Gadolinium Enhanced MR Angiography of the Hand

DA Connell, Department of Radiology, Victoria House, Melbourne, Australia;
HG Potter, Department of Radiology, Hospital for Special Surgery, New York, NY.

Introduction:
Three dimensional Gadolinium enhanced MR angiography is a technique which provides a rapid and accurate evaluation of aortic and peripheral vascular disease (1-5). However, these techniques need to be modified when applied to the small vessels of the foot and hand. High resolution is necessary in order to depict the vessels of the superficial and deep palmar arches and digital vessels which are often less than 1mm in diameter. Because of the relatively slow transit times occurring in these distal vessels, bolus timing is not as critical as for the aorta and larger vessels of the arterial tree. By manipulating imaging parameters of established Gadolinium enhanced MRA techniques, and by taking advantage of recent advances in surface coil technology, sub-millimetre pixel sizes can be achieved which are essential for imaging of the digital vessels.

The purpose of this study is to demonstrate that Gadolinium enhanced MRA is a quick and effective way of evaluating the vasculature of the hand in patients with a broad variety of clinical pathology.

Materials and Methods:
A total of 75 individuals comprising 10 volunteers, and 65 patients, were evaluated using Gadolinium MRA techniques. Ten volunteers underwent Gadolinium enhanced MRA, 2D time-of-flight, phase contrast and ultrasound color Doppler, (10MHz probe, Aspen, Acuson). All 65 patients with clinical pathology were evaluated with Gadolinium enhanced MRA, and 2D time-of-flight technique. A further 8 underwent angiography and 5 underwent color Doppler ultrasound. There were 34 females and 41 males with a mean age of 41.7 years. The 65 patients presented with a variety of conditions including rheumatoid arthritis, vasculitis, traumatic transection of a vessel, cavernous haemangioma, peripheral embolus and both benign and malignant tumours of the hand including synovial sarcoma. An arterial road map provided information concerning tumour blood supply prior to surgery.

Technique:
The Gadolinium enhanced MR angiography technique was as follows: Either a send-receive phase ray extremity coil (EXTREMPA, Medrad) or wrist quadrature phase array surface coil (Medical Advances). The mid point of the third metacarpal was used as a central landmark. The hand must lie flat within the coil with the fingers slightly spaced apart. The centre of the field was determined from a coronal localiser and the FOV estimated to cover the region of interest. An axial localiser was taken through this central point on which the boxed volume was placed. A 15 second delay from the onset of administration of contrast was used for arterial studies and a 25 second delay for venous study.

However, increased delays are appropriate for patients with considerable ischaemic/vasculitic disease. Ideally the inflow of contrast contrast into the volume of interest should occur 10 seconds from the onset at time of scanning. An injection rate of 2ml/sec was used and 40ml of Gadolinium was administered. A mask was obtained followed by 3-4 volume acquisitions.

The following scan parameters were used; 3D SPGR, fast, extended dynamic range, VBW. No phase wrap should be off or imaging time is doubled. A 30 degree flip angle with a minimum TE was used. FOV varied from 10-18cm, adjusted to cover the region of interest. Slice thickness ranged from 0.5-0.7mm. Phase encoding steps numbered 120/160 with a frequency of 256. Rectangular FOV was used to save imaging time. Single volume should be acquired in less than 45 seconds. Image analysis was performed by two independent readers.

Results:
Gadolinium MRA of the hand was shown to be superior to 2D time-of-flight and phase contrast techniques and comparable to colour Doppler ultrasound and angiography. Satisfactory studies were obtained in 71 of the 75 cases. Suboptimal studies were secondary to contracture deformities seen in rheumatoid arthritis or due to excessive wrap. Tapering and occlusion of blood vessels have been seen in vasculitides and emboli. Sudden termination of a peripheral vessel is shown in transection. Blood supply to small lesions of the hand was readily shown.

Fig 1 (left): A 35 y.o. male with Raynaud’s disease shows tapering of the digital vessels with severe vasospasm of the radial digital artery of the second digit. Note the capillary congestion in the distal 1st and 5th digits.

Fig 2 (right): A 42 y.o. female with vasculitis shows occlusion of the digital arteries supplying the 3rd, 4th and 5th digits. These fingers were later amputated.

Discussion:
Gadolinium enhanced MRA of the hand is superior to other MRA techniques and comparable to colour Doppler ultrasound and conventional angiography. However, unlike colour Doppler ultrasound, Gadolinium enhanced MRA provides a visual road map of the arterial tree that is readily recognisable. Furthermore, it is a quick and easy examination technique taking less than five minutes. It is relatively non invasive and is free of ionising radiation unlike conventional angiography. Image quality is dependent upon a dedicated surface core that provides high signal to noise allowing for a small pixel size and high resolution. Troublesome artefacts include wrap around effects.

References: