Anesthesia For Interventional Neuroradiology: Part 1

A Rosas

Citation

A Rosas. *Anesthesia For Interventional Neuroradiology: Part 1*. The Internet Journal of Anesthesiology. 1996 Volume 1 Number 1.

Abstract

INTRODUCTION

Since its inception in the 1960's, the subspecialty of interventional neuroradiology (INR) has grown dramatically, opening many new therapeutic options. With improvements in embolic materials, catheter systems, and computerized imaging, new treatments and refined techniques are rapidly becoming available.[1 2 3]

The aims of therapeutic embolization are:

1. selective occlusion of abnormal blood vessels, while maintaining perfusion to normal tissues.
2. A selective increase in blood flow is the intent with thrombolysis or angioplasty.
3. arterial delivery of chemotherapeutic agents, or embolic material is sought in tumor therapy.

Embolization of intracranial aneurysms or fistulas with detachable balloons or thrombogenic coils offers alternatives to traditional neurosurgery, and often the only opportunity for successful treatment of those which are surgically inaccessible.[4] Arterio-venous malformations (AVMs) of the brain, spinal cord, or extracranial circulation, can be embolized, not only prior to surgical resection, or as a palliative procedure, but also as definitive therapy.[5]

GENERAL CONSIDERATIONS

STANDARDS FOR FACILITIES AND PHYSICAL PLANT

Neuroradiology suites, often lacking adequate space, equipment, or support facilities, have not generally been designed with the needs of the anesthesiologist in mind. The Anesthesiology department at Harvard Medical School has developed standards for anesthetizing in locations outside the operating room. According to these standards, the following must be available:

1. piped oxygen in addition to the cylinders attached to the anesthesia machine
2. suction
3. good lighting
4. a telephone near the anesthetist's work area
5. electrical outlets reserved for anesthesia use
6. immediate access to the patient
7. anesthesia machine and supplies of the same quality as those in the operating room
8. emergency equipment and defibrillator within 2 minutes
9. attending anesthesiologist.6 7

Sufficient space must be provided for an anesthesia machine, ventilator, supply cart, infusion pumps, and monitors. Anesthesia supplies such as extra gas cylinders, fluids, circuits, a difficult airway cart, and emergency medications must also be readily available.

The anesthesia machine is best located on the opposite side of the radiologist, caudally to the patient's head. In this location, the anesthesiologist and his equipment are not an obstacle, and imaging devices can rotate freely around the head. All anesthesia circuits, as well as I.V. tubing, monitoring cables, and lines must be long enough to reach the patient in all positions of the procedure table. Pressure transducers, IV poles, and infusion pumps can be mounted on the radiology table to move as the patient moves. The radiology table should turn so that the anesthesia equipment does not have to be moved when inducing general anesthesia. The supply hoses for oxygen, nitrous oxide, air, suction, and gas evacuation should preferably come from

behind the anesthesia machine to avoid entanglements. There must be enough space behind the anesthesia machine to allow for cylinder changes, machine check-out, and monitor adjustments.

MONITORING

The monitoring standards of the American Society of Anesthesiologists apply to all locations where anesthetics are administered.[8 9] These are considered a national standard of practice and should be followed, or medical-legal risk becomes paramount.[10 11] The only acceptable exceptions include nuclear magnetic resonance imaging (MRI), and external beam radiotherapy.[12 13] The quality of monitoring devices must be equal to that found in any major neurosurgical operating room.[14] There are some additional considerations to traditional monitoring:

INVASIVE BLOOD PRESSURE MONITORING

An arterial line is frequently indicated in these procedures and can be placed preoperatively, using local anesthesia, with minimum discomfort.[15] In our institution, we usually insert a radial artery catheter, preferably in the side closest to the anesthetist. In other centers,[16] the side port of the radiologist's femoral artery sheath introducer is used to monitor arterial pressure. Pressures in the carotid or vertebral arteries as well as more distal pressures can be measured by transducing other ports of the radiologist's coaxial catheter system.[17] This method accurately measures mean pressure, but tends to overestimate the diastolic pressure and underestimate the systolic.[18]

In cases where thrombolytic therapy is used, hematoma formation at the site of arterial puncture can occur. In these cases, arterial pressure may be monitored from the femoral sheath introducer, instead of inserting a radial line, to avoid another arterial puncture and the possibility of hematoma formation.

Indications for direct arterial line monitoring in interventional neuroradiology:

- Systemic heparinization with frequent monitoring of ACT
- Controlled hypotension
- Induced hypertension
- Hemodynamic instability
- Intracranial or spinal cord procedures
- Medically unstable patients

PULSE OXIMETRY

In interventional radiology, the pulse oximeter is also used to detect arterial occlusion distal to the femoral arterial catheterization site by placing a probe on the ipsilateral toe. Since the oximeter amplifies the pulse signal, it will pick up a complete loss of a pulse, but not significant decreases. Therefore, a pulse oximeter will not detect decreasing perfusion, but will alarm only after the pulse is totally lost.[19]

TEMPERATURE

In the sedated patient, shivering can interfere with image quality. With severe hypothermia, neurologic signs may appear such as delirium, coma, or delayed awakening from anesthesia.[20] In our institution, perioperative hypothermia is unusual in adults since the neuroradiology suite is generally not as cold as an operating room, the patient is covered with warm blankets, and body cavities are not exposed. In small children however, significant heat loss can occur [21] while the patient is uncovered during induction of anesthesia, insertion of lines or while irrigating the angiography catheter with cold solutions. In children, we use a heat lamp while the patient is uncovered, and also warm irrigation fluids to prevent the development of hypothermia.

