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ACR–SIR PRACTICE PARAMETER FOR THE PERFORMANCE OF DIAGNOSTIC INFUSION VENOGRAPHY

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care¹. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents 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 practitioner in light of all the circumstances presented. Thus, an approach that differs from the guidance in this document, 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 this document 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 this document. However, a practitioner who employs an approach substantially different from the guidance in this document 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 the guidance in this document 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 this document is to assist practitioners in achieving this objective.

¹ Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, 831 N.W.2d 826 (Iowa 2013) Iowa Supreme Court refuses to find that the *ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures* (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.

I. INTRODUCTION

This practice parameter, originally developed and written by the Society of Interventional Radiology (SIR) in collaboration with the American College of Radiology (ACR), was revised by the ACR in collaboration with the SIR.

Diagnostic infusion venography is a radiographic study of venous anatomy using contrast media injection via a peripheral intravenous access. The term does not imply a specific method, type, or rate of contrast media injection. Such a study will often visualize the venous system to the right atrium. However, the term diagnostic infusion venography does not include central or selective venography through an angiographic or central venous catheter.

Diagnostic infusion venography is an established, safe, and accurate method when used as indicated and is considered the diagnostic standard for peripheral venography by which the accuracy of other venous imaging modalities should be judged. However, alternative methods of studying the venous system such as duplex ultrasound, computed tomography (CT) venography, and magnetic resonance (MR) venography may be preferable or complementary in specific clinical situations [1-4]. In particular, duplex ultrasound has largely replaced diagnostic infusion venography of the upper or lower extremity since the sensitivity and specificity of duplex ultrasound above the elbow or knee are satisfactory for diagnosing acute deep venous thrombosis (DVT) and venous insufficiency [5-20]. Infusion venography has small but definite risks of complications including nephrotoxicity, contrast allergy, and/or infection [21-33].

Diagnostic infusion venography should be performed only for a valid medical reason (eg, see section II below) and with the minimum radiation dose necessary to answer the clinical questions for which the study is performed. Although venography is an invasive test with defined risks, it is a valuable and informative procedure for evaluating disorders of the venous system. The information obtained by infusion venography, combined with other clinical and noninvasive imaging findings, can be used to diagnose a problem, and/or plan therapy or intervention, and/or evaluate results of treatment.

This practice parameter can be used in institution-wide quality-improvement programs to assess the practice of venography. The most important processes of care are 1) patient selection, preparation, and education; 2) performing and interpreting the procedure; and 3) monitoring the patient. The outcome measures for these processes are indications, success rates, and complication rates. Outcome measures are assigned threshold levels.

II. INDICATIONS AND CONTRAINDICATIONS

Noninvasive imaging modalities have largely replaced the need for diagnostic infusion venography. In the majority of patients in whom there is suspicion for venous thrombosis, duplex ultrasound is sufficient to diagnose thrombosis of both deep and superficial veins of the upper and lower extremities, as well as the jugular veins [8,12]. In these same venous segments, duplex ultrasound is general sufficient for venous mapping or the detection of venous reflux [5,6,11,14,20,34-36]. In patients where ultrasound is limited or inadequate, or where there is persistent high clinical suspicion and a negative ultrasound, diagnostic infusion venography may be of clinical utility.

CT and MR venography has demonstrated high sensitivity and specificity for the detection of DVT, with these techniques particularly useful for evaluating for thrombosis or encasement of the deep thoracic, abdominal, or pelvic veins [28,37]. Newer MR venography protocols may even be performed without the need for administration of gadolinium-based contrast [38].

Indications for diagnostic infusion venography include, but are not limited to:

1. Diagnosis of DVT in patients not a candidate for, or with a limited, CT or MR venogram, when duplex ultrasound is:
 - a. Nondiagnostic or not technically feasible.
 - b. Negative, but there is a high clinical suspicion for DVT or calf-vein thrombosis.
2. Evaluation of valvular insufficiency prior to thermal ablation of the veins.
3. Evaluation of perforator incompetency prior to sclerotherapy, thermal ablation, or subfascial endoscopic ligation.

