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 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. 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. PaCO2 should be normal or slightly elevated.

Intracerebral Hemorrhage (ICH).
Intracerebral hemorrhage is usually associated with trauma or hypertension. 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 and/or seizures. Intraparenchymal tumors are usually not very 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. There is abundant experimental evidence that currently used anesthetics e.g. sevoflurane, propofol, thiopentone, produce cerebral protection as assessed by multiple surrogate endpoints. However, 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 summed 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. 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. <1 MAC without N2O.

Motor Evoked Potentials (MEP)

Clinical use of MEPs is relatively new and utilizes multiple transcranial electrical stimulations to stimulate a motor response in the upper and lower limbs. MEPs are very much more sensitive to anesthetic suppression than SSEP 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. In contrast ketamine and etomidate may actually increase the amplitude making them useful adjutants 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 with constant TOF. Suitable techniques include propofol-opioid TIVA, low dose vapor together with opioid, low doses of propofol, vapor with opioid and any technique may be supplemented with a low dose ketamine infusion. Newer stimulation paradigms are increasingly less anesthetic sensitive.

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. acute subdural or more gradual e.g. tumor. Patients with acute coma producing elevated ICP or very large lesions will have exhausted endogenous compensatory mechanisms and will be less tolerant of anesthetic techniques that may increase ICP. In such patients a prudent option may be a propofol-opioid infusion or sevoflurane-opioid at least until the dura is opened and the mass decompressed. In patients with very small masses the actual choice is likely less important, at least in relation to ICP and no prospective randomized trials have yet shown a difference in patient outcome.

Propofol and thiopental have been shown to reduce elevated ICP. Of the vapors, sevoflurane is the least vasodilatory and does not seem to increase ICP until well above 1 MAC. No inhalational agent actually decreases ICP.

Hyperventilation has been a “tradition” in neuroanaesthesia but has fallen into disfavor as there is evidence, at least with prolonged use in head trauma, that it produces ischemia and potentially a worse neurological outcome. The current recommendation is to keep the PaCO2 in the mid 30s and to reduce it further only if needed and preferably for short periods. Our recent multicenter randomized blinded trial found that hyperventilation (PaCO2 28) improved operating conditions and ICP in patients with supratentorial tumors.

Other techniques to reduce ICP or a bulging brain include a head-up position, avoidance of venous outflow obstruction and mannitol. There is also current interest in the use of hypertonic saline for this purpose. One should also eliminate or reduce the amount of cerebral vasodilators being used including (high dose) inhaled anesthetics and vasoactive drugs such as nitroprusside & nitroglycerine.

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.

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