

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: Recurrent Symptoms Following Lower Extremity Angioplasty

Variant 1: Claudication.

Radiologic Procedure	Rating	Comments	RRL*
US segmental Doppler pressures and pulse volume recordings	9	Usual first tests.	None
MRA lower extremity	8	Able to triage between catheter and surgical management and thus may substitute for other noninvasive studies. See statement regarding contrast in text under "Anticipated Exceptions."	None
US lower extremity with Doppler	8	May be useful to identify focal lesions amenable to percutaneous intervention.	None
Arteriography lower extremity	7	Used for a lesion amenable to percutaneous intervention (eg, restenosis).	Low
CTA lower extremity	7	Can be an alternative to MRA. Heavy calcification, especially in calf arteries, can limit evaluation of outflow disease.	Med
US lower extremity intravascular	1	May be indicated as part of an interventional procedure but not for diagnostic use.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 2: Threatened limb.

Radiologic Procedure	Rating	Comments	RRL*
Arteriography lower extremity	9	Allows most timely diagnosis and treatment.	Low
US segmental Doppler pressures and pulse volume recordings	8		None
MRA lower extremity	5	Useful if angiography is not performed (ie, surgical treatment is necessary). See statement regarding contrast in text under "Anticipated Exceptions."	None
CTA lower extremity	5	Useful if angiography is not performed with limitations as described above.	Med
US lower extremity with Doppler	4	May be useful to identify focal lesions amenable to percutaneous intervention.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

RECURRENT SYMPTOMS FOLLOWING LOWER EXTREMITY ANGIOPLASTY

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Summary of Literature Review

Endovascular interventions for lower extremity arterial obstructive disease, both for lifestyle-limiting claudication and for critical ischemia with threatened limb, have become accepted treatment modalities. The availability of these techniques has reduced the numbers of surgical reconstructive procedures. But in spite of their very high initial technical success rates, restenosis after angioplasty with recurrent symptoms is frequent, especially with infrainguinal lesions [1,2].

The use of nitinol stents appears to decrease restenosis in the peripheral arteries. The long-term results—of drug-eluting stents in decreasing restenosis are still under investigation [3]. The literature has not clarified the importance of the follow-up of patients after lower extremity intervention. Recurrent symptoms usually precede the onset of limb- or life-threatening events, in contrast to coronary artery disease. Close surveillance of these patients, therefore, is often not routine; follow-up has often been driven by recurrence of symptoms.

Clinical examination with evaluation of the peripheral pulses and determination of the ankle-brachial indices (ABIs) is a low-cost and well-accepted first step in evaluation. However, restenosis is not always clinically discernible, since the natural progression of the patient's disease process is often characterized by development of new lesions at different sites. Thus definitive diagnosis is important for therapeutic planning, whether for repeat endovascular intervention, for reconstructive vascular surgery, or for medical management.

Noninvasive Hemodynamic Studies

Segmental Doppler pressures (SDP) and pulse volume recordings (PVR) (commonly referred to as lower extremity noninvasives or LENIs) are the most commonly

performed noninvasive techniques for evaluating peripheral vascular disease. Deterioration of SDP from previous levels by 15% or more has been accepted as indicative of restenosis [4-6]. However, this measurement does not clearly specify the site or length of the lesion beyond general terms, such as “femoropopliteal” or “inflow” disease, and it is of little value in patients with noncompressible arteries, as often occurs in diabetics and patients with renal insufficiency. Similarly, segmental PVR, a useful adjunct in calcified arteries, are not accurate with regard to location or length of lesions nor do they provide specific enough information for treatment decision-making in patients with symptomatic recurrent peripheral vascular disease [7]. In conjunction with ABIs, however, they do provide a useful guide to the overall clinical severity of the obstructive disease.

Ultrasound Imaging

Duplex color Doppler ultrasound (US) imaging is the lowest cost cross-sectional imaging modality and has widespread usage and acceptance in this patient population. US is recommended for routine surveillance and in the setting of recurrent symptoms following surgical or percutaneous intervention. It has the ability to localize lesion sites and assess their hemodynamic significance.

One limitation of US is its operator dependence. With meticulous technique (by either a technologist or a physician), there is a high, although not perfect, correlation with catheter angiography, especially for infrainguinal disease. A second limitation is that US alone is unable to triage patients between catheter and surgical management. As discussed below, contrast-enhanced magnetic resonance angiography (CE-MRA) is more sensitive and specific for peripheral arterial disease [8].

Catheter Angiography

Although the acceptance of MRA, computed tomography angiography (CTA), and US have decreased the role of catheter angiography with digital subtraction, it is still considered the “gold standard” for peripheral arterial imaging and allows for intervention at the time of diagnosis. This can prove invaluable in patients with a threatened limb [9]. Contrast-based catheter angiography can localize and quantify obstructive lesions with an accuracy exceeded only by intravascular US. Moreover, it allows physiological evaluation by determining pressure gradients. In addition to its diagnostic capabilities, it permits immediate intervention in many circumstances. In high-acuity settings, such as a thrombosed bypass graft, where immediate catheter-based intervention is likely to be indicated, direct referral to catheter angiography is the preferred option. However, catheter angiography is an invasive technique with a small but definite risk in every patient and a variable higher risk in patients with severe widespread vascular disease, diabetes, renal insufficiency, or other contraindications to the use of iodinated contrast media. CO₂-negative contrast angiography may be of value in these-patients. In light of the risk of nephrogenic

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systemic fibrosis (NSF) in patients with severe renal disease, there is no role for gadolinium chelates as X-ray contrast agents.

