The Occasional Neuroanesthesiologist – All the questions you didn’t know to ask.

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The preoperative work up of the neurosurgical patient obviously involves the “routine” history, physical and appropriate laboratory tests. However there are a few additional questions which will make planning the intraoperative care easier. These are:

What’s the diagnosis and what operation will you do?
What position will the patient be in?
How much bleeding will there be?
Do you anticipate any ischemia?
Will there be any neuromonitoring?
Is the ICP elevated?
Where will the patient go afterwards?

**What’s the diagnosis and what operation will you do?**

**Acute subdural.**

These are usually associated with acute head trauma so that the underlying brain is injured as well. The extent of the underlying injury to the brain and other organs will determine whether the patient can be extubated at the end of the procedure. Management is focused on the associated elevated intracranial pressure (ICP) and the other injuries. Surgery is usually a craniotomy.

**Chronic subdural.**

These usually occur in older patients who fell in the recent past and then developed slowly progressive neurological deterioration. Many are on anticoagulants for cardiovascular disease. The neurological deterioration is slow because of cortical atrophy which results in a lot of space for the hematoma to accumulate in before ICP starts increasing. The underlying brain is usually not injured. Surgery may be for burr holes through which the hematoma is irrigated out or a full craniotomy. Initial anesthetic management may involve managing the elevated ICP but once the hematoma has been removed, the brain should be allowed to fill the space i.e. P\textsubscript{a}C\textsubscript{O\textsubscript{2}} should be normal or slightly elevated.

**Intracerebral Hemorrhage (ICH).**

Intracerebral hemorrhage is usually associated with trauma or hypertension. However, acute hemorrhage into a tumor can occur. An aneurysm or AVM may also be the cause of the bleed and if not diagnosed preoperatively may result in torrential intraoperative bleeding.

**Tumor**
These usually present with features of elevated intracranial pressure e.g. head ache and symptoms of compression of adjacent brain. Seizures may also occur. Intraparenchymal tumors are usually not too vascular but meningiomas can be exceedingly vascular. In patients with the latter tumor preoperative angiography and embolization should be considered. Anesthetic management is focused on preventing increases in ICP and preferably lowering it.

**What position will the patient be in?**

**Supine**

**Lateral**

**Modified Lateral (Park Bench)** – The patient is placed lateral and then leaned forward with the head turned towards the floor. It is used by some for posterior fossa and cervical procedures.

**Prone** – used for posterior fossa and spinal procedures.

**Sitting** – infrequently used these days because of concerns about air embolism.

**How much bleeding will there be?**

Performing a craniotomy i.e. “the opening” should usually result in <250 ml blood loss. Most intraparenchymal tumors are not very vascular and should not result in significant hemorrhage. Conversely meningiomas can be very vascular and adherent. Preoperative angiography and embolization can often substantially reduce blood loss.

Cerebral aneurysms have the potential to bleed significantly although this is uncommon with experienced, competent aneurysm surgeons. Arteriovenous malformations are usually embolized in advance of surgery thus reducing intraoperative bleeding.

Blood loss from spine surgery ranges from 50ml to 15 liters depending on the lesion and extent of surgery. Ask the surgeon for an estimate and then multiply by an appropriate factor.

**Do you anticipate any ischemia?**

The potential for neural ischemia may be an indication for neuromonitoring and the surgeon may request some (purported) neuroprotective drugs, most commonly thiopental. In the context of neurosurgery there are no prospective randomized trials showing a benefit to any of the commonly used techniques including drugs, shunts and physiological manipulation.

**Will there be any neuromonitoring?**

Evoked potential monitoring is frequently used during intracranial, neurovascular and spinal procedures. The purpose of the monitoring is to prevent ischemic injury. Sensory and/or motor pathways are selectively stimulated resulting in very small evoked responses that require rapid repeated stimuli which are summated in order to produce an interpretable signal. Prospective randomized trials of all the neuromonitoring modalities are lacking and the best available studies are cohort studies and historical controls.
Somatosensory Evoked Potentials (SSEP)

Most commonly the median and/or the posterior tibial nerves are stimulated and the responses collected at the cervical and cortical levels. The SSEP indicates the integrity of the specific sensory neural pathway stimulated and injury to areas of the nervous system outside these tracts may not be detected. SSEPs are sensitive to inhalational anesthetics and become progressively suppressed as concentration increases. Sevoflurane and desflurane are somewhat less suppressive than older agents. SSEPs are very much less influenced by intravenous agents such as propofol, opioids, thiopental. Thus suitable anesthetic choices are a TIVA anesthetic or low dose inhalational agent with an opioid e.g. <0.5 MAC with N₂O or <1 MAC without N₂O.

Motor Evoked Potentials (MEP)

Clinical use of MEPs is relatively new and utilizes multiple transcranial electrical stimulations to stimulate the pyramidal tracts which evoke a motor response in the upper and lower limbs. MEPs are very sensitive to anesthetics and are progressively suppressed by >0.3MAC of the volatile agents. Thiopental, propofol and midazolam can also suppress the signals but the inhalational agents are much more suppressive than the IV. N₂O and opioids have small effects while ketamine and etomidate may actually increase the amplitude making them useful adjuvants when good quality signals are not being obtained. Early experience with dexmedetomidine suggests that it may be suitable. Muscle relaxants should be avoided or kept to a minimum. Suitable techniques include propofol-opioid TIVA, low dose vapor together with opioid & N₂O and both techniques may be supplemented with a low dose ketamine infusion.

Is the ICP elevated?

Elevated ICP is most easily determined when it is directly measured although the majority of patients will not have intracranial monitors in place and a clinical estimate should be made from clinical signs e.g. headache, drowsiness, pupillary dilation, hemiparesis, and from CT/MRI e.g. midline shift and ventricular compression. It is also important to determine if the increase in ICP is sudden e.g. subdural or more gradual e.g. tumor. Patients with acute coma producing elevated ICP will have exhausted endogenous compensatory mechanisms and will be less tolerant of anesthetic techniques that may increase ICP, e.g. vapor based techniques. In such patients a prudent option may be a propofol-opioid infusion at least until the dura is opened and the mass decompressed. In other patients the actual choice is likely not important, at least in relation to ICP and no prospective randomized trials have shown a difference in patient outcome.

Propofol and thiopental have been shown to reduce elevated ICP while all inhalational agents will increase ICP at high enough dose. Of the vapors, sevoflurane is the least vasodilatory but no inhalational agent actually decreases ICP.

Hyperventilation has been a “tradition” in neuroanesthesia but has now fallen into disfavor as there is evidence, at least with more prolonged use, that it produces ischemia and potentially a worse neurological outcome. The current recommendation is to keep the PaCO₂ in the mid 30’s and to reduce it further only if needed and preferably for short periods.

Other techniques to reduce ICP or a bulging brain include a head-up position, avoidance of venous outflow obstruction and mannitol. One should also eliminate or reduce the amount of
cerebral vasodilators being used including inhaled anesthetics and vasoactive drugs such as nitroprusside.

**Where will the patient go afterwards?**

The disposition of the patient to the ICU or the PACU may influence the anesthetic choice and may also be reflective of the severity of the neurologic impairment or the extent of the planned surgery.

**References:**


http://www.braintrauma.org [provides guidelines for the anesthetic and surgical management of the patient with traumatic brain injury]

http://www.trauma.org/neurotrauma [outlines management of elevated intracranial pressure in trauma patients]


PATEL P. No magic bullets: the ephemeral nature of anesthetic-mediated neuroprotection. Anesthesiology 2004 May;100(5):1049-51.


