# *AWAKE CRANIOTOMY : ANAESTHETIC CONSIDERATIONS*

*ZIKRULLAH*

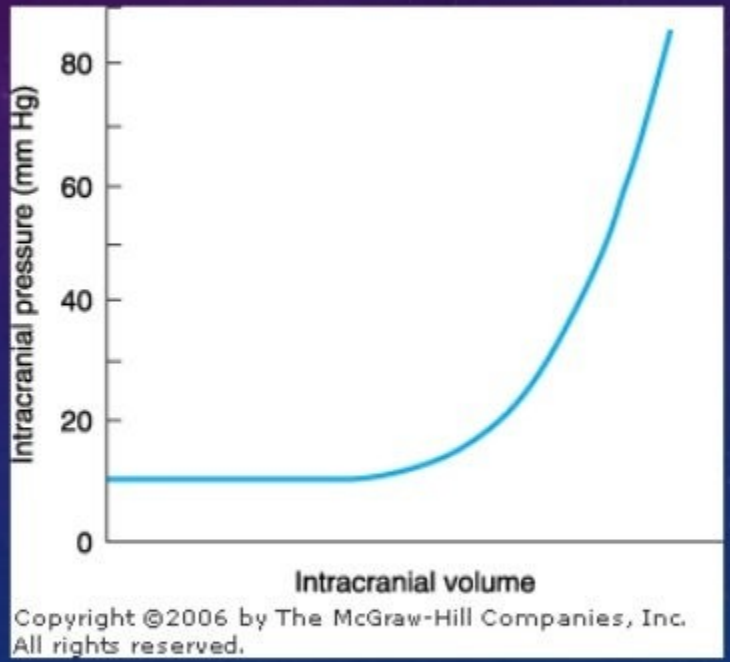
# What is cerebral perfusion pressure?

- **CPP = difference b/w mean arterial pressure (MAP) and intracranial pressure (ICP) or central venous pressure (CVP) , whichever is greater**
- **MAP – ICP (or CVP) = CPP**
- **Normally CPP = 80-100 mmHg**
- **ICP normally is ≤ 10 mm Hg, so , CPP depends primarily on MAP**

- **Moderate to severe ↑ ICP (≥ 30 mm Hg) - impairs CPP and CBF even in presence of normal MAP**
- **CPP ≤ 50 mm Hg – slowing on EEG**
- **CPP 25 - 40 mm Hg – flat EEG**
- **CPP ≤ 25 mm Hg – irreversible brain damage**

# What is the meant by intracranial compliance?

- Increase in volume are initially well compensated
- Later a point is eventually reached, at which precipitous rises in ICP occurs



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# *CEREBRAL BLOOD FLOW:*

- **Varies with metabolic activity**
- **CBF can vary from 10-300 ml/100g/min**
- **Total CBF: on an average 50 ml/100g/min OR 750ml/min**
  - **Approx 15% of total cardiac output**
  - **Gray matter : 80ml/100g/min**
  - **White matter : 20ml/100g/min**

- **CBF 20–25 ml/100 g/min - cognitive impairment**
- **CBF 15 – 20 ml/100 g/min - isoelectric EEG**
- **CBF < 10ml/100 g/min – irreversible brain damage**

# What are the factors affecting cerebral blood flow?

- Chemical/ metabolic/ humoral:
  - CMR – depends on : anesthetic agents temperature & seizures
  - $PaCO_2$
  - $PaO_2$
  - Vasoactive drugs: vasopressors & vasodilators

- Myogenic :
  - Autoregulation/ MAP

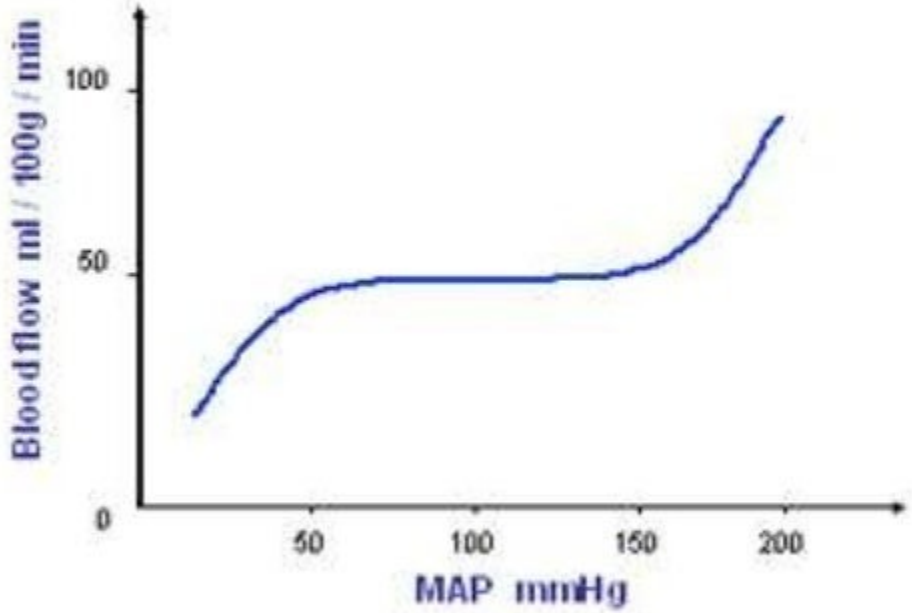
- Rheologic: blood viscosity
- Neurogenic