4. Venous mapping prior to, during, or following a surgical or interventional procedure.
5. Evaluation for venous stenosis, anatomic entrapment, or venous hypertension.
6. Evaluation for venous malformations.
7. Preoperative evaluation for tumor involvement or encasement in patients not a candidate for, or with a limited, CT or MR venogram.
8. Evaluation for deep pelvic, thoracic, or caval thrombosis in a patient not a candidate for, or with a limited, CT or MR venogram.
9. Evaluation for central venous catheter placement in the setting of no suitable access site by ultrasound and failed attempts with the use of anatomic landmarks.

The threshold for these indications is 95%. When fewer than 95% of procedures are for these indications, the department should review the process of patient selection.

There are no absolute contraindications to diagnostic infusion venography. Relative contraindications include, but are not limited to:

1. Cellulitis or local infection for which venous access needs to be obtained.
2. Severe allergy to iodinated contrast media.
3. Renal insufficiency in patients who are not on dialysis, particularly those with diabetes or congestive heart failure.

For the pregnant or potentially pregnant patient, see the [ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#) [39].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

A. Physician

Core Privileging: This procedure is considered part of or amendable to image-guided core privileging.

Initial Qualifications

Diagnostic infusion venography examinations must be performed under the supervision of and interpreted by a physician who has the following qualifications:

1. Certification in Radiology, Diagnostic Radiology or Interventional Radiology/Diagnostic Radiology (IR/DR) by the American Board of Radiology, the American Osteopathic Board of Radiology, the Royal College of Physicians and Surgeons of Canada, or the Collège des Médecins du Québec and has performed (with supervision) a sufficient number of Venography procedures to demonstrate competency as attested by the supervising physician(s).

or

2. Completion of radiology or interventional radiology residency program approved by the Accreditation Council for Graduate Medical Education (ACGME), the Royal College of Physicians and Surgeons of Canada (RCPSC), the Collège des Médecins du Québec, or the American Osteopathic Association (AOA)

and has performed (with supervision) a sufficient number of venography procedures to demonstrate competency as attested by the supervising physician(s).

or

3. In the absence of appropriate approved residency training as outlined in section III.A.2 above or postgraduate training that included comparable instruction and experience in diagnostic venography, the physician must have experience and demonstrated competency as primary operator in diagnostic venography under the supervision of an on-site qualified physician, during which a minimum of 10 extremity venograms were performed with documented success and complication rates that meet the threshold criteria in section VIII.

and

4. Physicians meeting any of the qualifications in 1, 2, and 3 above must also have written substantiation that they are familiar with all of the following:
 - a. Indications and contraindications for the procedure.
 - b. Preprocedural assessment, monitoring, and management of the patient and complications.
 - c. Fluoroscopic and radiographic equipment and other electronic imaging systems.
 - d. Principles of radiation protection, the hazards of radiation, and radiation monitoring requirements.
 - e. Pharmacology of contrast agents and recognition and treatment of adverse reactions to them.
 - f. Technical aspects of performing the procedure, including appropriate injection rates and volumes of contrast media, and imaging sequences.
 - g. Anatomy, physiology, and pathophysiology of peripheral venous vasculature.
 - h. Interpretation of diagnostic venography.
 - i. Postprocedural patient management, especially recognition and initial management of complications.

The written substantiation should come from the chief of interventional radiology, director or chief of body imaging or ultrasound, or the chair of the radiology department of the institution in which the physician will be providing these services. Substantiation could also come from a prior institution in which the physician provided the services, but only at the discretion of the current interventional director or chair to solicit the additional input.

Maintenance of Competence

Physicians must perform a sufficient number of overall procedures applicable to the spectrum of core privileges to maintain their skills, with acceptable success and complication rates as laid out in this parameter. Continued competence should depend on participation in a quality improvement program that monitors these rates. Consideration should be given to the physician's lifetime practice experience.

Continuing Medical Education

The physician's continuing education should be in accordance with the [ACR Practice Parameter for Continuing Medical Education \(CME\)](#) [40].

