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General Considerations for Endovascular Surgical Neuroradiologic Procedures

Certain general principles of performance qualifications, preparation, procedure care and conduct, and post-procedural care apply to the contemporary performance of most neurointerventional surgical procedures subsequently detailed in this standards document. These considerations should be generally applicable to the individual disease processes and procedures discussed in the following disease process/procedure sections. The considerations are discussed herein so as to diminish redundancy that might be created by discussing them in each individual section. However, more detailed consideration is included in the individual sections where applicable. The principles include the following.

Qualifications

The neurointerventionist performing the treatment should have appropriate training and experience in and meet the qualifications for performance of neuroangiography and cerebrovascular and head/neck intervention. He or she should adhere to and satisfy the ASITN/American Society of Neuroradiology/Society of Cardiovascular and Interventional Radiology guidelines for performance of neuroangiography as previously published (1). He or she must fully appreciate the benefits, alternatives, and risks of the procedure. He or she must have a thorough understanding of extracranial and intracranial vascular anatomy (including congenital and developmental variants and common collateral pathways), angiographic equipment, radiation safety considerations, and physiological monitoring equipment and must have access to an adequate supply of catheters, guidewires, and personnel to safely perform the procedure. The physician must understand the principles of prevention of thromboembolic phenomena with anti-coagulation and catheter flushing, the need for adequate hydration, puncture site hemostasis, and management of neuroangiographic complications. Furthermore, the performing physician must be able to detect and understand the clinical significance of angiographic abnormalities, including expected and unsuspected findings. Image interpretation is not a casual by-product of the procedure but an intrinsic requirement that directs the conduct of the procedure. The physician should have a full understanding of the disease process and alternative methods of treatment. Some endovascular surgical neuroradiologic procedures might be performed by persons with formal training. However, more advanced techniques might most appropriately be performed by persons whose experience and training reflect the principles espoused in the training guidelines of the recently approved Accreditation Council on Graduate Medical Education program in endovascualr surgical neuroradiology (2).

Radiographic Imaging Equipment and Staff

Biplane angiography with digital subtraction angiography, high resolution image intensifier and imaging chain, digital subtraction imaging (preferably with a 1024 × 1024 matrix) is recommended. Road map fluoroscopy capability is mandatory, preferably with simultaneous live unsubtracted imaging. The ability to document fluoroscopy time is mandatory, and availability and use of a dosimetry program is encouraged. Staff requirements include radiologic technologists who are trained to operate angiographic equipment and are knowledgeable in radiation physics and protection.

Materials

It is often not possible to predict which embolic materials, catheters, or guidewires will be required to treat a specific disease process. Therefore, multiple sizes and types of guiding catheters, guidewires, balloon catheters, microcatheters, microguidewires, and embolic materials should be in the inventory or available on short notice.

Patient Selection and Preparation Considerations

Indications for treatment should be documented. Patients should fulfill the relevant clinical (as documented in the history and physical examination) and morphologic criteria (as documented in pretreatment imaging and diagnostic angiography) for treatment. The potential need for surgical back-up should be taken into consideration in preoperative planning.

A written medical history should be available, including history of the presenting symptoms, indications for the procedure, pertinent medical and surgical histories, list of current medications, history of allergies, and vascular and neurologic risk factors.

A physical examination should be performed, including a detailed neurologic examination, and further general examination of sufficient depth to exclude significant concurrent illnesses. The examination should be tailored to the involved tis-

sue territory and to assist in planning the angiographic approach.

Sufficiently complete diagnostic neuroangiography should precede any intervention. The results of this study should be permanently recorded and should be of sufficient detail to appropriately characterize the extent of vascular disease that might contribute to the symptomatology and the relevant collateral circulation. The neuroangiography can be performed at the time of the intervention and can represent an intention-to-treat paradigm, if appropriate counseling and consent for treatment can be obtained. In all cases, post-procedural arteriography should be performed and permanently recorded to document the anatomic result and to identify potential complications. Images obtained should be conveniently available to consulting physicians for review, either as film, paper, or digital copy.

Informed consent should be obtained in all cases, unless imminently life-threatening circumstances necessitate emergent treatment. Informed consent should include discussion of the indications for treatment, the nature of the procedure, the potential alternative treatments (eg, no treatment, medical management, surgical resection or occlusion, radiotherapy), and the discomforts, benefits, and risks of the procedure. Radiation risks vary among neurointerventional procedures but should be discussed when appropriate. An appropriate chart note regarding the discussion should be considered.

Laboratory evaluation (which typically includes testing hemoglobin, hematocrit, platelet count, creatinine, electrolyte levels, and coagulation parameters) is usually warranted before cerebrovascular neurointervention.