# What is the meant by cerebral autoregulation?

- Normally, brain tolerates wide swings in BP
- Cerebral vasculature adapts rapidly (10-60 sec) to change in CPP
- But , abrupt changes in MAP, even with intact autoregulation, lead to transient changes in CBF.
  - ↓ CPP- cerebral vasodilation
  - ↑ CPP- cerebral vasoconstriction

- CBF nearly remains constant b/w MAP of about 60-160 mm Hg
  - beyond these limits, CBF becomes pressure dependent
  - MAP ↑ 150-160 mm Hg – disruption of BBB & cerebral edema

# Autoregulation of Cerebral Blood Flow




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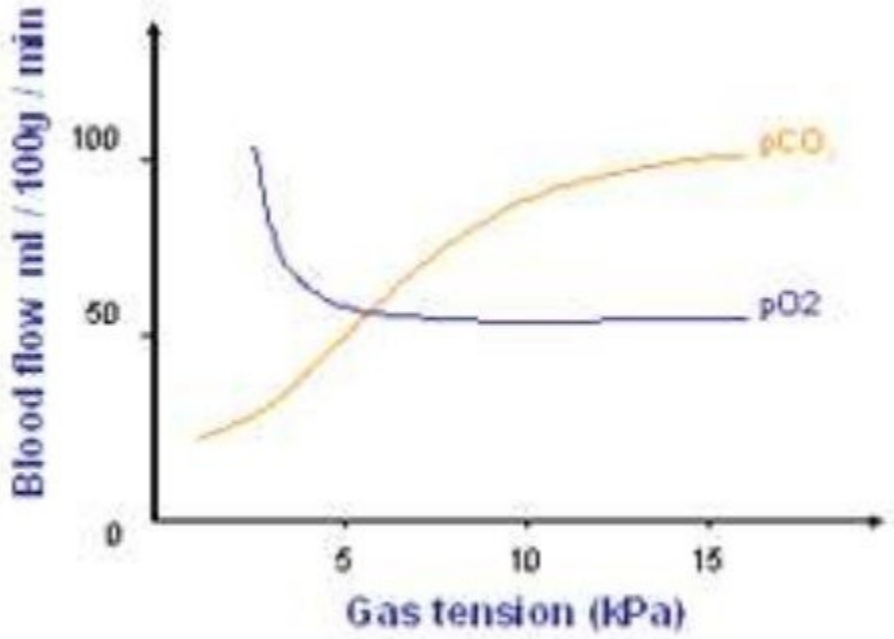
# *RESPIRATORY GAS TENSIONS:*

- **Most imp. extrinsic influences on CBF – esp. $PaCO_2$**
- **CBF directly proportional to $PaCO_2$ b/w tensions of 20-80 mm Hg**
- **CBF changes 1-2 ml/100g/min/mmHg change in PaCO2**

- Change occurs very quickly – almost immediate
  - Results from $CO_2$ readily crossing BBB
  - Acute changes in $PaCO_2$, but not $HCO3,^-$affect CBF
  - So, acute metabolic acidosis- little effect on CBF

- Chronic Changes (24 – 48 hrs) offset by $HCO3^-$ in CSF.

# Effects chemical factors on CBF




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# What is the meant by the term awake craniotomy?

- **Awake craniotomy literally means a procedure where the patient is awake during critical portions of the surgery so that his vital functions such as speech and movement can be monitored continuously**

# What is the need for awake craniotomy ?

- For intraoperative functional cortical mapping for lesions close to eloquent areas

- For localisation of epileptic foci, during intraoperative electrocorticogram (ECoG)

# What are the indications of awake craniotomy ?

- **Epilepsy Surgery**
- **Excision of lesions adjacent to eloquent areas of the cortex in the dominant hemisphere**
- **Stereotactic surgery**

- Deep brain stimulation (DBS) surgery for Parkinson's disease
- Pallidotomy, Thalamotomy
- Ventriculostomy, Endoscopy, Excision of small lesions

# What are the contraindications of awake craniotomy?

- Inability to cooperate or communicate
  - Small children
  - Decreased level of consciousness
  - Profound confusion
  - Mental Retardation
  - Severe Language Barrier

