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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

2007 (Resolution 32)*

ACR–AIUM–SIR PRACTICE GUIDELINE FOR THE PERFORMANCE OF PHYSIOLOGIC EVALUATION OF EXTREMITY ARTERIES

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

The clinical aspects contained in specific sections of this guideline (Introduction, Indications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American College of Radiology (ACR), the American Institute of Ultrasound in Medicine (AIUM), and the Society of Interventional Radiology (SIR). Recommendations for physician requirements, written request for the examination, procedure documentation, and quality control vary among the three organizations and may be addressed by each separately.

This guideline has been developed to assist physicians performing a nonimaging physiological examination of the extremity arteries. Although it is not possible to detect every abnormality with physiological testing, following this guideline will maximize the detection of abnormalities of arterial blood supply to the lower extremities.

II. INDICATIONS/CONTRAINDICATIONS

Indications for the examination include, but are not limited to:

1. Evaluation of exercise induced limb pain.
2. Assessment of digital or extremity ulceration, gangrene, and/or rest pain.
3. Evaluation of wound healing.
4. Preoperative assessment for renal transplant.
5. Evaluation of cold sensitivity or discoloration of extremities or digits.
6. Evaluation of suspected thoracic outlet syndrome.
7. Evaluation of suspected steal distal to a fistula or graft.
8. Preoperative assessment for arterial harvesting.
9. Follow-up of surgical and endovascular procedures.
10. Surveillance of arterial bypass grafts in asymptomatic patients to detect those at high risk for thrombosis.

There are no absolute contraindications for this examination.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

Each organization addresses this requirement individually. ACR language is as follows:

See the [ACR–SPR–SRU Practice Guideline for Performing and Interpreting Diagnostic Ultrasound Examinations](#).

IV. WRITTEN REQUEST FOR THE EXAMINATION

Each organization addresses this requirement individually. ACR language is as follows:

The written or electronic request for a physiologic evaluation of extremity arteries should provide sufficient information to demonstrate the medical necessity of the procedure and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms, 2) relevant history (including known diagnoses, and/or 3) prior imaging). Additional information regarding the specific reason for the procedure or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the procedure.

The request for the procedure must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of

practice requirements. (ACR Resolution 35, adopted in 2006)

V. SPECIFICATIONS OF THE EXAMINATION

Description of the component parts of the examination:

1. Segmental blood pressures
The laboratory should have a protocol specifying the size cuff to be used at each location where blood pressure is commonly obtained. Extremity pressures are taken using a hand held continuous wave (CW) Doppler to listen for return of arterial blood flow. Digital pressure can instead be assessed using photoplethysmography to determine when blood flow returns. Bilateral brachial pressures are obtained when possible. The highest brachial pressure is the pressure used in index calculations whether in the upper extremities, lower extremities, or digits.
2. CW Doppler waveforms
CW Doppler waveforms can be obtained from one or more arteries. In the lower extremity, the arteries most commonly assessed are the common femoral, popliteal, posterior tibial, and dorsalis pedis. In the upper extremity, arteries commonly assessed are the subclavian, axillary, brachial, radial, and ulnar. Those performing the examination should be familiar with the appropriate external anatomic landmarks to assure accurate performance of the examination. There should be strict adherence to technique, including attempting to maintain as close to a 60 degree Doppler angle as possible.
3. Plethysmography
Volume plethysmography can be obtained at one or more levels. In the lower extremity, the most common places to obtain waveforms are in the upper thigh, lower thigh, calf, and ankle. A waveform can be obtained in the toes using a photoplethysmography cell.

Physiological tests are indirect tests. Results are used to infer the presence or absence of disease. Specific locations in the arterial tree are not directly assessed with physiological techniques. See the [ACR–AIUM–SRU Practice Guideline for the Performance of Peripheral Arterial Ultrasound Using Color and Pulsed Doppler](#) for duplex evaluation of the arteries, which supplies a direct assessment of the arterial segments that may be involved with disease.

Levels in the lower extremity that are most commonly assessed are the upper thigh, lower thigh, upper calf, ankle, and digits. In the upper extremity, levels include the upper arm, forearm, and digits. The examination may be done at one level only (e.g., the ankle) or at multiple

levels of the extremity. The physiological tests that are most commonly used are the CW Doppler-assisted measurement of blood pressures, the obtaining of Doppler ultrasound waveforms, and the recording of plethysmographic waveforms. Whether done at one level or at multiple levels, the examination should be bilateral when possible so that flow in the two limbs can be compared, and it should always include at least two physiological tests at the ankle to allow the accuracy of pressure measurements at the ankle to be internally validated.

Physiological tests, particularly ankle pressure measurements, may be repeated after exercise of the involved limb when indicated. This is particularly valuable for the assessment of exercise-induced symptoms. When the patient is exercised, use of a treadmill is recommended when possible. This provides for reproducible quantification of exercise while allowing simultaneous assessment of symptoms produced during exercise. These symptoms should also be recorded.

It is important that the examination be done in a warm room so that the effects of peripheral vasoconstriction are minimized. If possible, the patient should be recumbent for the examination and should be at rest for at least 5 minutes before starting the examination to diminish any effects that prior patient activity might have on the examination.

