Neuroanesthesia

- Spinal Arachnoid Cysts: A Single-Center Preliminary Surgical Experience with a Rare and Challenging Disease
- Anesthetic and perioperative management of pregnant patients undergoing neurosurgery: a case series from a single center in Morocco (2017-2024)
- Fasting and nutrition in neuroanesthesia and neurocritical care patients
- Prediction of functional outcome after traumatic brain injury: a narrative review
- From indication to initiation of invasive intracranial pressure monitoring time differences between neurosurgeons and intensive care physicians: can intracranial hypertension dose be reduced? TIMING-ICP, a multicenter, observational, prospective study
- Remimazolam in neuroanesthesia
- Exploring the Effects of Ketofol and Etomidate on Cerebral Blood Flow and Oxygenation during Anesthesia Induction in Supratentorial Tumor Patients: A Randomized Double-Blind Study
- CT-Guided Percutaneous Cryoablation of Small Renal Masses: General Anesthesia Versus Conscious Sedation with Dexmedetomidine

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The practice of neuroanaesthesia has expanded significantly in recent years to keep up with various challenges posed in the perioperative care of patients for neurosurgical, interventional, neuroradiological, and diagnostic procedures. Technological advancements in neuroscience include the intraoperative use of computed tomography scans and angiograms for vascular neurosurgery, magnetic resonance imaging, neuronavigation, expansion of minimally invasive neurosurgery, neuroendoscopy, stereotaxy, radiosurgery, the performance of increasingly complex procedures, advancements in neurocritical care, etc. Recent advancements in neuroanaesthesia that can meet these challenges include the resurgence of ketamine, opioid-free anaesthesia, total intravenous anaesthesia, techniques to facilitate intraoperative neuromonitoring, awake neurosurgical and spine surgeries, etc [1)].

The main goals in neuroanesthesia are maintaining intracranial pressure (ICP), cerebral perfusion pressure (CPP), and aerobic brain metabolism, together with diminishing secondary brain injury [2)].

Worldwide including USA, there is no formal and accredited fellowship training program in neuroanesthesia despite the early establishment of the speciality and the society of neuroscience anesthesia and critical care (SNACC) in 1972.

Neuroanesthesia is one of the specialties that has contributed tremendously over the years to neuroscience yet it remained non-accredited and supported. In fact, there is a discouraging trend to pursue advocating the necessity of neurosurgery cases to be done by neuroanesthesiologists. It is one of the specialties that is lagging behind compared with other specialties and subspecialties in neuroscience. There is an ongoing debate within the neuroanesthesia society about the role of neuroanesthesiologists in neurosurgery. The author, being a neurosurgeon, neuroanesthesiologist, and neurointensivist, is presenting the topic, the views and expressing his opinion [3].

Pasternak et al provide a synopsis of innovative research, recurring themes, and novel experimental findings pertinent to the care of neurosurgical patients and critically ill patients with neurological diseases. The following broad topics are covered: general neurosurgery, spine surgery, stroke, traumatic brain injury, anesthetic neurotoxicity, perioperative cognitive dysfunction, and monitoring [4].

Links

http://www.openanesthesia.org/subspecialty/neuroanesthesia/

Neuroanaesthesia Society of Great Britain and Ireland

http://www.nasgbi.org.uk/

Manual of Neuroanesthesia Written by Cleveland Waterman: http://www.uam.es/departamentos/medicina/anesnet/gtoa/manualneuro/contents.html

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The field of minimally invasive neurosurgery has evolved rapidly in its indications and applications over the last few years. New, less invasive techniques with low morbidity and virtually no mortality are replacing conventional neurosurgical procedures. Providing anesthesia for these procedures differs in many ways from conventional neurosurgical operations. Anesthesiologists are faced with the perioperative requirements and risks of newly developed procedures. This review calls attention to the anesthetic issues in various minimally invasive neurosurgical procedures for cranial and spinal indications. Among the procedures specifically discussed are endoscopic third ventriculostomy, endoscopic transsphenoidal hypophysectomy, endoscopic strip craniectomy, deep brain stimulation, video-assisted thorascopic surgery, vertebroplasty and kyphoplasty, cervical discectomy and foraminectomy, and laparoscopically assisted lumbar spine surgery [5].

