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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.

Revised 2008 (Resolution 20)\*

## **ACR–ASNR PRACTICE GUIDELINE FOR THE PERFORMANCE OF MYELOGRAPHY AND CISTERNOGRAPHY**

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### **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**

This guideline was revised collaboratively by the American College of Radiology (ACR) and the American Society of Neuroradiology (ASNR).

Myelography has been an important diagnostic modality for a wide range of spinal disease processes for more than 80 years. Cisternography using intrathecal contrast media has also been used for many years in the diagnostic evaluation of disease processes involving the basal cisterns and skull base.

These procedures typically involve performance of a lumbar puncture under fluoroscopic guidance followed by the fluoroscopically monitored introduction into the subarachnoid space of a nonionic water soluble iodinated contrast medium that is FDA approved for intrathecal administration. Alternatively, when the lumbar approach is contraindicated or less advantageous, the contrast medium may be introduced into the thecal sac via a lateral C1 to C2 puncture, which is described in section V.C.9. Following the introduction of a sufficient quantity of intrathecal contrast medium, the needle is withdrawn.

With the aid of a tilting table, the opacified cerebrospinal fluid (CSF) is positioned in the desired region of the

spinal subarachnoid space (lumbar, thoracic, or cervical) or in the intracranial basal cisterns, and appropriate radiographic/fluoroscopic (conventional myelogram) and/or computed tomographic (CT) myelogram or cisternogram images are obtained.

Institutions offering myelography should insist on documentation of appropriate training, demonstrated competence, and maintenance of skills for all physicians who receive privileges to perform these procedures.

## II. INDICATIONS

Although myelography and cisternography have largely been superseded by the development of high resolution CT and magnetic resonance imaging (MRI), there remain the following indications for these procedures:

1. Demonstration of the site of a cerebrospinal fluid leak (postlumbar puncture headache, postspinal surgery headache, rhinorrhea, or otorrhea).
2. Surgical planning, especially in regard to the nerve roots.
3. Radiation therapy planning.
4. Diagnostic evaluation of spinal or basal cisternal disease.
5. Nondiagnostic MRI studies of the spine or skull base.
6. Poor correlation of physical findings with MRI studies.
7. Use of MRI precluded because of:
  - a. Claustrophobia
  - b. Technical issues, e.g., patient size
  - c. Safety reasons, e.g., pacemaker
  - d. Surgical hardware

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

## III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

### A. Physician

Certification in Radiology or Diagnostic Radiology 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 the performance of myelography with acceptable success and complication rates.

or

Completion of a residency or fellowship training 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) to include evidence of training and competency in myelography. Adequate training should include the performance of a sufficient number of myelographic procedures to become facile in the technique.

and

Instruction in all of the following areas should be substantiated by the director of the training program:

1. Anatomy, physiology, and pathophysiology of the central and peripheral nervous systems.
2. Physics of ionizing radiation, including an understanding of its production, detection, and risks, and of techniques to minimize radiation exposure.
3. Pharmacology and dosage of contrast media used in myelography. (Use of only those agents approved for intrathecal use should be emphasized.)
4. Indications for myelography and cisternography.
5. Preprocedural assessment of the patient.
6. Conduct of the myelographic examination. This includes spinal puncture, patient positioning, and fluoroscopic and filming techniques.
7. Conduct of the postmyelogram CT examination. This includes timing, patient positioning, and technical factors.
8. Postprocedural patient management, especially the recognition and initial management of complications.
9. Interpretation of lumbar, thoracic, and cervical myelograms and cisternograms, as well as interpretation of postmyelogram CT scans.
10. Contraindications to myelography.
11. Knowledge of the drugs that can increase risk of myelographic adverse events.

### Maintenance of Competence

To maintain privileges, physicians must perform a sufficient number of myelographic procedures to maintain their skills with acceptable success and complication rates.

### Continuing Medical Education

Continuing education should be in accordance with the [ACR Practice Guideline for Continuing Medical Education \(CME\)](#).

### B. 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” 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)

#### C. Radiologic Technologist

Certification by the American Registry of Radiologic Technologists or unrestricted state licensure is required. In addition, the radiologic technologist should have training in and be skilled in performing fluoroscopic examinations on patients with intrathecal contrast media, including patient positioning, fluoroscopic beam limitation, and methods of applying safe physical restraint during table tilting. Continuing education programs and on-the-job training under the supervision of qualified physicians should be available.

### IV. EQUIPMENT SPECIFICATIONS

#### A. Myelographic Facility

The minimum requirements for the facility are:

1. High-quality radiographic/fluoroscopic imaging equipment, film or digital records of the examination, and a tilt table. The tilt table should be capable of –30 degrees of tilt in the head downward direction. A proper support device for securing the patient on the tilt table should be available.
2. An adequate selection of spinal needles and appropriate nonionic contrast media approved for intrathecal use.
3. Appropriate facilities and equipment for treating adverse reactions (e.g., seizure, vasovagal reactions, and/or cardiorespiratory collapse).
4. Appropriately trained personnel to provide proper patient care and operation of the equipment.
5. A CT scanner to perform postmyelogram CT studies. Multiplanar reconstruction capability for CT is highly desirable.