B. Qualified Medical Physicist

A Qualified Medical Physicist is an individual who is competent to practice independently in one or more of the subfields in medical physics. The American College of Radiology considers certification, continuing education, and experience in the appropriate subfield(s) to demonstrate that an individual is competent to practice in one or more of the subfields in medical physics and to be a Qualified Medical Physicist. The ACR strongly recommends that the individual be certified in the appropriate subfield(s) by the American Board of Radiology (ABR), the Canadian College of Physics in Medicine, or by the American Board of Medical Physics (ABMP).

A Qualified Medical Physicist should meet the [ACR Practice Parameter for Continuing Medical Education \(CME\)](#). (ACR Resolution 17, 1996 – revised in 2012, Resolution 42) [40]

The appropriate subfield of medical physics for this practice parameter is Diagnostic Medical Physics. (Previous medical physics certification categories including Radiological Physics, Diagnostic Radiological Physics, and Diagnostic Imaging Physics are also acceptable.)

C. Registered Radiologist Assistant

A registered radiologist assistant is an advanced level radiographer who is certified and registered as a radiologist assistant by the American Registry of Radiologic Technologists (ARRT) after having successfully completed an advanced academic program encompassing an ACR/ASRT (American Society of Radiologic Technologists) radiologist assistant curriculum and a radiologist-directed clinical preceptorship. Under radiologist supervision, the radiologist assistant may perform patient assessment, patient management and selected examinations as delineated in the Joint Policy Statement of the ACR and the ASRT titled "Radiologist Assistant: Roles and Responsibilities" [41]

and as allowed by state law. The radiologist assistant transmits to the supervising radiologists those observations that have a bearing on diagnosis. Performance of diagnostic interpretations remains outside the scope of practice of the radiologist assistant. (ACR Resolution 34, adopted in 2006 –Revised 2016, Resolution 1-c)

D. Radiologic Technologist

1. The technologist, together with the physician and nursing personnel, should have responsibility for patient comfort and safety. The technologist should be able to prepare and position² the patient for the venographic procedure. The technologist should provide assistance to the physician as required, which may include operating the imaging equipment and obtaining images prescribed by the supervising physician. The technologist should also perform the regular quality control testing of the equipment under supervision of the physicist.
2. The technologist should be trained in basic cardiopulmonary resuscitation and in the function of the resuscitation equipment.
3. The technologist should be certified by the American Registry of Radiologic Technologist (ARRT) or have an unrestricted state license with documented training and experience in diagnostic venography procedures.

E. Other Ancillary Personnel

Other ancillary personnel who are qualified and duly licensed or certified under applicable state law may, under supervision by a radiologist or other qualified physician, perform specific interventional fluoroscopic or other image-guided procedures. Supervision by a radiologist or other qualified physician must be direct or personal, and must comply with local, state, and federal regulations. Individuals should be credentialed for specific fluoroscopic and other image-guided interventional procedures and should have received formal training in radiation management and/or application of other imaging modalities as appropriate. See the [ACR–AAPM Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures](#) [42].

F. Nursing Services

Nursing services are an integral part of the team for preprocedural, intra-procedural, and postprocedural patient management and education and are recommended in monitoring the patient during the procedure when deemed appropriate by the performing physician.

G. Nonphysician Practitioners

Physician assistants and nurse practitioners can be valuable members of the interventional radiology team but should not perform diagnostic venography independent of supervision by physicians with training, experience, and privileges to perform the relevant procedures. See the [ACR–SIR–SNIS–SPR Practice Parameter for Interventional Clinical Practice and Management](#) [43].

IV. SPECIFICATIONS OF THE EXAMINATION

There are several technical requirements to ensure safe and successful diagnostic infusion venography. These include adequate radiographic imaging equipment, institutional facilities, and physiologic monitoring equipment.