VI. DOCUMENTATION

Each organization addresses this requirement individually. ACR language is as follows:

Adequate documentation is essential for high-quality patient care. There should be a permanent record of the ultrasound examination and its interpretation. Comparison with prior relevant imaging studies may prove helpful. Images of all appropriate areas, both normal and abnormal, should be recorded. There should be a permanent record of all CW Doppler waveforms, plethysmographic waveforms, segmental blood pressures and their interpretation. Variations from normal size should generally be accompanied by measurements. Images should be labeled with the patient identification, facility identification, examination date, and image orientation. An official interpretation (final report) of the ultrasound examination should be included in the patient's medical record. Retention of the ultrasound examination images should be consistent both with clinical need and with relevant legal and local healthcare facility requirements.

Reporting and communication efforts should be in accordance with the [ACR Practice Guideline for Communication of Diagnostic Imaging Findings](#).

VII. EQUIPMENT SPECIFICATIONS

Arterial waveforms are obtained with a CW Doppler instrument 2 to 10 MHz with a zero-crossing detector. The instrument should have audio output through a speaker or headphones. The instrument should also have a digital or analog recording device so that waveforms can be saved.

The same CW Doppler instrument can be used to detect arterial waveforms for the performance of segmental pressures. Appropriate size blood pressure cuffs attached to a manometer are necessary to perform segmental blood pressures. A rapid inflation device is helpful. Small cuffs are necessary to measure digital pressures. A photoelectric plethysmograph can be used to assist in digital pressure measurement. A treadmill with adjustable speed and incline is recommended for reproducible, quantifiable exercise testing. A digital or analog display is desirable to allow for recording of the exercise parameters used.

Plethysmography can be performed with the same cuffs used to measure pressures connected to an air-filled plethysmograph.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Each organization addresses this requirement individually. ACR language is as follows:

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR web page (<http://www.acr.org/guidelines>).

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Real Time Ultrasound Equipment](#).

ACKNOWLEDGEMENTS

This guideline was revised according to the process described under the heading *The Process for Developing ACR Practice Guidelines and Technical Standards* on the ACR web page (<http://www.acr.org/guidelines>) by the ACR Guidelines and Standards Committees of the Commissions on Interventional and Cardiovascular Radiology and Ultrasound, in collaboration with the AIUM, and the SIR.

Principal Drafter: Raymond E. Bertino, MD

Collaborative Subcommittee

Raymond E. Bertino, MD, Chair
Gretchen A. Gooding, MD
John S. Pellerito, MD
Carol M. Rumack, MD

AIUM

Edward I. Bluth, MD
Mary C. Frates, MD
Laurence Needleman, MD

SIR

John F. Cardella, MD
Clement J. Grassi, MD
David Sacks, MD

ACR Guidelines and Standards Committee –
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Matthew A. Mauro, MD, Chair, Commission

ACR Guidelines and Standards Committee – Ultrasound

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John S. Pellerito, MD
Philip W. Ralls, MD
Michelle L. Robbin, MD
Carol M. Rumack, MD, Chair, Commission

Robert JD. Tarver, MD, CSC Subcommittee

Bill H. Warren, MD, CSC Subcommittee

REFERENCES

1. ACR practice guideline for the performance of peripheral arterial ultrasound using color and pulsed Doppler. In: *Practice Guidelines and Technical Standards*. Reston, Va: American College of Radiology; 2006:857-861.

2. Mohler ER 3rd. Peripheral arterial disease: identification and implications. *Arch Intern Med* 2003;163:2306-2314.
3. Moneta GL, Yeager RA, Lee RW, Porter JM. Noninvasive localization of arterial occlusive disease: a comparison of segmental Doppler pressures and arterial duplex mapping. *J Vasc Surg* 1993;17:578-582.
4. Polak JP. Efficacy of vascular diagnostic tests. In: *Peripheral Vascular Sonography*, 2nd edition, Lippincott, Williams & Wilkins; 2004.
5. Rose SC. Noninvasive vascular laboratory for evaluation of peripheral arterial occlusive disease: Part I – hemodynamic principles and tools of the trade. *J Vasc Interv Radiol* 2000;11:1107-1114.
6. Rose SC. Noninvasive vascular laboratory for evaluation of peripheral arterial occlusive disease: Part II – clinical applications: chronic, usually atherosclerotic, lower extremity ischemia. *J Vasc Interv Radiol* 2000;11:1257-1275.
7. Rose SC. Noninvasive vascular laboratory for evaluation of peripheral arterial occlusive disease. Part III – clinical applications nonatherosclerotic lower extremity arterial conditions and upper extremity arterial disease. *J Vasc Interv Radiol* 2001;12:11-18.
8. Schroder F, Diehm N, Kareem S, et al. A modified calculation of ankle-brachial pressure index is far more sensitive in the detection of peripheral arterial disease. *J Vasc Surg* 2006;44:531-536.
9. Zierler RE. Nonimaging physiologic tests for assessment of lower extremity arterial occlusive disease. In: Zwiebel WJ, Pellerito JS, eds. *Introduction to Vascular Ultrasonography*, 5th edition, Elsevier Saunders; 2005.

*Guidelines and standards are published annually with an effective date of October 1 in the year in which amended, revised or approved by the ACR Council. For guidelines and standards published before 1999, the effective date was January 1 following the year in which the guideline or standard was amended, revised, or approved by the ACR Council.

Development Chronology for this Guideline
2007 (Resolution 32)