Lesson 241: PreAnesthetic Assessment of the Patient for Endovascular Coiling

LEARNING OBJECTIVES
At the end of this activity, the participant should be able to:
1. List examples of intracranial pathology that can be treated in the neurointerventional suite.
2. Discuss current neuroendovascular therapy for the treatment of intracranial aneurysms.
3. Explain the theory and mechanism of Guglielmi detachable coils.
4. Make an assessment of preoperative concerns before a neurointerventional procedure.
5. Describe the importance of timing of anesthetic induction with regard to the planned procedure.
6. Explain the importance of blood pressure control for cases of intracranial pathology, and give examples when controlled hypertension and hypotension would be indicated.
7. Recognize the anesthesiologist’s role in monitoring and controlling anticoagulation parameters in these cases.
8. Discuss how to minimize the risk of radiation exposure in the neuroradiology suite.
9. List reasons why intraoperative hypothermia is so prevalent in this patient population.
10. Present an anesthetic plan for the neuroradiology suite.

NEEDS STATEMENT
The management of intracranial lesions such as aneurysms and arteriovenous malformations was, at one time, relegated exclusively to neurosurgeons for remedy within the operating room. However, advances in imaging techniques and therapeutic tools over the past 20 years have opened new vistas for the treatment of these conditions. New therapies have resulted in significant decreases in morbidity, mortality, and hospital stay when compared with open craniotomy surgeries. For many anesthesiologists, the neuroradiology suite—at some distance from the operating room—remains a daunting work environment. Identification of these challenges has been requested by a committee of the Anesthesiology News advisory board and by suggestions from readers.

CALL FOR CONTRIBUTIONS
If you have an idea for a CME lesson in Anesthesiology News, please e-mail Elizabeth A.M. Frost, MD, at ElzFrost@aol.com.

Elizabeth A.M. Frost, MD, who is the editor of this continuing medical education series, is Clinical Professor of Anesthesiology at Mount Sinai School of Medicine in New York City. She is the author of Clinical Anesthesia in Neurosurgery (Butterworth-Heinemann, Boston) and numerous articles. Dr. Frost is also past president of the Anesthesia History Association and former editor of the journal of the New York State Society of Anesthesiologists, Sphere. She is editor of the book series based on this CME program, Preanesthetic Assessment, Volumes 1 through 3 (Birkhauser, Boston) and 4 through 6 (McMahon Publishing, New York City).

A COURSE OF STUDY FOR AMA/PRA CATEGORY 1 CREDIT
1) Read this article, reflect on the information presented, then complete the online posttest before May 31, 2006. (CME credit is not valid past this date.)
2) You must achieve a score of 70% or better to earn CME credit.
3) The estimated time to complete this activity is 2 hours.

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PREANESTHETIC ASSESSMENT
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reduce the vascularity of the lesion before surgical excision for the same procedure over protracted periods of time. Embolized sites. Therefore, these patients will be seen frequently embolized in a single session, which allows the remaining vessels to remain close to the patient’s head to ensure and maintain a patent airway. Proximity increases radiation exposure to the physician or the certified registered nurse anesthetist. If general anesthesia is chosen, the timing of induction must coincide with the goals of the neuroradiologist. If the coating of an aneurysm or arteriovenous malformation is judged to be difficult or impossible, the neuroradiologist may choose instead to sacrifice the entire artery that feeds the particular site. Before sacrificing an artery, the neuroradiologist typically assesses whether there is adequate collateral circulation via a balloon test occlusion. The neuroradiologist inserts a balloon into the target artery and inflates it to locally obstruct distal blood flow. The patient is observed for deficits in speech, motor function, or any other symptoms that would indicate hypoperfusion to the area served by the artery in question. The patient obviously needs to be awake and only minimally sedated for this portion of the procedure. If no deficits are noted, collateral circulation is deemed to be adequate to sacrifice the artery and general anesthesia can be induced. The patient’s complete medical history should focus on blood pressure, including any medications the patient takes to control hypertension. The neuroradiologist requires tight control of blood pressure throughout the case, and it is important to ascertain the patient’s baseline range based on ≥3 preoperative measurements. Renal and fluid status also must be noted, as the patient receives a large bolus of contrast and a significant volume of fluid (typically ≥3 L) via the femoral introducer. The patient’s diabetic status must be determined: hyperglycemia should be assiduously treated before induction to minimize the risk for further neurologic insult. Finally, any preexisting neurologic deficits should be documented and fully described. Intraoperative Management In addition to American Society of Anesthesiologists standard monitoring, an arterial line will almost always be necessary to assist in tight blood pressure control, as well as to facilitate the drawing of activated clotting time studies. Depending on the patient’s condition, the anesthesiologist may choose to insert the arterial line postinduction to minimize patient anxiety and discomfort. Central venous or pulmonary artery pressure/wedge monitoring may be indicated, at the discretion of the anesthesiologist, and often is based on the patient’s underlying cardiopulmonary status. Induction and paralysis can be accomplished safely with any number of agents. At the University of Miami (author’s affiliation), fentanyl typically is used in addition to thiopental sodium or propofol for induction, followed by rocuronium for paralysis. Tight control of neuromuscular function enhances imaging as the patient is completely still, but at the same time allows for the use of lower concentrations of inhalation agents. If the duration of the case is expected to exceed 3 hours, we typically change to pancuronium after the patient regains neuromuscular transmission. Many neuroradiologists use somatosensory-evoked potentials and/or motor-evoked potentials during the course of the embolization, with obvious consequences for the anesthesiologist. If somatosensory-evoked potentials are monitored, volatile agents and nitrous oxide (N₂O)
flush the contrast medium. Furthermore, the room is kept cold— in the vicinity of 22°C—to ensure the optimal operation of the fluoroscopy equipment and computers. As a result, a forced-air heating device often proves beneficial for these patients. If a lower-body blanket is chosen, it must not obscure the femoral puncture site.