Procedural Care

All patients should undergo continuous cardiac monitoring and intermittent blood pressure monitoring during the procedure, although intra-arterial pressure monitoring is necessary in many situations. A record of vital signs should be maintained. All patients should have appropriate intravenous (IV) access for the administration of fluids and medications as needed. Where heparin is to be administered, activated clotting time (ACT) measurements should be available.

If the patient is to be sedated, pulse oximetry should be monitored. A registered nurse or other trained professional whose primary responsibility is to monitor the patient should be present throughout the procedure. The interventional suite should be fully equipped for general anesthesia in accordance with the hospital's standards.

Equipment and medications for emergent resuscitation should be immediately available, and the personnel present should be trained in their use. Equipment, pharmaceuticals, and physician expertise to manage angiographic and procedural complications, including thrombolysis of thromboembolic complications, should be available. When the risk of a procedural intracranial hemorrhage exists, a ventriculostomy tray should be readily available.

A record of materials used, and all devices implanted, should be maintained. Fluoroscopy times should be recorded.

Techniques used for pediatric patients may require attention to certain procedural aspects that are different from those normally required for the treatment of adults. Modification of adult standards for neurointerventional procedures, if necessary, will depend on the age of the patient and the clinical condition for which treatment is performed. Specific considerations include indications, informed consent from parents or legal guardians, anesthesia, peri-procedural monitoring, and contrast medium dose. Variation from these guidelines may be necessary and appropriate, depending on specific clinical circumstances.

Because nearly all pediatric interventional procedures require general anesthesia, close coordination with the anesthesiology service is necessary for their safe performance. Specific positioning of anesthesia machines and monitors within the neurointerventional suite must permit unrestricted access to the patient throughout the procedure. The use of general anesthesia precludes clinical neurologic examination of the patient. In some cases, it may be possible to intermittently awaken the patient for neurologic examination. In others, the use of electrophysiological monitoring may achieve an increased level of safety, even during general anesthesia. When feasible, sedation, rather than general anesthesia, may be used to permit neurologic examination throughout the procedure.

The development of hypothermia, particularly in infants, should be anticipated and guarded against by the use of temperature monitors, ambient room temperature control, drapes, and head coverings. Fluid balance must be monitored to prevent overhydration as a result of flush solutions or osmotic dehydration from contrast medium injection. Additional hemodynamic monitoring may be appropriate, particularly in the setting of cardiac failure or when blood pressure manipulation is necessary during the procedure. The contrast medium dose must be kept to the minimum amount that is consistent with effective performance of the procedure. Minimal diagnostic injections and dilution of contrast medium for digital angiography should be used. If clinically appropriate, performing the procedure in stages can be considered to reduce the potential adverse effects of the contrast medium.

Post-procedural Care

All patients should be observed at bed rest during the initial post-procedural period. Depending on the size of the arteriotomy, use of arteriotomy closure devices, anticoagulants or antiplatelet agents, and procedural and disease-specific risk factors, continued bed rest may be required. During the initial post-procedural period, skilled nurses or

other trained professionals should periodically monitor the puncture site for hematoma development and the status of the vascular distribution distal to the puncture sites. Monitoring of indwelling arterial sheaths to assure continuous flushing should be performed. Neurologic monitoring is required to detect delayed neurologic deterioration.

Post-procedural monitoring should be conducted in a manner appropriate to the disease process and anatomic lesion treated. The patient should be monitored for urinary output, renal function, cardiac symptoms, pain, and other indicators of systemic complications. Further laboratory evaluation of hematologic, coagulation, or organ function may be indicated. Appropriate follow-up imaging (radiography of the skull, CT, MR, angiography) should be ordered as indicated.

The initial ambulation of the patient must be supervised. The operating physician or his or her designee should evaluate the patient's condition after the procedure. Documentation of involvement should consist of entries in the patient's hospital record. The operating physician or his or her designee should be available for continuing care during hospitalization and after discharge.

Thresholds for appropriateness, success, and neurologic complications will be individually discussed in each section according to disease process. Thresholds for puncture site complications, preliminary planning neuroangiography complications, and contrast media-induced nephropathy may be greater than those suggested for diagnostic neuroangiography (1) because the need for larger or bilateral guide catheters can be expected to lead to more puncture site complications with neurointerventional procedures. Dissection of catheterized vessels are reported more frequently during neurointerventional procedures because of more prolonged positioning of generally larger guide catheters.

References

1. Cooperative Study between the ASNR, ASITN, and SCVIR: **Quality improvement guidelines for adult diagnostic neuroangiography.** *AJNR* 21:146–150, 2000.
2. Higashida RT, Hopkins LN, Berenstein A, Halbach VV, Kerber C: **Program Requirements for Residency/Fellowship Education in Neuroendovascular Surgery/Interventional Neuroradiology: A Special Report on Graduate Medical Education.** *AJNR:* 2000; 21:1153–1159.