² The American College of Radiology approves of the practice of certified and/or licensed radiologic technologists performing fluoroscopy in a facility or department as a positioning or localizing procedure only, and then only if monitored by a supervising physician who is personally and immediately available*. There must be a written policy or process for the positioning or localizing procedure that is approved by the medical director of the facility or department/service and that includes written authority or policies and processes for designating radiologic technologists who may perform such procedures. (ACR Resolution 26, 1987 – revised in 2007, Resolution 12m)

*For the purposes of this guideline, “personally and immediately available” is defined in manner of the “personal supervision” provision of CMS—a physician must be in attendance in the room during the performance of the procedure. Program Memorandum Carriers, DHHS, HCFA, Transmittal B-01-28, April 19, 2001.

A. Venography Equipment and Facilities

1. The following are considered the minimum equipment requirements for performing diagnostic infusion venography. A radiography suite that is large enough to allow easy transfer of the patient from the bed to the table and to accommodate the procedure table, monitoring equipment, and other hardware such as intravenous pumps, respirators, anesthesia equipment, and oxygen tanks. Ideally, there should be adequate space for circulation of technical staff in the room without interfering with the contrast injection [44].
2. For lower extremity venography, a tilt table fluoroscopy unit is desirable [45].

B. Resuscitation Equipment

There should be ready access to emergency resuscitation equipment including an emergency defibrillator, an oxygen supply and appropriate tubing and delivery systems, suction equipment, tubes for endotracheal intubation, laryngoscope, ventilation bag-mask-valve apparatus, and central venous line sets. Drugs for treating cardiopulmonary arrest, contrast reaction, vasovagal reactions, narcotic or benzodiazepine overdose, bradycardia, and ventricular arrhythmias should also be readily available. In fluoroscopy suites where pediatric patients are treated, appropriate pediatric emergency resuscitation equipment and drugs should be available. Resuscitation equipment should be monitored and checked on a routine basis in compliance with institutional policies.

C. Patient Care

The appropriate anatomic region/site and side(s) should be indicated on the initial examination request.

3. Preprocedure care

- a. The physician performing the procedure must have knowledge of the following:
 - Clinically significant history, including the indications for the procedure.
 - Clinically significant physical examination findings, including an awareness of clinical or medical conditions that may necessitate specific care.

Possible alternative imaging modalities, such as ultrasound, MR, or CT, to obtain the desired diagnostic information.

- b. Informed consent must be in compliance with all state laws and applicable ACR practice parameters and technical standards. See the [ACR–SIR–SPR Practice Parameter on Informed Consent for Image-Guided Procedures](#) [46].
- c. If peripheral venous access for the procedure is obtained by nursing or other support staff, desired site of access should be discussed with the interpreting physician prior to obtaining access.

4. Procedural care

- a. Adherence to the Joint Commission’s current Universal Protocol for Preventing Wrong Site, Wrong Procedure, Wrong Person Surgery™ is required for procedures in non–operating room settings, including bedside procedures.

The organization should have processes and systems in place for reconciling differences in staff responses during the “time out.”

- b. During the use of fluoroscopy, the physician should have knowledge of exposure factors, including kVp, mA, frame rate, magnification factor, and dose rate, and should consider additional parameters such as collimation, field of view, and last image hold to decrease radiation dose. See the [ACR–AAPM Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures](#) [42].
- c. Nursing personnel, technologists, and those directly involved in the care of patients undergoing venography should have protocols for use in standardizing care. These should include, but are not limited to:
 - Equipment needed for the procedure.
 - Patient monitoring.

Protocols should be reviewed and updated periodically.

5. Postprocedural care.

Patients should be monitored after diagnostic infusion venography per local practice for the evaluation of potential procedural-related complications, particularly allergic reaction to intravenous contrast or access site infiltration.

V. DOCUMENTATION

Documentation of a complete venogram procedure will vary according to the indication for the examination, as outlined in section II. At a minimum, for any indication, the operator should document and archive a sufficient number of images with complete contrast filling of the veins of the anatomic region being studied to answer the clinical question that prompted the examination.

The physician responsible for the performance and interpretation of the study should have full knowledge of the pathophysiology of venous diseases and should tailor the examination appropriately to provide optimal diagnostic information while attempting to minimize the patient's exposure to iodinated contrast and ionizing radiation.

