



# Radiology Rounds

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## Renal and Lower Extremity Contrast-Enhanced MR Angiography

- When the clinical suspicion for renal vascular disease is high, renal/abdominal MR angiography (MRA) is a sensitive method for detecting stenoses in renal arteries as well as vascular abnormalities in other abdominal arteries;
- When the clinical suspicion for peripheral vascular disease in the lower extremities is high, run-off MRA is a sensitive method for detecting stenoses and aneurysms in the iliac, femoral, popliteal, and crural arteries.

In patients who have a high clinical index of suspicion for vascular disease, MR angiography (MRA) is the preferred imaging method for assessing the patency of renal and lower extremity arteries. MRA images can be easier to interpret than CT angiography (CTA) at times because calcified plaques may obscure the lumen in some CTA. Artifacts from calcified plaques are usually minor in MRA images. In addition, MRA has no exposure to ionizing radiation, the contrast agents have low nephrotoxicity, and MRA is also non-invasive. However, MRA is not suitable for patients with pacemakers and may be contraindicated by the presence of some metallic implants.

The sensitivity of MRA for detecting stenoses is very high but the specificity is lower. Therefore, the positive predictive value is high only when the clinical index of suspicion for vascular disease is high. For this reason, it is good medical practice to arrange a thorough clinical examination by a physician knowledgeable in the field of vascular medicine before a patient is sent for an MRA in order to find evidence that the likely cause of symptoms is vascular disease.

### Renal MRA

Renal vascular disease is characterized by symptoms of hypertension that respond poorly to medication, elevated BUN, and absence of proteinuria or active urine sediment, which may be associated with evidence of peripheral vascular disease. In addition, some patients may be recognized when they develop poor renal function in response to ACE inhibitors. Renal vascular disease may cause the affected kidney to shrink, which can be determined by an ultrasound scan to detect asymmetric renal size. If one kidney is >2 cm smaller than the other, it is likely that the smaller kidney has lost function permanently and the patient will not be helped by revascularization.



Renal MRA showing healthy vasculature and early renal artery bifurcation.

If the clinical index of suspicion for renal vascular disease is high or moderate, renal/abdominal MRA is warranted. In this examination, a bolus of gadolinium contrast agent is administered intravenously and images are acquired in a series of four to six 20 second breath-holds as the contrast agent flows through the arteries, into the kidneys, and in the ureteral pelvis, and ureters through renal excretion. The total time for the examination is less than 45 minutes, during which time the patient must lie supine and motionless. The MRA data are post-processed into 3-D maximum intensity projection (MIP) images, which show the abdominal aorta and arteries from the diaphragm to the iliac

arteries, as well as contrast agent enhancement of the kidneys, ureteral pelvis, and ureters.

Renal/abdominal MRA can detect renal artery stenoses with 94% sensitivity and 92% specificity. Although there is more inter-observer variability in the accuracy of MRA compared to angiography for detecting stenoses with  $\geq 50\%$  occlusion, renal/abdominal MRA can also detect stenoses and/or aneurysms in other arteries in the abdomen and pelvis, including the aorta. On the other hand, MRA may miss stenoses caused by fibromuscular dysplasia, which have a characteristic beaded appearance in CTA or angiograms. Renal /

abdominal MRA is also used to examine potential kidney donors in order to image the vascular anatomy prior to surgery, which may detect the presence of accessory arteries or early branching of the renal artery. However, if an accessory artery is very small, there is a risk that it may be missed by MRA.

Renal/abdominal MRA may also show evidence of loss of renal function, which is indicated by asymmetry in renal enhancement or in the time of arrival of contrast agent into the ureters. In addition, MRA can detect tumors, if present.

Comparison of Conventional Angiography, MRA, and Duplex Doppler Ultrasound for Renal and Lower Extremity Vascular Imaging		
	Advantages	Limitations
<b>Conventional Angiography</b>	Gold Standard	Risks from catheterization Requires iodinated contrast agent* Exposure to ionizing radiation
<b>MRA</b>	Noninvasive Low toxicity of gadolinium contrast agents High sensitivity and specificity for stenoses May detect other vascular problems Associated anatomic views can detect tumors and other causes of disease	Contraindicated for patients with pacemakers and some metal implants May miss stenoses due to fibromuscular dysplasia May miss accessory renal arteries May miss distal renal artery stenoses
<b>Duplex Doppler Ultrasound</b>	Screening for asymmetry in kidney size and blood flow	Sensitivity and specificity lower than MRA  Time-consuming (up to 2 hours for lower extremity imaging and 45 minutes for renal imaging) Technically difficult and highly operator-dependent Limited by body habitus

\* Radiology Rounds, October 2003, [http://www.massgeneralimaging.org/newsletter/october\\_2003](http://www.massgeneralimaging.org/newsletter/october_2003)



Lower extremity MRA showing severe stenoses in left superficial femoral artery and smaller stenoses in right superficial femoral artery.



Lower extremity MRA showing severe stenoses in right posterior tibial artery and several stenoses in left posterior tibial artery.

## Lower Extremity MRA

Peripheral vascular disease is characterized by symptoms of pain on walking in the hips, buttocks, or calves, diminished pulse in the affected limb, bruit, evidence of poor capillary refill, and/or ulceration. Another important clinical indication of peripheral vascular disease is the finding of an abnormal ankle-brachial index, with or without exercise, although this test may falsely be negative in diabetic patients with poor circulation.

If the clinical index of suspicion for lower extremity vascular disease is high or moderate, a run-off MRA is warranted. In this examination, a bolus of gadolinium contrast agent is administered intravenously and images are acquired from the pelvis to the foot as the contrast agent flows through the arteries. The images may be viewed in multiple projections or using 3D displays. Significant stenoses in the pelvis and abdomen are detected with 94% sensitivity and 97% specificity.

## Scheduling

After thorough clinical examination for vascular disease, a renal/abdominal or run-off MRA can be ordered by completing the [MGH Radiology - Cardiovascular Intervention Procedure Request Form](#) and faxing it to 617-726-8472. If both renal/abdominal and run-off MRAs are needed, they must be ordered as two separate examinations because these two examinations require different kinds of MR coil in order to acquire high quality MRA images. The two MRA studies may be ordered in back-to-back appointments or at separate times. If you have any questions about scheduling, please call 617-726-8314.

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Run-off MRA can also detect aneurysms and assess the morphology of arterial by-pass grafts with findings that are 100% concordant with conventional angiography. A duplex Doppler ultrasound scan is an alternative examination that can be a good diagnostic test. However, this examination is time consuming (taking up to 2 hours) and, because it is user dependent, requires an experienced ultrasonographer.

If patients have evidence of renal and lower extremity vascular disease, a lower extremity MRA should be performed first. The renal arteries can be seen in this scan although the image quality may not be adequate. If there are still questions about the renal arteries, they can be examined in a follow-up abdominal/pelvic MRA. The wealth of data obtained from these two examinations is helpful in detecting incipient disease and in decision making about the suitability of therapy.

## Further Information

For further questions on pelvic/renal and run-off MRA examinations, please contact [Suhny Abbara, M.D.](#), Radiologist, Director of Non-Invasive CardioVascular Imaging, 617-726-0796.

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