#### B. Surgical and Emergency Support

Although serious complications of myelography are infrequent, there should be prompt access to surgical and interventional management of complications.

### V. SPECIFICATIONS OF THE EXAMINATION

#### A. Preprocedural Patient Care

The written or electronic request for myelography should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). 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. (ACR Resolution 35, adopted in 2006)

The clinical history and findings are to be reviewed by the performing physician.

1. Prior to myelography, any prior pertinent imaging studies, including lumbar CT or MRI, should be reviewed. The review should include evaluation for the position of the conus, as well as lumbar stenosis or any other potential hazard prior to choosing the level for LP or myelogram.
2. The patient should be asked specific questions about relevant medications, prior seizures, prior allergic reactions, and clotting ability.
3. Patients who are taking Plavix (clopidogrel) for prophylaxis of myocardial or cerebral ischemia should discontinue this drug for at least 5 days prior to undergoing myelography.
4. For patients with hematologic disorders or other conditions affecting blood coagulation, a platelet count and international normalized ratio (INR), prothrombin time (PT), and partial thromboplastin time (PTT) values within one week of the procedure should be available.
5. Informed consent should be obtained and documented. The patient should be informed of the risks and the benefits of the procedure.
6. The patient should be adequately hydrated.
7. If utilized, sedation should be administered in accordance with the [ACR–SIR Practice Guideline for Sedation/Analgesia](#).

## B. Relative Contraindications to Myelography

1. Known significant intracranial process with increased intracranial pressure.
2. Historical or laboratory evidence of bleeding disorder or coagulopathy.
3. Recent myelography performed within 1 week.
4. Previous surgical procedure in anticipated puncture site (can choose alternative puncture site).
5. Generalized septicemia.
6. History of significant adverse reaction to iodinated contrast media.
7. History of seizures (patient may be premedicated).
8. Grossly bloody spinal tap (may proceed when benefit outweighs risk).
9. Localized infection at region of puncture site.
10. Pregnancy.
11. Medications known to decrease seizure threshold, (e.g., phenothiazines, tricyclic antidepressants, monoamine oxidase inhibitors, SSRI medications) should be discontinued for at least 24 to 72 hours prior to myelography.

## C. Procedure

1. The patient is placed prone on the table top, and the skin of the midlumbar back is sterilized.
2. Using the lumbar approach, typically, the L2 to L3 or L3 to L4 interlaminar or interspinous space is localized under fluoroscopy. Subcutaneous and intramuscular local anesthetic is administered. A styletted spinal needle is introduced through the anesthetized region and directed toward the midline. The needle is advanced under intermittent fluoroscopic control in small increments. If a beveled needle is utilized, the bevel may be used to control the direction of the needle. When the subarachnoid space is reached, a pop may (but not always) be felt. The stylet is slowly removed to check for cerebrospinal fluid return. Fluid may be slowly withdrawn for laboratory studies if requested.
3. A nonionic iodinated contrast medium is slowly administered intrathecally through the lumbar needle under fluoroscopic control. For examination of the lumbar subarachnoid space, up to 17 ml of a concentration of 180 mg I/dl or up to 12 ml of a concentration of 240 mg/dl can be injected. For examination of the thoracic or cervical spinal canal or the basilar cisterns, up to 10 ml of a concentration of 300 mg I/dl is used. Generally, the total dose of iodine should not exceed 3.0 gm.
4. Prior to removing the needle from the back, an anteroposterior fluoroscopic "spot" image may

be obtained and documented on film or digital media.

5. The needle is then removed from the back, and the patient is secured to the table top by a support device prior to being tilted into Trendelenburg or reverse Trendelenburg positions.
6. Using intermittent fluoroscopy, table tilting, and patient rotation, anteroposterior, oblique, and cross-table lateral images of the region in question are documented on film or digital media. For lumbar myelography, if the conus has not been recently visualized by other means, evaluation of that area should be included in the study.
7. For cervical myelography, and in some instances thoracic myelography, the head is hyperextended on the neck, thus creating a lordotic "trough," and the table is then gradually and slowly tilted head downward until the opacified cerebrospinal fluid "column" flows through the area of interest. The myelographic table must have adequate and secure shoulder support for the patient's safety. The patient's chin is supported in a chin rest to prevent rapid ascent of the contrast into the intracranial basal cisterns. The lead-gloved hands of the technologist may also support the positioning of the patient's head and neck. As in the lumbar region, anteroposterior, oblique and cross-table lateral images can be documented on film or digital media.
8. If cisternography is requested, with the opacified cerebrospinal fluid "column" in the cervical spine canal, the table is restored to the horizontal position, and then the hyperextended head is gradually and slowly lowered (flexed) into a neutral position. Imaging for cisternography is typically obtained with computed tomography; conventional radiographic images are not usually obtained.
9. Using the lateral C1 to C2 approach, the patient is positioned prone on the table top, and the head is secured in a neutral position. Using C-arm lateral fluoroscopy, the head and neck are positioned in the true lateral projection, and local anesthesia is administered subcutaneously and intra-muscularly in the side of the neck at a point overlying the posterior aspect of the C1 to C2 interlaminar space immediately anterior to the spinolaminar junction line and inferior to the arch of C1. If C-arm fluoroscopy is not available or if the patient is unable to remain in a prone position on the tabletop but can lie quietly and comfortably in a nonrotated lateral decubitus position, lateral C1 to C2 puncture can be performed using vertical beam fluoroscopy. Under intermittent fluoroscopic control, the spinal needle is advanced incrementally into the