Reporting should be in accordance with the [ACR–SIR–SPR Practice Parameter for the Reporting and Archiving of Interventional Radiology Procedures](#) [47].

VI. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, registered radiologist assistants, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, “as low as reasonably achievable” (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel that work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection and application of dose limits) and the principles of proper management of radiation dose to patients (justification, optimization and the use of dose reference levels) http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1578_web-57265295.pdf

Nationally developed guidelines, such as the ACR's [Appropriateness Criteria](#)[®], should be used to help choose the most appropriate imaging procedures to prevent unwarranted radiation exposure.

Facilities should have and adhere to policies and procedures that require varying ionizing radiation examination protocols (plain radiography, fluoroscopy, interventional radiology, CT) to take into account patient body habitus (such as patient dimensions, weight, or body mass index) to optimize the relationship between minimal radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used whenever appropriate. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available at the Image Gently[®] for children (www.imagegently.org) and Image Wisely[®] for adults (www.imagewisely.org) websites. These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be measured and patient radiation dose estimated for representative examinations and types of patients by a Qualified Medical Physicist in accordance with the applicable ACR technical standards. Regular auditing of patient dose indices should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry, the NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director's National Evaluation of X-ray Trends. (ACR Resolution 17 adopted in 2006 – revised in 2009, 2013, Resolution 52).

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

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 website (<https://www.acr.org/Clinical-Resources/Practice-Parameters-and-Technical-Standards>).

Equipment performance monitoring should be in accordance with the [ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Fluoroscopic Equipment](#) and the [ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Radiographic Equipment](#) [48,49].

These data should be used in conjunction with the thresholds described in section VIII below to assess procedural efficacy and complication rates and to trigger institutional review when these thresholds are exceeded.

VIII. QUALITY IMPROVEMENT

These practice parameters are intended to be used in quality improvement (QI) programs to assess diagnostic infusion venography. The most important processes of care are patient selection, performance of the examination, interpretation of the images, and the communication of the findings to the referring physician. The major outcome measures for diagnostic venography include diagnosis of pathology and complication rates. Outcome measures are assigned threshold levels.

While practicing physicians should strive to achieve perfect outcomes (eg, 100% success, 0% complications), in practice all physicians will fall short of this ideal to a variable extent. Thus, in addition to QI case reviews customarily conducted after individual procedural failures or complications, outcome measure thresholds should be used to assess diagnostic infusion venography in ongoing QI programs. For the purpose of these practice parameters, a threshold is a specific level of an indicator which, when reached or crossed, should prompt a review of departmental policies and procedures. Procedure thresholds or overall thresholds refer to a group of outcome measures for a procedure, eg, major complications for diagnostic infusion venography. Individual complications

may also be associated with complication-specific thresholds, eg, fever or hemorrhage. When outcome measures such as success rates or indications fall below a minimum threshold, or when complication rates exceed a maximum threshold, a departmental review should be performed to determine causes and to implement changes, if necessary. Thresholds may vary from those listed here; for example, patient referral patterns and selection factors may dictate a different threshold value for a particular indicator at a particular institution. Thus, setting universal thresholds is very difficult, and each department is urged to alter the thresholds to higher or lower values to meet its own QI program needs.

Complications can be stratified on the basis of outcome. Major complications may result in admission to a hospital for therapy (for outpatient procedures), an unplanned increase in the level of care, prolonged hospitalization, permanent adverse sequelae, or death. Minor complications result in no sequelae; they may require nominal therapy or a short hospital stay for observation (generally overnight). See Appendix A. The complication rates and thresholds in Table 2 below refer to major complications.

Measures of Success

Technical success – Technical success describes the successful placement of appropriate intravenous (IV) access and the acquisition of acceptable images of diagnostic quality.

Complication rates – Published rates for individual types of complications are highly dependent on patient selection and are based on series comprising several hundred patients, which is a volume larger than most individual practitioners are likely to diagnose. Therefore, we recommend that complication-specific thresholds usually should be set higher than the complication-specific reported rates listed in Tables 1 and 2. It is also recognized that a single complication can cause a rate to cross above a complication-specific threshold when the complication occurs in a small volume of patients, eg, early in a QI program. In this situation, the overall procedure threshold is more appropriate for use in

a QI program.