The anesthetic technique varies depending on the traditions and requirements of each institution performing deep brain stimulation, and has included monitored anesthesia with local anesthesia, conscious sedation, and general anesthesia. The challenges and demands for the anesthesiologist in the care of these patients relate to the specific concerns of the patients with functional neurologic disorders, the effects of anesthetic drugs on microelectrode recordings, and the requirements of the surgical procedure, which often include an awake and cooperative patient. The purpose of the review of Venkatraghavan et al., is to familiarize anesthesiologists with deep brain stimulation by discussing the mechanism, the effects of anesthetic drugs, and the surgical procedure of DBS insertion, and the perioperative assessment, preparation, intraoperative anesthetic management, and complications in patients with functional neurologic disorders [6].

Functional neurosurgery has undergone rapid growth over the last few years fueled by advances in imaging technology and novel treatment modalities. These advances have led to new surgical treatments using minimally invasive and precise techniques for conditions such as Parkinson's disease, essential tremor, epilepsy, and psychiatric disorders. Understanding the goals and technological issues of these procedures is imperative for the anesthesiologist to ensure safe management of patients presenting for functional neurosurgical procedures. In a review, Dunn et al., discuss the advances in neurosurgical techniques for deep brain stimulation, focused ultrasound and minimally invasive laser-based treatment of drug resistant epilepsy and provide a guideline for neuroanesthesiologists caring for patients undergoing these procedures [7].

Fundamentals

Neuroanesthesia Fundamentals Preoperative Considerations Sedation Avoid sedatives and/or opiates if elevated ICP is a concern (decreased RR leading to elevated ICP, obscuration of neurologic exam – for every 1 mm Hg decrease in pCO2, CBF decreases by 1-2 mL/100g/min).

Electrolytes Most of these patients are at high risk for electrolyte abnormalities (mental status changes, steroids, diuretics, contrast dye), which should be corrected prior to surgery.

ICP Note that mannitol (0.25-1 g/kg) is a vascular smooth muscle relaxant and causes a transient increase in ICP, thus it must be given slowly (over ~ 10 mins). Also can cause hypotension. Consider giving furosemide as opposed to mannitol or HTS in neurosurgical patients with cardiac disease, as they may not tolerate a volume load

Primary Pathology Always think of the primary pathology: vascular lesions can bleed extensively. Tumors can lead to ICP issues both during and after surgery. Steroids may be indicated in patients with brain tumors. Patients on chronic steroids may be hypoadrenal, always consider this in the face of refractory hypotension. Anticonvulsants may also be required

Monitors Almost all of these patients require an arterial catheter (frequent lab draws), a second IV, and urinary catheterization. Central lines, if needed, should be placed in the subclavian or brachial veins, as access to the neck is often limited

Induction Opiates are often recommended in order to blunt the response to DL and craniotomy, so consider giving fentanyl (5-10 ucg/kg) as soon as you are ready to control the airway (ie before the induction agents). Lidocaine 1.5 mg/kg may help blunt the response to DL, as mat low dose volatile anesthetics. Etomidate (0.2-0.3 mg/kg) or midazolam (0.2-0.4 mg/kg) may help provide a more hemodynamically stable induction. Consider initiating hyperventilation immediately after induction (gives you a margin of safety in case DL is stimulating). Most practitioners prefer a non-depolarizing NMBD. Take extra care in securing the airway as it will most likely be inaccessible.

Intraoperative Considerations General Fluid of choice is 0.9% NS without dextrose, although be aware of the potential for hyperchloremic metabolic acidosis – send ABGs after several liters of NS and consider converting to lactated ringer’s solution of an acidosis is developing. Volume restriction is no longer used to treat elevated ICP as it is only moderately effective and comes with the side effects of hypotension, subsequent cerebral and renal hypoperfusion, and electrolyte and acid-base disturbances. In fact, preoperatively many neurosurgical patients are volume resuscitated

During surgery, blood loss should be replaced at a 3:1 ratio (3L crystalloid per 1L EBL) to a hematocrit of 25-30%. Glucose is avoided as it exacerbates ischemia (increases neuronal lactate production) and edema. Patients are usually kept at 15-30 degrees during surgery to facilitate venous drainage. PEEP