Mild hypothermia has been reported to offer protection against ischemic injury to the brain and spinal cord.[22 23] Therefore, when due to the nature or location of the neuropathology, the neuroradiologist feels that the patient is at high risk for development of stroke, we do not warm the patient, but rather allow the temperature to drift down passively to 34 or 35 degrees centigrade.

However, after successful completion of the procedure, these patients should be actively rewarmed before leaving the neuroradiology suite to avoid the risks of hypothermia in the postoperative period.

CENTRAL VENOUS AND PULMONARY ARTERY PRESSURE MEASUREMENT

Although there are no procedure-specific indications, central venous lines are frequently inserted in patients undergoing high risk neurovascular invasive procedures. These patients often have serious coexisting medical problems and need vasoactive drug infusions or central access for forthcoming surgery.

Invasive Neuroradiology; Principal Indications for CVP line

insertion:

- Monitoring of cardiac filling pressures
    - History of CHF
    - History of renal insufficiency
- Strong possibility of surgery with CVP indication
- Use of vasoactive drugs
- Poor peripheral intravenous access

At The Methodist Hospital of Houston (TMH), we prefer double lumen central venous catheters. One lumen can be a dedicated drug infusion line while the other can be used to monitor the central venous pressure. We usually insert these lines after induction of general anesthesia and the radiologist confirms the location with fluoroscopy. We prefer to use the subclavian approach in interventional neuroradiology because a carotid artery injury occurring during attempted internal jugular cannulation (1.9 to 3.6 percent incidence), [24] [25] could jeopardize the procedure and imperil the patient. Some feel that central lines placed into the jugular veins can cause cerebral venous obstruction and should not be used in neurosurgery.[26] [27]Although jugular vein catheterization is not our first choice, we use it, in the absence of increased intracranial pressure, when the subclavian route is difficult or contraindicated.

PULMONARY ARTERY CATHETERIZATION

Pulmonary artery flow- guided catheters (Swan-Ganz) are used in those cases where evaluation of left ventricular function is paramount. [28] [29]

At TMH, the two main indications are in:

1. Patients who develop cerebral vasospasm and will be treated with intravascular volume expansion therapy and controlled hypertension.
2. Patients in congestive heart failure, or with severe systemic disease, who have a neurovascular problem requiring immediate intervention.

Care must be taken to insert these catheters only after the patients coagulation status is checked, and to confirm their position with fluoroscopy.

NEURORADIOLOGIC TECHNICAL CONSIDERATIONS

Neuroradiologists use the Seldinger wire technique to insert a 7.5 French gauge introducer sheath into the femoral artery, although the femoral vein and/or other vessels are also occasionally used. This catheter introducer has a side port that is used for irrigation with heparinized saline, but can also be used for arterial pressure monitoring. A coaxial catheter (also with a side port) is then advanced, under fluoroscopic guidance, through the introducer sheath into the carotid or vertebral arteries and cerebral angiography is performed.

A superselective microcatheter is then inserted through the coaxial catheter and advanced with fluoroscopic guidance into the lesion. This catheter is used to deliver drugs or embolic materials into the lesion.

ANESTHETIC CONSIDERATIONS

The anesthetic objectives in interventional neuroendovascular procedures are the same as those in traditional neurosurgery. However, because the cranium is not open, the management of intracranial pressure dynamics, blood pressure and intravascular volume, administration of proper pharmacologic agents, and PaCO2 control, become even more preeminent. The interventions of the anesthesiologist are critical, especially during microcatheter advancement, embolization, and in emergency treatment of complications.

The patient's neurological status during or immediately after the procedure needs to be evaluated. Of prime importance for this, is a rapid and smooth emergence from anesthesia, without hemodynamic stress, cough, or strain to prevent increases in intracranial pressure.

These procedures are associated with significant potential complications, which frequently require postoperative intensive care support, such as vascular rupture, thrombosis, cerebral infarction, or anaphylactic reactions to contrast agents.[30] [31] At TMH, patients are routinely admitted to the neurosurgical intensive care unit after undergoing most INR procedures.

