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ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF ULTRASOUND VASCULAR MAPPING FOR PREOPERATIVE PLANNING OF DIALYSIS ACCESS

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 on 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 of this guideline (Indications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American College of Radiology (ACR) and the American Institute of Ultrasound in Medicine (AIUM). Recommendations for physician requirements, written request for the examination, procedure documentation, and quality control vary between the two organizations and are addressed by each separately.

Mapping of arm vessels prior to surgical placement of dialysis access has been shown to be useful in helping achieve a higher percentage of arteriovenous fistula (AVF) placements, as well as increased fistula success rate [1-3]. This guideline is intended to help physicians in the performance of preoperative mapping, to guarantee a high-quality examination and to help promote successful placement of the most preferred types of dialysis access. Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines [4,5] define an order of preference for placement of vascular access in patients with kidney failure who will become hemodialysis dependent:

1. A forearm cephalic vein AVF (radial artery-cephalic vein), followed by an upper arm cephalic vein AVF (brachial artery-cephalic vein), is preferred.
2. If it is not possible to create either of these fistulae, access may be established using a transposed basilic vein fistula (brachial artery-basilic vein), or other AVF configuration.
3. If the vascular anatomy is not suitable for any AVF placement, a graft of synthetic material (e.g., polytetrafluoroethylene, abbreviated PTFE) may be placed. A forearm loop graft (brachial artery to antecubital vein) is preferred over an upper arm straight graft (brachial artery to basilic vein). If no other upper extremity access is possible, an upper arm loop graft (axillary artery to axillary vein) may be placed, if the anatomy is suitable.
4. Thigh grafts (common femoral artery to great saphenous vein or common femoral vein) are the next usual site for access placement [6].
5. Placement of an upper extremity AVF or an arm or thigh graft is preferred to catheter-based hemodialysis, due to increased catheter infection rates and often lower catheter flow rates as compared to a graft or fistula.

II. INDICATIONS/CONTRAINDICATIONS

Indications for vascular mapping for preoperative planning of dialysis access include planning of vascular access for hemodialysis. There are no absolute contraindications for this examination.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Diagnostic Ultrasound Examinations.

IV. WRITTEN REQUEST FOR THE EXAMINATION

The written or electronic request for a dialysis access ultrasound examination should provide sufficient information to demonstrate the medical necessity of the examination and allow for the proper performance and interpretation of the examination.

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

The request for the examination 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. 2006 (Res. 35)

V. SPECIFICATIONS OF THE EXAMINATION

The ultrasound examination for dialysis access planning is designed to gather information about both the arterial system and the venous system. It is important to understand the techniques to be used by the local dialysis access surgeon(s) in order to obtain information tailored to the technique.

A. Venous Examination

The nondominant arm is examined first unless there is known to be a contraindication to the use of this arm. The examination is focused first towards finding a vein suitable for AVF creation. If no suitable vein is found, veins suitable for graft creation are sought.

The vein mapped to receive the arterial anastomosis should be measured after it is dilated. This measurement will more closely approximate the size of the arterialized vein that will be seen after fistula formation. The vein is generally dilated by use of tourniquets or an inflated blood pressure cuff on the arm. It can also be dilated by letting the arm hang below the level of the heart, by rubbing or tapping the vein, or by wrapping the forearm with a warm compress for several minutes.

The forearm vein most commonly used for AVF creation is the cephalic vein. The anastomosis is usually at the wrist, or the lower one-third of the forearm. The cephalic vein is insonated at the site of the expected anastomosis at the wrist. It is assessed for compressibility and for size. Measurements are obtained with a minimal diameter of 0.25 cm for all veins used for an AVF. However, there may be variations based on clinical factors or surgical preference. Vein diameter is measured at the caudal, mid and cranial forearm; at the antecubital fossa; and at the caudal, mid, and cranial upper arm, as applicable. The sites and length of any vein stenosis are noted. Veins that are borderline in size (within 0.05 cm of the desired size) are measured again after more focused percussion or after application of a warm compress for several minutes.

Veins must be relatively superficial to be easily cannulated after placement of a fistula. Depending on local practices and surgical preferences, the depths of the cephalic veins may be measured if of adequate diameter, to assess the need for a subsequent superficialization procedure [7].

Large branches of veins near the site of a fistula can result in nonmaturation of the fistula [8]. Depending on local practices, the sites of vein branches and the sizes of those branches may be noted.