Hemodynamic parameters must be reviewed frequently with the neuroradiologist because different phases of the case may require different blood pressure parameters. In the case of an acute subarachnoid hemorrhage, blood pressure should be maintained at the lowest safe level to minimize the extent of further intracranial bleeding. Short-acting agents (esmolol, sodium nitroprusside) are preferred because of their relatively easy titration and discontinuation. On the other hand, patients who have bled 7 to 10 days previously are at peak risk for cerebral vasospasm, and will benefit instead from “triple H” therapy (hemodilution, hypervolemia, and hypertension). Although some neurosurgeons have used pulmonary catheter monitoring to guide therapy, it usually is not preferred at this writer’s institution.

Patients with arteriovenous malformations may prove even more challenging from a hemodynamic standpoint. The neuroradiologist first may request the induction of hypertension to increase cerebral blood flow and enhance optimal placement of the microcatheter. Following this, the induction of hypotension (as low as 50 mm Hg systolic) upon glue injection will slow the flow of the agent, thereby allowing it to polymerize within the arteriovenous malformation. In addition, a Valsalva maneuver may be helpful to raise central venous pressure and intracranial pressure and further inhibit the flow of the glue out of the arteriovenous malformation. If the glue does not polymerize within the malformation, it will form embolic particles in the venous circulation and ultimately lodge in the pulmonary vascular bed. This rare but potentially fatal complication requires high levels of positive end-expiratory pressure to support ventilation, and surgical retrieval of the plug may be necessary.

The monitoring of neuromuscular transmission should be performed throughout the entire case, as any patient movement can result in catastrophic vessel rupture. If motor-evoked potentials are not monitored, the patient usually is paralyzed for the length of the procedure. If ventilation is controlled, some degree of permissive hypercapnia (Paco₂, 45 mm Hg) may facilitate microcatheter placement from a vasodilatory effect.

Bladder catheterization is mandatory because of the contrast-induced diuresis and the large volume of intravenous fluid administered by the neuroradiologist. As there is little, if any, bleeding or evaporative fluid loss, at this writer’s institution the intravenous infusions typically are kept running as slowly as possible to avoid a heavily positive fluid balance.

Heparin typically is given at the time of introduction of the microcatheter; repeated heparin doses are based on subsequent activated clotting time values. The arterial cannula provides a convenient access for the anesthesiologist to routinely check activated clotting times to ensure that anticoagulation goals are met.

Throughout the case, the anesthesia provider is responsible for ensuring his or her own safety with regard to radiation exposure. A lead gown should be worn at all times to protect the thorax and pelvic region; protection of the thyroid and eyewear also are recommended. Many centers use a clear leaded acrylic barrier, either freestanding or suspended from the ceiling, to offer further protection. The dose of radiation decreases by the square of the distance from the source, so positioning as far as safely possible from the radiation beam also is helpful. A pelvic apron also should be considered for the patient, especially in the pediatric population.

**Postoperative Management**

The most common complications in the immediate postoperative period are bleeding from the puncture site and the appearance of a new neurologic deficit. A smooth emergence...
with controlled hemodynamic parameters can significantly reduce the likelihood of either of these problems. Exubation performed under relatively deep anesthesia with the patient spontaneously breathing approxi-mately 1 minimum alveolar concentration (MAC) of volatile agent allows for an emergence that is free from bucking, and greatly reduces the incidence of hypertension, tachycardia, increased intracranial pressure, and external bleeding.

After emergence, the neurointerventionalist prefers the patient remain flat to allow clot formation at the groin. If respiration is difficult in this position because of anatomic or physiologic considerations, the anesthesiologist should consider keeping the trachea intubated and supporting ventilation for several hours until the patient is allowed to sit up right.

In either case, such patients typically are observed for 1 to 2 days in an intensive care setting; they are usually discharged home by postoperative day 3 or 4.

Delayed awakening in the neuroangiography suite (Figure 3) may be due to many causes. The most serious of these is the emergence of a new, possibly reversible, neurologic deficit. Ediologies such as vasospasm, intracranial hemorrhage, or coil migration must be aggressively investigated by the neuroradiologist with angiography, MRI, or computed tomography scanning. Simultaneously, the anesthesiologist must look for other causative factors such as electrolyte imbalance, hypocarbia, or the presence of residual anesthetic.

Management of the Case Presented

Anesthesia was induced smoothly with thiopental sodium. A tracheal intubation was placed subsequent to intubation. Maintenance of anesthesia was achieved with isoflurane—1 MAC, fentanyl: Q 30%/N2O 70%, and pancuronium. The neurointerventionalist requested a systolic blood pressure in the range of 130 to 140 mm Hg to properly direct the flow-directed catheter—which necessitated a phenylephrine infusion of 0.8 mcg/kg per minute. After the administration of 3,500 units of heparin, 9 GDC coils were performed under relatively deep anesthesia with the patient awake or minimally sedated. Maintenance of anesthesia was achieved with sevoflurane and N2O—which were then discontinued. The sevoflurane 2% was started in lieu of isoflurane, and the anesthesiologist must look for other causative factors such as electrolyte imbalance, hypocarbia, or the presence of residual anesthetic.

Conclusion

Neurointerventional procedures are no longer just tangential therapies on the horizon. Physicians have demonstrated reduced morbidity and mortality rates, while patients appreciate the opportunity to avoid an open craniotomy. Surprisingly, with the cost of endovascular coils at about $1,700 per coil, the expected and was transported to the intensive care unit.

that time revealed that the aneurysm had been excluded from cerebral circulation. Phenylephrine was discontinued, protamine 10 mg was given to bind the residual heparin, sevoflurane 2% was started in lieu of isoflurane, and the effects of pancuronium were reversed. Exubation was performed while the patient was spontaneously breathing sevoflurane and N2O—which were then discontinued. The patient awake smoothly, displayed no neurologic deficits, and was transported to the intensive care unit.

PreAnesthetic Assessment of the Patient For Endovascular Coiling

Lesson 241: Post-test

Select the single-letter response that most correctly answers the question or completes the sentence.

1. All of the following conditions are easily treated in the neurointerventional suite except:
   a. middle cerebral artery aneurysms
   b. dural arteriovenous fistulas
   c. trigeminal neuralgia
d. embolic stroke

2. Which of the following is true about Guglielmi detachable coils (GDC)?
   a. They are used to treat arteriovenous malformations as frequently as aneurysms.
   b. Once they are placed within an aneurysm, they cannot be removed.
   c. Once they are inserted, the patient cannot have an MRI scan.
   d. If no neurologic deficits are noted, the balloon is inflated in the contralateral artery to check for collateral flow.

3. Which of the following is true about the management of arteriovenous malformations?
   a. A Valsalva maneuver is often requested to assist with flow dynamics.
   b. Hypotension upon glue injection will adversely affect polymerization.
   c. Most arteriovenous malformations can be completely treated in a single intervention.
   d. Embolization of glue particles is a rare but easily treated complication.

4. Administration of a paralytic agent is indicated for all of the following reasons except:
   a. reduction of volatile anesthetic requirements
   b. facilitation of recording somatosensory and motor-evoked potentials
   c. enhancement of digital subtraction imaging
d. decreased risk of aneurysm rupture

5. Which of the following statements is false?
   a. Large aneurysms that are difficult to coil may be treated by sacrificing the feeding artery.
   b. A balloon test occlusion can be performed to obstruct distal blood flow within the artery.
   c. A balloon test occlusion must be performed with the patient awake or minimally sedated.
   d. If no neurologic deficits are noted, the balloon is inflated in the contralateral artery to check for collateral flow.

6. Which of the following is least likely to be responsible for hypothermia within the neurointerventional suite?
   a. Low ambient temperature
   b. Euvaporative fluid loss
   c. Fluid and contrast medium administered by the neuroradiologist
d. Conduction loss via the operating table

7. Each of the following is a useful therapy for a patient with a Valsalva maneuver at 7 days post-subarachnoid hemorrhage except:
   a. hemodilution
   b. hypertension
c. hypervolemia
d. hypothermia

8. Which of the following statements concerning anticoagulation is false?
   a. Heparin is the preferred agent to inhibit thrombus formation.
   b. An activated clotting time of 225 seconds may be subtherapeutic.
   c. An elevated activated clotting time at the conclusion of the case may require protamine administration.
   d. In the case of aneurysm rupture, protamine should be given as an I.V. push to reduce the extent of intracranial bleeding.

9. A patient is having an aneurysm coiled with the assistance of somatosensory-evoked potentials. Which of the following is least likely to be responsible for the patient’s delayed awakening from anesthesia?
   a. Residual isoflurane
   b. Hypothermia
c. GDC coil migration
d. Midazolam 3 mg preoperatively with an I.V. technique

10. Appropriate protection from radiation exposure includes:
    a. covering the thorax and pelvis with a lead apron
    b. using a thyroid shield and protective eyewear
c. maintaining a safe distance from the fluoroscopy beam
da. all of the above

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Readers: Please Note! Beginning this month, anyone seeking CME credit for PreAnesthetic Assessment lessons will have to take the post-test online. The paper post-test is no longer available. Visit www.mssm.procampus.net today for instant online processing of your CME post-tests.