In Tables 1 and 2, all values are supported by the weight of literature evidence and panel consensus.

Table 1 – Table 1 Successful Rates for Diagnostic Infusion Venography [8,10,16,28,29,33]

Success Rates	Reported Rates	Suggested Thresholds
Diagnostic Infusion Venography	84% to 100%	95%

Table 2 – Table 2 Major Complications of Diagnostic Infusion Venography [21-33]

Major Complications	Reported Rates	Suggested Thresholds
Death	<1%	<1%
Bronchospasm	<1%	<1%
Cardiovascular collapse	<1%	<1%
DVT with ionic contrast	2.6% to 10%	<3%
DVT with nonionic contrast	0% to 9%	<3%
Contrast-media-induced nephrotoxicity	0% to 0.15%	<2%
Skin necrosis	0% to .05%	0% to .05%

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REFERENCES

1. Krishan S, Panditaratne N, Verma R, Robertson R. Incremental value of CT venography combined with pulmonary CT angiography for the detection of thromboembolic disease: systematic review and meta-analysis. *AJR. American journal of roentgenology*. 2011;196(5):1065-1072.
2. Orbell JH, Smith A, Burnand KG, Waltham M. Imaging of deep vein thrombosis. *The British journal of surgery*. 2008;95(2):137-146.
3. Spritzer CE. Progress in MR imaging of the venous system. *Perspectives in vascular surgery and endovascular therapy*. 2009;21(2):105-116.
4. Lindquist CM, Karlicki F, Lawrence P, Strzelczyk J, Pawlyshyn N, Kirkpatrick ID. Utility of balanced steady-state free precession MR venography in the diagnosis of lower extremity deep venous thrombosis. *AJR. American journal of roentgenology*. 2010;194(5):1357-1364.
5. Di Nisio M, Van Sluis GL, Bossuyt PM, Buller HR, Porreca E, Rutjes AW. Accuracy of diagnostic tests for clinically suspected upper extremity deep vein thrombosis: a systematic review. *Journal of thrombosis and haemostasis : JTH*. 2010;8(4):684-692.
6. Andrews EJ, Jr., Fleischer AC. Sonography for deep venous thrombosis: current and future applications. *Ultrasound Q*. 2005;21(4):213-225.
7. Cronan JJ. Venous thromboembolic disease: the role of US. *Radiology*. 1993;186(3):619-630.
8. de Valois JC, van Schaik CC, Verzijlbergen F, van Ramshorst B, Eikelboom BC, Meuwissen OJ. Contrast venography: from gold standard to 'golden backup' in clinically suspected deep vein thrombosis. *Eur J Radiol*. 1990;11(2):131-137.
9. Foley WD, Middleton WD, Lawson TL, Erickson S, Quiroz FA, Macrander S. Color Doppler ultrasound imaging of lower-extremity venous disease. *AJR. American journal of roentgenology*. 1989;152(2):371-376.
10. Kristo DA, Perry ME, Kollef MH. Comparison of venography, duplex imaging, and bilateral impedance plethysmography for diagnosis of lower extremity deep vein thrombosis. *South Med J*. 1994;87(1):55-60.
11. Lapidus L, de Bri E, Ponzer S, Elvin A, Noren A, Rosfors S. High sensitivity with color duplex sonography in thrombosis screening after ankle fracture surgery. *Journal of thrombosis and haemostasis : JTH*. 2006;4(4):807-812.
12. Lewis BD, James EM, Welch TJ, Joyce JW, Hallett JW, Weaver AL. Diagnosis of acute deep venous thrombosis of the lower extremities: prospective evaluation of color Doppler flow imaging versus venography. *Radiology*. 1994;192(3):651-655.
13. Michiels JJ, Gadisseur A, Van Der Planken M, et al. A critical appraisal of non-invasive diagnosis and exclusion of deep vein thrombosis and pulmonary embolism in outpatients with suspected deep vein thrombosis or pulmonary embolism: how many tests do we need? *Int Angiol*. 2005;24(1):27-39.
14. Michiels JJ, Kasbergen H, Oudega R, et al. Exclusion and diagnosis of deep vein thrombosis in outpatients by sequential noninvasive tools. *Int Angiol*. 2002;21(1):9-19.
15. Miller N, Satin R, Tousignant L, Sheiner NM. A prospective study comparing duplex scan and venography for diagnosis of lower-extremity deep vein thrombosis. *Cardiovasc Surg*. 1996;4(4):505-508.