Computed Tomography Angiography

Early multidetector CT (MDCT) had insufficient spatial resolution, temporal resolution, and volume coverage per gantry rotation to adequately evaluate the lower extremity arterial system. With improvements in technology, CTA is rapidly evolving in the imaging of peripheral vascular obstructive disease [10,11]. It now has the advantage of allowing very rapid, noninvasive evaluation of a large portion of the arterial tree (for example, from the level of the renal arteries to the foot vessels). Although particularly useful for evaluating a defined vascular segment, CTA is still somewhat limited in the ability to grade the severity of stenotic lesions accurately when the presence of calcium is significant with respect to the vessel diameter [12]. CTA can be used to study segmented arterial components and is particularly good for evaluating aortoiliac disease, especially with its ability to view the image in coronal and sagittal views in addition to the conventional axial projection [13]. Large calcified plaques currently remain a significant problem in quantifying the degree of stenosis [14,15], and thus CT can be limited in surgical planning of touch-down in the calf. Although it is relatively noninvasive compared with catheter angiography, it has similar disadvantages with respect to iodinated contrast medium.

Magnetic Resonance Angiography

MRA has become a widespread method of imaging arterial obstructive disease, particularly with gadolinium enhancement [16,17]. This modality has the benefit of being noninvasive with minimal risk. It can image the entire vascular system, including difficult-to-visualize tibial and pedal arteries. With specialized techniques it also may be able to assess hemodynamic significance. With newer time-resolved MRA sequences, MRA correlates more accurately with catheter angiography, especially in the calf vessels [3,18,19]. Moreover, in a patient with total occlusion, MRA more reliably defines the reconstituted vessels. Metallic stents, especially stainless steel, cause signal intensity dropout, which can be indistinguishable from an occlusion. This is less of a problem with nitinol stents. MRA is now widely available, and its use, especially in conjunction with duplex vascular US, allows reliable determination of appropriate intervention when symptoms occur after angioplasty [20-30]. It takes longer to acquire images with MRA when compared to CTA. It is, however, similarly noninvasive and has the advantages of not requiring iodinated contrast agents and not using ionizing radiation. However, recent associations with gadolinium administration and the development of NSF in patients with chronic renal insufficiency has the potential to reduce its use in this patient population [31-33] (see anticipated exceptions).

Summary

A complete vascular physical examination, including measurement of the ABIs, is always the first step in

assessing a patient with recurrent symptoms after an initially successful endovascular intervention. With this knowledge the clinician/angiographer can decide on appropriate imaging studies. If it is clear that reintervention is necessary, as is often the case with a threatened limb, proceeding directly to catheter angiography is timely and appropriate. Preliminary US imaging in less urgent cases may be helpful to define the problem by confirming a recurrence at the previously treated site or suggesting progression elsewhere.

Both MRA and CTA continue to develop and thus are likely to assume a greater role in patient evaluation within the next few years. Some of the development is evolutionary, such as the use of time-resolved sequences in CE-MRA to evaluate calf vessels when venous contamination using more traditional methods can be problematic. Another example is noncontrast MRA. Meticulously performed time-of-flight MRA, while time-consuming, has proven efficacy in infrapopliteal disease [34,35]. In patients at high risk for NSF, these noncontrast techniques, after clinical testing, may prove useful to direct patient management [32].

Another fundamental development with respect to imaging science is the potential to perform CTA with two keV settings (dual-energy CT), in theory allowing separation between calcium and iodinated contrast material in small, calcified vessels. As with the new techniques above, at present there is only anecdotal experience, and thus while extremely promising, use of these advanced strategies in MR and CT must ultimately be supported by scientific evidence. Current MR and CT protocols are quite robust, but they are somewhat limited in practice by the lack in distribution of high-end MR and MDCT equipment and the limited number of trained professionals. However, where this equipment and expertise are available, the improved accuracy, comprehensiveness, and reproducibility of MR and CT make them appropriate first exams after clinical examination. The choice of modality is usually related to the expertise of the imager. Considering the technology alone, MRA has the advantage of more easily visualizing lesions obscured by overlying bone cortex in the calf, in particular the anterior tibial artery. In properly screened patients or in patients who are at risk for significant reactions to iodinated contrast medium, MRA is the procedure of choice.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, $<30 \text{ mL/min/1.73m}^2$), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent

patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m². For more information, please see the [ACR Manual on Contrast Media](#) [36].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations	
Relative Radiation Level	Effective Dose Estimate Range
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

Supporting Document(s)

- [ACR Appropriateness Criteria® Overview](#)
- Evidence table under review

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.