subarachnoid space at the posterior margin of the thecal sac behind the posterior margin of the upper cervical spinal cord. Great caution with frequent fluoroscopic monitoring should always be used during needle advancement, as the dura is punctured and as the iodinated contrast medium is cautiously and slowly injected into the subarachnoid space. When this is completed, a fluoroscopic “spot” image may be documented, and the needle is withdrawn from the neck. The desired area of the opacified subarachnoid space is then examined and documented.

10. Following completion of the examination as described above, the patient is transferred to the CT scanner for appropriate CT myelographic or cisternographic imaging.

#### D. Postprocedural Care

1. The patient should be adequately hydrated.
2. The patient should be observed following the examination.
3. If the myelogram is performed on an outpatient basis, the patient should be properly instructed regarding limitations following the procedure (e.g., driving).
4. Instructions regarding postprocedural care, including warning signs of adverse reactions and the possibility of persistent headaches, should be given to the patient by a trained professional. The instructions should include a recommendation that the patient should be in the company of a responsible adult for 12 hours following the procedure.
5. A physician should be available to answer questions and provide patient management following the procedure.

### VI. DOCUMENTATION

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

### VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, radiologic technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as “as low as reasonably achievable (ALARA).”

Facilities, in consultation with the medical physicist, should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary examination protocols to take into account patient body

habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active; if not, manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Periodically, radiation exposures should be measured and patient radiation doses estimated by a medical physicist in accordance with the appropriate ACR Technical Standard. (ACR Resolution 17, adopted in 2006 – revised in 2009, Resolution 11)

### VIII. 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 web page (<http://www.acr.org/guidelines>).

### ACKNOWLEDGEMENTS

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**Suggested Reading** (Additional articles that are not cited in the document but that the committee recommends for further reading on this topic)

1. ACR ASRT joint statement radiologist assistant roles and responsibilities. In: *Digest of Council Actions*. Reston, Va: American College of Radiology; 2007:149.
2. Bartynski WS, Lin L. Lumbar root compression in the lateral recess: MR imaging, conventional myelography, and CT myelography comparison with surgical confirmation. *AJNR* 2003;24:348-360.
3. Bohn HP, Reich L, Suljaga-Petchel K. Inadvertent intrathecal use of ionic contrast media for myelography. *AJNR* 1992;13:1515-1519.
4. Dube LJ, Blair IG, Geoffroy G. Pediatric myelography with iohexol. *Pediatr Radiol* 1992;22:290-292.
5. Ebersold MJ, Houser OW, Quast LM. Iopamidol myelography: morbidity in patients with previous intolerance to iodine derivatives. *J Neurosurg* 1991;74:60-63.
6. Maly P, Sundgren P, Baath L, Golman K, Walday P. Adverse reactions in myelography. *Acta Radiol* 1995;399:230-237.
7. *Manual on Contrast Media* Version 5. Reston, Va: American College of Radiology; 2005.
8. Orrison WW, Eldevik OP, Sackett JF. Lateral C1-2 puncture for cervical myelography. Part III: historical, anatomic, and technical considerations. *Radiology* 1983;146:401-408.
9. Peterman SB. Postmyelography headache: a review. *Radiology* 1996;200:765-770.
10. Russell EJ. Computed tomography and myelography in the evaluation of cervical degenerative disease. *Neuroimaging Clin North Am* 1995;5:329-348.
11. Sandow BA, Donnal JF. Myelography complications and current practice patterns. *AJR* 2005;185:768-771.
12. Schick RM. Myelographic techniques. *Postgrad Radiol* 1989;9:40-54.
13. Suss RA, Udvarhelyi GB, Wang H, Kumar AJ, Zinreich SJ, Rosenbaum AE. Myelography in achondroplasia: value of a lateral C1-2 puncture and non-ionic, water-soluble contrast medium. *Radiology* 1983;149:159-163.

14. Wang H, Binet EF, Gabrielsen TO, Rosenbaum AE. Lumbar myelography with iohexol in outpatients: prospective multicenter evaluation of safety. *Radiology* 1989;173:239-242.

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\*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.

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Amended 2009 (Resolution 11)