16. Naidich JB, Feinberg AW, Karp-Harman H, Karmel MI, Tyma CG, Stein HL. Contrast venography: reassessment of its role. *Radiology*. 1988;168(1):97-100.
17. O'Connell ND. Venography. *Radiography*. 1973;39(464):211-216.
18. Rabinov K, Paulin S. Roentgen diagnosis of venous thrombosis in the leg. *Arch Surg*. 1972;104(2):134-144.
19. Terao M, Ozaki T, Sato T. Diagnosis of deep vein thrombosis after operation for fracture of the proximal femur: comparative study of ultrasonography and venography. *J Orthop Sci*. 2006;11(2):146-153.
20. Theodorou SJ, Theodorou DJ, Kakitsubata Y. Sonography and venography of the lower extremities for diagnosing deep vein thrombosis in symptomatic patients. *Clin Imaging*. 2003;27(3):180-183.
21. AbuRahma AF, Powell M, Robinson PA. Prospective study of safety of lower extremity phlebography with nonionic contrast medium. *Am J Surg*. 1996;171(2):255-260.
22. Albrechtsson U. Side-effects at phlebography with ionized and non-ionized contrast medium. *Diagn Imaging*. 1979;48(4):236-240.
23. Albrechtsson U, Olsson CG. Thrombosis following phlebography with ionic and non-ionic contrast media. *Acta Radiol Diagn (Stockh)*. 1979;20(1):46-52.
24. Bettmann MA, Paulin S. Leg phlebography: the incidence, nature and modification of undesirable side effects. *Radiology*. 1977;122(1):101-104.
25. Bettmann MA, Robbins A, Braun SD, Wetzner S, Dunnick NR, Finkelstein J. Contrast venography of the leg: diagnostic efficacy, tolerance, and complication rates with ionic and nonionic contrast media. *Radiology*. 1987;165(1):113-116.
26. Bettmann MA, Salzman EW, Rosenthal D, et al. Reduction of venous thrombosis complicating phlebography. *AJR. American journal of roentgenology*. 1980;134(6):1169-1172.
27. Blumgart RL, Immelman EJ, Jeffery PC, Lipinski JK. Thrombotic side-effects of lower limb venography. The use of heparin-saline flush. *S Afr Med J*. 1991;79(2):88-89.
28. Carpenter JP, Holland GA, Baum RA, Owen RS, Carpenter JT, Cope C. Magnetic resonance venography for the detection of deep venous thrombosis: comparison with contrast venography and duplex Doppler ultrasonography. *J Vasc Surg*. 1993;18(5):734-741.
29. Cogo A, Lensing AW, Prandoni P, Hirsh J. Distribution of thrombosis in patients with symptomatic deep vein thrombosis. Implications for simplifying the diagnostic process with compression ultrasound. *Arch Intern Med*. 1993;153(24):2777-2780.
30. Fink A, Kosecoff J, Chassin M, Brook RH. Consensus methods: characteristics and guidelines for use. *Am J Public Health*. 1984;74(9):979-983.
31. Leape LL, Hilborne LH, Park RE, et al. The appropriateness of use of coronary artery bypass graft surgery in New York State. *Jama*. 1993;269(6):753-760.
32. Thomas ML, MacDonald LM. Complications of ascending phlebography of the leg. *Br Med J*. 1978;2(6133):317-318.
33. Wells PS, Hirsh J, Anderson DR, et al. Accuracy of clinical assessment of deep-vein thrombosis. *Lancet*. 1995;345(8961):1326-1330.
34. Lomonte C, Basile C. Preoperative assessment and planning of haemodialysis vascular access. *Clinical kidney journal*. 2015;8(3):278-281.
35. Mercer KG, Scott DJ, Berridge DC. Preoperative duplex imaging is required before all operations for primary varicose veins. *The British journal of surgery*. 1998;85(11):1495-1497.
36. Temizkan V, Ugur M, Arslan G, et al. Comparison of conventional technique and ultrasonographic mapping in saphenous vein harvesting. *The heart surgery forum*. 2013;16(5):E248-251.
37. Goodman LR, Stein PD, Matta F, et al. CT venography and compression sonography are diagnostically equivalent: data from PIOPED II. *AJR. American journal of roentgenology*. 2007;189(5):1071-1076.
38. Mendichovszky IA, Priest AN, Bowden DJ, et al. Combined MR direct thrombus imaging and non-contrast magnetic resonance venography reveal the evolution of deep vein thrombosis: a feasibility study. *European radiology*. 2016.
39. American College of Radiology. ACR–SPR practice parameter for imaging pregnant or potentially pregnant adolescents and women with ionizing radiation. 2013; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/pregnant-pts.pdf?la=en>. Accessed December 9, 2016.
40. American College of Radiology. ACR practice parameter for continuing medical education (CME). 2016; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CME.pdf>. Accessed December 9, 2016.
41. American College of Radiology. ACR–ASRT joint statement radiologist assistant roles and responsibilities. 2017;