References

1. Hilal SK, Sane P, Mawad ME, Michelsen WJ: Therapeutic interventional radiological procedures in neuroradiology, Angiography. 3rd edition. Edited by Abrams H. Boston, Little Brown, 1983.
2. Brown MM: Surgery, angioplasty, and interventional neuroradiology. Curr Opin Neurol Neurosurg 6:66-73, 1993.
3. Barnwell SL: Interventional neuroradiology. West J Med

158:162-170, 1993.
4. Higashida RT, Hieshima GB, Halbach V: Advances in the treatment of complex cerebrovascular disorders by interventional neurovascular techniques. Circulation 83 (sup):I-196, 1991.
5. Moret J, Picard L: Endovascular therapy of intracranial arteriovenous malformations; Results in242 patients. Paper presented at the World Interventional Neuroradiological society, Vald'Isere, France, Jan., 1989.
6. Eichorn JH, Cooper JB, Cullen DJ et al: Anesthesia practice standards at Harvard: a review. J Clin Anes 1:55, 1988.
7. Eichhorn JH, Cooper JB, Cullen DJ et al: Standards for patient monitoring during anesthesia at Harvard Medical School, JAMA 256:1017, 1986.
8. Burk NS: Anesthesia for magnetic resonance imaging, Anesth Clin North Am 7:(3)707, 1989.
9. Peer Review in Anesthesiology-American Society of Anesthesiologists, Park Ridge, Ill, 1989, ASA.
10. Eichhorn JH, Cooper JB, Cullen DJ et al: Standards for patient monitoring during anesthesia at Harvard Medical School, JAMA 256:1017, 1986 .
11. Eichhorn JH: Prevention of intraoperative anesthesia accidents and related severe injury through safety monitoring, Anesthesiology 70:572, 1989 .
12. Kanal E, Shellock F, SMRI Safety Committee: Policies, guidelines, and recommendations for MR imaging safety and patient management, J Magnet Res Imaging 2:247 1992.
13. Peden C, Menon D, Hall A et al: Magnetic resonance for the anaesthetist. Part II. Anaesthesia and monitoring in MR units. Anesthesia 47:508 1992.
14. Gravenstein JS, Paulus DA: Clinical Monitoring practice, ed. 2, Philadelphia, 1987, JB Lippincott.
15. Slogoff S, Keats AS, and Arlund C: On the safety of radial ,artery cannulation, Anesthesiology 59:42, 1983.
16. Young WL, Pile-Spellman J: Anesthetic considerations for interventional neuroradiology. Anesthesiology 80:427-455, 1994.
17. Duckweiler GR, Dion J, Vinuela F, Jabour B, Martin N, Bentson J: Intravascular microcatheter pressure monitoring: Experimental results and early clinical evaluation. American J Neuroradiol 11:169-175, 1990.
18. Gorback MS: Considerations in the interpretation of systemic pressure monitoring p 296 In Lumb PD, Bryan-Brown CW (eds.): Complications in Critical Care Medicine. Year Book Medical Publishers, Chicago 1988.
19. Swedlow DB, Irving SM: Monitoring and patient safety. In Blitt CD, ed.: Monitoring in anesthesia and critical care medicine, ed. 2, New York, 1990, Churchill-Livingstone.
20. Plum F, Posner JB: The diagnosis of stupor and coma, ed. 3, Philadelphia, 1980, FA Davis.
21. Aidinis SJ, Zimmerman RA, Shapiro HM, Bilanink LT, et al: Anesthesia for brain computed tomography. Anesthesiology 44:420, 1976.
22. Frank SM, Parker SD, Rock P, et al: Moderate hypothermia with partial bypass and segmental repair for thoracoabdominal aortic aneurysm. J Vasc Surg 19:687-697, 1994 .
23. Busto R, Dietrich WD, Globus MY, et al: Small differences in intraischemic brain temperature critically determine the extent of ischemic neuronal injury. J Cereb Bl Flow Met 7:729-738, 1987.
24. Sise MJ, Hollingsworth P, Brimm JE Complications of the flow-directed pulmonary catheter: a prospective analysis in 219 patients. Crit Care Med 9:315 1981.
25. Shah KB, Rao TLK, Laughlin S, El-Etr AA: A review of pulmonary artery catheterization in 6,245 patients. Anesthesiology 61:271 1984.
26. Harper R, Grossman R, personal communication: Rosas A .
27. Shapiro HM, Drummond JC: Neurosurgical Anesthesia: in Miller RD, Cuchiara RF, Miller ED, et al. Anesthesia 4e Churchill Livingstone, New York 1994.
28. Swan HJC, Ganz W, Forrester JS et al: Catheterization of the heart in man with use of a flow-directed-balloon-tipped catheter, N Engl J Med 283:477, 1970 .
29. Kassell NF, Peerles SJ, Durward QJ et al: Treatment of ischemic deficits from vasospasm with intravascular volume expansion and induced arterial hypertension, Neurosurgery 11:337, 1982.
30. Earnest F, Forbes G, Sandok BA et al: Complications of cerebral angiography: Prospective assessment of risk. AJR 142:247 1984.
31. Faught E, Trader SD, Hanna GR: Cerebral complications of angiography for transient ischemia and stroke: prediction of risk. Neurology 29:4 1979. .

Author Information

Alejandro L. Rosas, M.D.