currently used technique does.