

- Nonemergent C-section: For all C-sections regardless of level of immediacy, standard OR and anesthesia machine check, left uterine displacement to maximize uterine blood flow, and application of ASA standard monitors. For *elective C-section*, usually spinal anesthesia is used to achieve a T4 level to pain sensation. This can be accomplished by 1.8–2 mL of 0.75% bupivacaine injected at L3-L4 interspace, often combined with opioid (fentanyl and/or preservative-free morphine) and epinephrine. Maintain BP within normal limits using adequate IV hydration, and phenylephrine or ephedrine when necessary.
- Emergency C-section: Following labor *without* fetal distress (e.g., failure to progress) or labor *with* fetal distress (e.g., Category III fetal heart tracing), if pt has a reliable epidural block, epidural anesthesia is extended, using a higher-concentration local anesthetic (e.g., 3% chloroprocaine, 2% lidocaine, or 0.5% ropivacaine) if time permits. If pt does not have a functioning epidural catheter, then a spinal technique may be used (again, if time allows). Otherwise, general anesthesia with rapid sequence induction may be required.

Anticipated Problems/Concerns

- If there is no epidural catheter in place and a difficult airway is suspected, then consider spinal anesthesia or performing an awake intubation for general anesthesia. Emergency airway equipment (e.g., LMA, video laryngoscope, fiberoptic scope, jet ventilator) should be readily available.
- Neuraxial anesthesia should only be attempted while the fetus is not in imminent danger. The clinical situation must be discussed fully, effectively, and efficiently with the managing obstetricians to develop the safest plan for both the pt and fetus.

Cerebral Arteriovenous Malformations

L. Jane Easdown

Risk

- Cerebral AVMs are rare: 1–2% cause of CVA in a younger population; mean age of diagnosis is 31 y.
- 55% of pts are men.
- Symptomatic cases: 1:100,000 per y.
- Found in 4.3% of population at autopsy.
- Of those affected, 45–70% present with hemorrhage, 30% with seizures, 12% with persistent neurologic deficits, and 1% with headaches.
- Yearly risk of hemorrhage is 1–3%.

Perioperative Risks

- Risk of hemorrhage at embolization is 2–4%.
- Intraop blood pressure management is critical.
- Postop NPPB occurs as blood is diverted from the AVM to the surrounding brain, presenting risk of cerebral edema or hemorrhage.

Worry About

- Massive intraventricular or intraparenchymal hemorrhage

- Seizure
- New neurologic deficits
- Cerebral edema, hyperemia post resection, or endovascular embolization

Overview

- Localized arteriovenous shunt comprised of a tangle or “nidus” of abnormally walled vessels, which cause symptoms by rupture, ischemia, and diversion of flow or pressure on adjacent structures; many are detected on routine scans. The majority of AVMs will bleed at least once.
- 0% are supratentorial, and 4–10% are associated with aneurysms.
- Increased risk of rebleed of 6–33% within the first year.
- As the result of hemorrhage, 16% of pts are moderately or severely disabled. Hemorrhage leads to mortality in 10–30% of cases.
- Vein of Galen malformations are rare congenital lesions with connections between the intracerebral vessels and the great vein of Galen. This disorder in

neonates or infants may result in high output CHF or increased ICP from hydrocephalus.

Etiology

- Although congenital in origin, no specific genetic defect has been determined. Sometimes AVMs are associated with hereditary hemorrhagic telangiectasia.

Usual Treatment

- Evidence-based neurosurgic management is based on the Spetzler-Martin grading scale. AVMs are graded 1–5, based on their size, location (eloquent or non-eloquent brain), and pattern of venous drainage.
- Smaller and more superficial AVMs (grades 1–3) might be surgically resected for cure. Higher-grade AVMs may be treated with endovascular embolization or stereotactic radiotherapy. Multimodal therapy is common, especially embolization before surgical resection. Embolic materials include solid or liquid agents. Conservative management may improve outcomes in high-grade or unruptured AVMs.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Airway protection	Aspiration	Active gag reflex	
CV	CHF in children with vein of Galen AVM		S ₃ and CHF	CXR, ECHO, ECG
CNS	Seizures, focal deficits, CVA, and raised ICP	Headaches, seizures, changes in mentation, and focal deficits	Neurologic exam	MRI, MRA, CT, cerebral angiography

Key References: Miller C, Mirski M: Anesthesia considerations and intraoperative monitoring during surgery for arteriovenous malformations and dural arteriovenous fistulas. *Neurosurg Clin N Am* 23(1):153–164, 2012; Bendok BR, El Tecle NE, El Ahmadieh, TY, et al: Advances and innovations in brain arteriovenous malformation surgery. *Neurosurgery* 74(Suppl 1):S60–S73, 2014.

Perioperative Considerations

Preoperative Preparation

- Endovascular embolization procedures usually require GA to ensure BP control and no pt movement during microcatheter placement.
- Craniotomy for resection requires preop preparation similar to aneurysm clipping.
- Neurologic exam with attention to focal deficits and raised ICP.
- Prior embolization/radiotherapy may have been performed.
- Carefully assess size and location of AVM.

Monitoring

- Invasive BP monitoring
- Central venous access for craniotomy procedures anticipating extensive blood loss.
- O₂ saturation monitor, which might be placed on the foot on the side of the femoral introducer to monitor arterial integrity during angiography
- Precordial Doppler for detection of air

- Jugular bulb venous O₂ monitoring (has been described)
- Intraop neuro monitoring, which may include EEG and SSEPS

Airway

- ETT for craniotomy and LMA or intubation for airway management for embolization

Induction

- Careful management of BP to prevent Htn (increased ICP or hemorrhage) or hypotension (ischemia)

Maintenance

- Manage BP and ICP carefully, especially with intubation, pinning, and incision.
- Surgeons may request burst suppression with propofol for brain protection if temporary clips are used during resection.
- Surgeons may request hypotension or hypocapnia.
- Control blood glucose.
- Maintain strict isotonic/hypertonic fluid.
- Perform angiography before emergence.
- Plan for arousal and neurologic testing immediately after operation.

Extubation

- Careful BP control: Labetalol and additional opioid
- Expected request for neurologic exam
- May keep intubated to control NPPB hyperemia

Adjuvants

- Cell saver and blood products immediately available
- BP control with nicardipine, NTG, NTP, and beta-blockers
- Phenylephrine infusion
- Propofol infusion for TIVA or burst suppression
- Steroids and mannitol
- Antiepilepsy medications

Postoperative Period

- Complete obliteration of a large AVM will lead to redistribution of CBF and hyperemia or NPPB. Until autoregulation returns, pt may require lower BP and control of CO₂ by intubation and ventilation.
- Postop ICU neurologic monitoring will be required.
- After arteriogram, the femoral cath site should be monitored for bleeding.