The cephalic vein should be evaluated central to its draining vein to verify a wide connection to the upper arm. The examination should be continued to include the main draining vein for the fistula to the axillary vein. If the cephalic vein drains via a large antecubital vein into the basilic or brachial veins, note should be made that the vein is suitable for AVF creation even if the upper arm cephalic vein is too small.

The internal jugular and subclavian veins should be examined bilaterally for respiratory phasicity and transmitted cardiac pulsatility. These veins should generally be evaluated by duplex color sonography including gray scale, spectral, and color Doppler. Unilateral or bilateral monophasic waveforms or low peak systolic velocity venous waveforms are abnormal [9,10]. Abnormal waveforms in the jugular veins or subclavian veins should prompt further evaluation of the brachiocephalic veins and/or superior vena cava by magnetic resonance or venography if access placement on that side is desired.

If the cephalic vein in the forearm is not adequate for fistula creation, then other veins in the forearm may be examined to determine whether they may be adequate. These veins in general will need to be transposed to an easier accessible position in the anterior surface of the forearm, typically a basilic or other vein. If no suitable vein is found in the forearm, the veins in the upper arm should be evaluated.

The upper arm cephalic vein should be examined for upper arm fistula creation. If it is too small or thrombosed, the basilic vein is evaluated. There needs to be 2 cm of adequately sized basilic vein caudal to the antecubital fossa to create a basilic vein transposition AVF. If no suitable upper arm vein for AVF creation is found, the largest brachial vein and axillary vein should be measured for potential graft placement as previously described. An even larger vein is needed for grafts, with a minimum diameter of 0.4 cm.

Similar assessment techniques should be used in all these veins (i.e., vein dilatation prior to insonation, demonstration of adequate size and normal venous compressibility, and determination of adequate venous drainage).

B. Arterial Examination

The artery used must be of sufficient size (0.20 cm) [1,7] to construct the fistula and for it to have adequate flow for maturation. The artery is evaluated with gray scale. The presence of calcifications is recorded and reported since the surgical anastomosis can be difficult to perform if significant concentric calcifications are present. The luminal diameter of the artery is measured at the level of expected fistula creation. Arterial spectral waveforms should be assessed for normalcy, to screen for inflow disease.

For a forearm AVF the radial and ulnar arteries are assessed for diameter, peak systolic/end diastolic velocity, and the presence of calcification at the wrist. For either AVF or graft creation the brachial artery is assessed for diameter, peak systolic/end diastolic velocity, waveform and the presence of calcification at the antecubital fossa. An artery at this location that is smaller than expected can be a clue to the patient having a high bifurcation of the brachial artery (high radial artery takeoff), a vascular anomaly occurring in 5% to 10% of patients. When suspected, the anomaly should be confirmed by insonating the radial and ulnar arteries to determine whether they arise from the brachial artery. If noted, it should be reported, as some surgeons will place an AVF, but not a graft, below the high radial artery takeoff.

A duplex Allen test may be performed. This is often most easily done by identifying the radial artery at the wrist and/or at the dorsum of the hand (posteriorly between the bases of the first and second metacarpals to become the deep palmar arch). The radial artery is compressed proximal to this site during insonation with spectral and color Doppler to occlude its flow. Reversal of blood flow distal to the proximal occlusion confirms patency of a palmar arch [11].

VI. DOCUMENTATION

Adequate documentation is essential for high-quality patient care. There should be a permanent record of the sonographic examination and its interpretation. Images of all appropriate areas, both normal and abnormal, should be recorded in an appropriate format. Variations from normal size should be accompanied by measurements. Images are to be appropriately labeled with the examination date, patient identification, and image orientation. A report of the sonographic findings should be included in the patient's medical record. Retention of the permanent record of the sonographic examination should be consistent both with clinical need and with the 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

Real-time imaging should be conducted at the highest clinically appropriate frequency, realizing that there is a trade-off between resolution and beam penetration. This should usually be at a frequency of 10 MHz or greater, with the occasional need for a lower frequency transducer. A linear transducer should be used. Flow analyses are performed with duplex sonography, using pulsed Doppler. Evaluation of the flow signals originating from within the lumen of the vessels should be conducted with a carrier frequency of 2.5 MHz or above. Images of the relevant gray scale, color, and spectral Doppler waveforms should be recorded and archived. Color Doppler should be used for relevant portions of the procedure.

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

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 Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

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

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