- **Highly vascular lesion with significant dural involvement**
- **Obstructive Sleep Apnoea**
- **Morbid Obesity**

# What are our anaesthetic aims?

1. **Maintaining patient cooperation:**

   - **Optimal analgesic care**
   - **Adequate sedation and anxiolysis during the different stages**
   - **Comfortable position**
   - **Nausea, vomiting and seizure prevention**

2. **Homeostasis:**

   - **Safe Airway and adequate ventilation**
   - **Hemodynamic stability**
   - **Normal intracranial pressure**

3. **Most important for epilepsy surgery:**

   - **Limited interference with electrophysiological recordings**

# What are the various techniques we can employ for awake craniotomy?

**Numerous techniques have evolved along with surgical indications:**

- **MAC (Monitored Anaesthesia Care)**
- **AAA (Asleep-Awake-Asleep)**

# MONITORED ANAESTHESIA CARE

- **MAC includes careful monitoring and support of vital functions : ASA**
- **Anaesthetist administers sedatives, analgesics, hypnotics**
- **Addresses any clinical problems, and provides the patient with psychological support during diagnostic and therapeutic procedures**
- **ASA recommends that provider of MAC must be prepared and qualified to convert to GA, if necessary**

# AWAKE ASLEEP AWAKE

- AAA anaesthetic approach consists of GA before and after brain mapping
- In the 1950's, Penfield described blind nasotracheal intubation after cortical mapping
- In same year, Hall & Ingvar, used nasotracheal intubation to maintain the tracheal tube during craniotomy for intractable epilepsy

- In 1993, Weiss placed a tracheal tube in one nostril at 22 cm in order to support ventilation during propofol administration with $N_2O$ GA
- In 1998, Huncke *et al* gave great force to the AAA technique for epilepsy surgery by reporting 10 cases, who were intubated awake using a fibreoptic laryngoscope before & after brain mapping

# INTRAOPERATIVE MONITORING

# BRAIN MAPPING

- Originally used for epileptic surgery, is now utilized for tumor resection
- More widely used within the last 2 decades
- Identifies:
  - Regions of language representation *(dominant cerebral hemisphere)*
  - Motor cortex *(either hemisphere)*

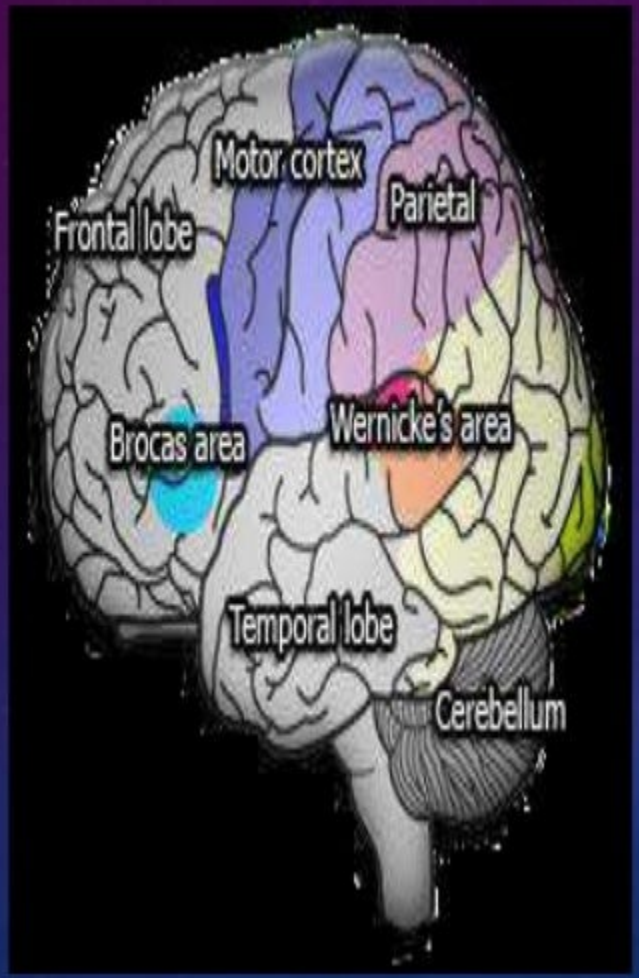
- **Intra-op mapping helps distinguish between eloquent cortex and tumor tissue, which facilitates:**
  - **Accessing the tumor from safest transcortical route**
  - **Aggressive tumor resection while preserving functional tissue**