> 10 cm H2O is avoided, above which venous drainage and ICP are affected. For major neurosurgical procedures, the following monitors are recommended – arterial line / ABG, central venous catheter, urine output. Paralyze adequately and achieve deep general anesthesia before DL, maintain PaCO2 of 30-35 mm Hg during surgery, avoiding PEEP if possible, as it can impair venous return from the brain. Avoid agitation on emergence

Intracranial Brain relaxation can be achieved with hyperventilation, increasing the depth of anesthsia, administration of 10-20 mg furosemide IV, or mannitol (1 mg/kg), PRIOR to opening of the dura. Additional means include administration of thiopental or lumbar catheter drainage (if available)

Following the craniotomy and dural incision, anesthetic requirements drop substantially, as the brain itself is insensate. Propofol at 50 -150 ucg/kg/min and remifentanil at 0.1-0.5 ucg/kg/min can produce adequate anesthesia with rapid awakening (IVA in craniotomies should incorporate remifentanil, as it allows for rapid awakening). Relaxants should be held until the head dressing is completely on, as movement in response to the endotracheal tube can be detrimental

IV versus volatile anesthesia Note that propofol is often recommended over volatile agents for intracranial neurosurgery as it was originally thought to produce less vasodilation/increase in ICP [Petersen KD et al. Acta Neurochir Suppl 81: 89, 2002]. Two recent studies have cast doubt on this common assumption – first, in a follow up study, Petersen et al. studied 117 patients and found no difference in ICP between fentanyl/volatile and fentanyl/propofol-based anesthesia. Interestingly, fentanyl/volatile led to a significantly higher jugular venous oxygen saturation and a significantly lower AVDO2 as compared to the fentanyl/propofol group, both before and after hyperventilation [Petersen KD et al. Anesthesiology. 98: 32, 2003]. More recently, Gelb et al. examined the effects of hyperventilation on operating conditions and ICP (both in propofol and isoflurane-based anesthetics), finding no difference between propofol and isoflurane in terms of ICP or surgeon-assessed brain bulk [Gelb AW et al. Anesth Analg 106: 585, 2008; FREE Full-text at Anesthesia & Analgesia]

Elements of Intracranial Neuroanesthesia to Keep in Mind Elements of Intracranial Neuroanesthesia to Keep in Mind – CNS: minimize opiates and benzos (elevated pCOs). Avoid ICP changes. Bed at 15-30 degrees facilitates venous draininge from brain. Always infuse mannitol over 10 minutes – CV: a-line is almost always recommended – Pulm: maintain pCO2 30-35 mm Hg. Hyperventilation only lasts 4-6 hrs. Keep PEEP < 10 – Renal: volume restriction is not recommended – FEN: avoid glucose – Anesthesia: consider a pseudocardiac induction (midazolam + fentanyl) to minimize hypotension. Deeply paralyze for intubation, avoid agitated emergence

Spine Total IV Anesthesia Emergence

There is a known association between emergence hypertension and post-operative hemorrhage – Basali et. al. reviewed 16 years of craniotomy data from the Cleveland Clinic, and found 69 cases of post-operative intracranial hemorrhage, which they matched in a 2-1 ratio by age, DOS, pathology, procedure, and surgeon. 62% of POH patients had intraoperative HTN (> 160/90), as opposed to only 32% of those who did not develop POH ($p < 0.001$, OR 4.6). Mortality rate in patients who suffered POH increased from 1.6 to 18.2%. Note, however, that the overall POH rate was only 0.77% [Basali et. al. Anesthesiology 93: 48, 2000]

In order to prevent intraoperative hemorrhage on emergence, consider the following techniques: 1. do not reverse paralytics until the head dressing is on 2. give 1.5 mg/kg IV lidocaine 90 seconds before suction/extubation 3. consider prophylactic labetalol on emergence

A neurologic exam should be performed prior to taking the patient from the operating room. If the patient does not wake up, consider elevated ICP (bleeding, swelling, HCP), residual anesthesia or paralysis, CO2 narcosis, hypoxia, and hypercarbia. Consider giving physostigmine (0.01-0.03 mg/kg) and/or naloxone (0.04 – 0.4 mg) to facilitate awakening

Post-Operative Care

Elevate the head of bed 30 degrees immediately. Consider checking serum electrolytes and osmolalities. Other critical PACU concerns include diabetes insipidus, SIADH, seizures, and tension pneumocephalus.

Parameters

Blood pressure

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