Available at: <https://www.acr.org/-/media/ACR/Files/Governance/Digest-of-Council-Actions.pdf>. Accessed February 21, 2018.

42. American College of Radiology. ACR–AAPM technical standard for management of the use of radiation in fluoroscopic procedures. 2013; Available at: <https://www.acr.org/-/media/ACR/Files/Technical-Standards/MgmtFluoroProcedures.pdf?la=en>. Accessed September 28, 2017.
43. American College of Radiology. ACR–SIR–SNIS–SPR practice parameter for interventional clinical practice and management. 2014; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/irclin-prac-mgmt.pdf?la=en>. Accessed December 9, 2016.
44. Baerlocher MO, Kennedy SA, Ward TJ, et al. Society of Interventional Radiology Position Statement: Staffing Guidelines for the Interventional Radiology Suite. *Journal of vascular and interventional radiology: JVIR*. 2016;27(5):618-622.
45. Sidhu PS, Alikhan R, Ammar T, Quinlan DJ. Lower limb contrast venography: a modified technique for use in thromboprophylaxis clinical trials for the accurate evaluation of deep vein thrombosis. *The British journal of radiology*. 2007;80(959):859-865.
46. American College of Radiology. ACR–SIR–SPR practice parameter on informed consent for image-guided procedures 2016; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/informedconsent-imaguided.pdf?la=en> Accessed December 9, 2016.
47. American College of Radiology. ACR–SIR–SPR practice parameter for the reporting and archiving of interventional radiology procedures 2014; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/reporting-archiv.pdf?la=en>. Accessed December 9, 2016.
48. American College of Radiology. ACR–AAPM technical standard for diagnostic medical physics performance monitoring of fluoroscopic equipment 2016; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Fluoro-Equip.pdf>. Accessed December 9, 2016.
49. American College of Radiology. ACR–AAPM technical standard for diagnostic medical physics performance monitoring of radiographic equipment 2016; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/RadEquip.pdf>. Accessed December 9, 2016.

Appendix A

Society of Interventional Radiology Standards of Practice Committee Classification of Complications by Outcome

Minor Complications

- A. No therapy, no consequence.
- B. Nominal therapy, no consequence; includes overnight admission for observation only.

Major Complications

- A. Require therapy, minor hospitalization (<48 hours).
- B. Require major therapy, unplanned increase in level of care, prolonged hospitalization (>48 hours).
- C. Permanent adverse sequelae.
- D. Death.

*Practice parameters and technical 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 practice parameters and technical standards published before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

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