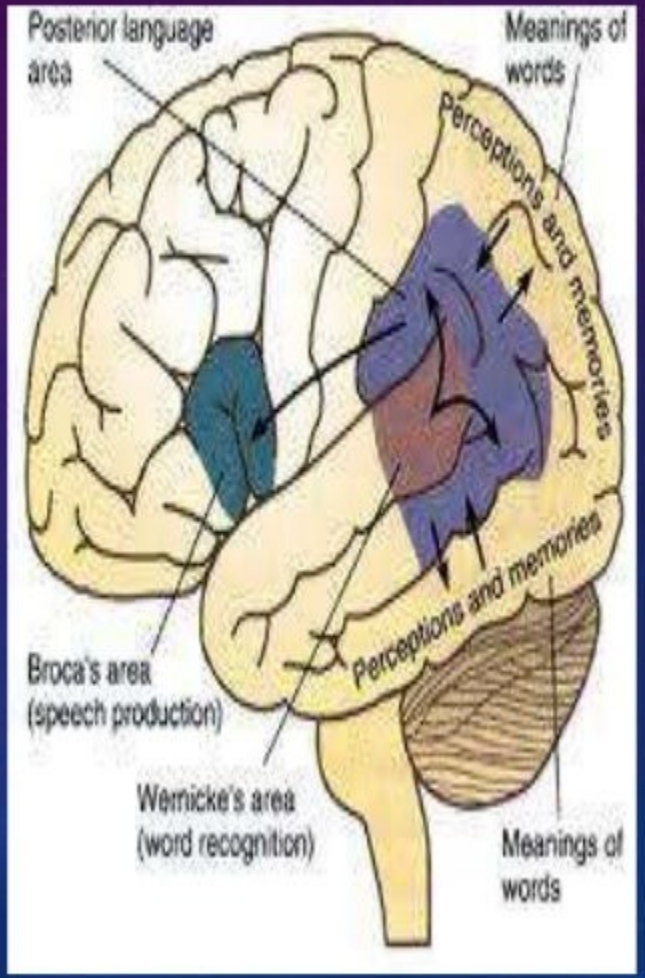
# BRAIN MAPPING : LANGUAGE

- **Indicated if surgical site is near language associated cortical sites or "speech areas"**
  - **Broca's *(expression)*:posterior/inferior/frontal lobe of dominant hemisphere**
  - **Wernicke's *(comprehension)*:posterior/temporal lobe of dominant hemisphere**
- **Direct electrical stimulation of the cortex during language tasks while observing for *speech hesitation, arrest or dysnomia*.**

# BRAIN MAPPING: MOTOR

- **Grid of electrodes placed on brain surface to identify a phase reversal of SSEPs recorded over the *posterior sensory cortex* and *precentral motor gyrus***
- **Direct electrical stimulation of the cortex to elicit motor movement.**


Motor cortex
Parietal
Frontal lobe
Brocas area
Wernicke's area
Temporal lobe
Cerebellum


Posterior language area
Meanings of words
Perceptions and memories
Perceptions and memories
Broca's area (speech production)
Wernicke's area (word recognition)
Meanings of words

# DEPTH OF ANAESTHESIA

- Bispectral Index: Measures anaesthetic depth (correlates with hypnotic component of anaesthesia)
  - 40-60 (asleep phase)
  - >85 (awake phase)
- Entropy: Another method of assessing anaesthetic depth commercially developed by Datex-Ohmeda
  - RE (Response Entropy)
  - SE (State Entropy)

## Ramsay Sedation Assessment Scale

| | | |
|---|---|---|
| **Awake** | Patient anxious or agitated or both | 1 |
| **Levels:** | Patient cooperative, oriented and tranquil | 2 |
| | Patient responds to commands only | 3 |
| **Asleep** | A brisk response to a light glabellar tap | 4 |
| **Levels:** | A sluggish response to a light glabellar tap | 5 |
| | No response | 6 |

# ANAESTHETIC CONSIDERATIONS & MANAGEMENT

# How do we evaluate the patient preoperatively?

- **Patient preparations:**
  - **Obtaining the patient's confidence & agreement to cooperate during surgery is key**
  - **Developing good rapport with pt & family**
  - **Inform pt. of our expectations of them during the awake phase**

# What are the various aspects to consider during pre operative evaluation?

- Upper airways:
  - Prediction of difficult tracheal intubation (physical confirmation and past intubation)
  - Obstructive apnea risk (obesity, sleep apnea, retrognathia)
- Epilepsy:
  - Pharmacotherapy
  - Antiepileptic drug serum concentration
  - Type & frequency of seizures

- Nausea & Vomiting:
  - Past anaesthesia
  - Motion Sickness
- Intracranial pressure estimation:
  - Type of lesion
  - Radiological & clinical signs
- Hemorrhagic risk:
  - Type & localization of lesion
  - Therapy (Antiplatelet drugs)
  - Medical history

- **Patient cooperation:**
  - **Anxiety**
  - **Pain tolerance**
  - **Neurological deficits**

**A visit to the operating room before surgery to familiarize the patient with sounds & equipment in OT**

# Premedications?

- No general consensus regarding premedication
- Decisions should be made based on patient’s clinical condition, anaesthetist's opinion, and hospital standards

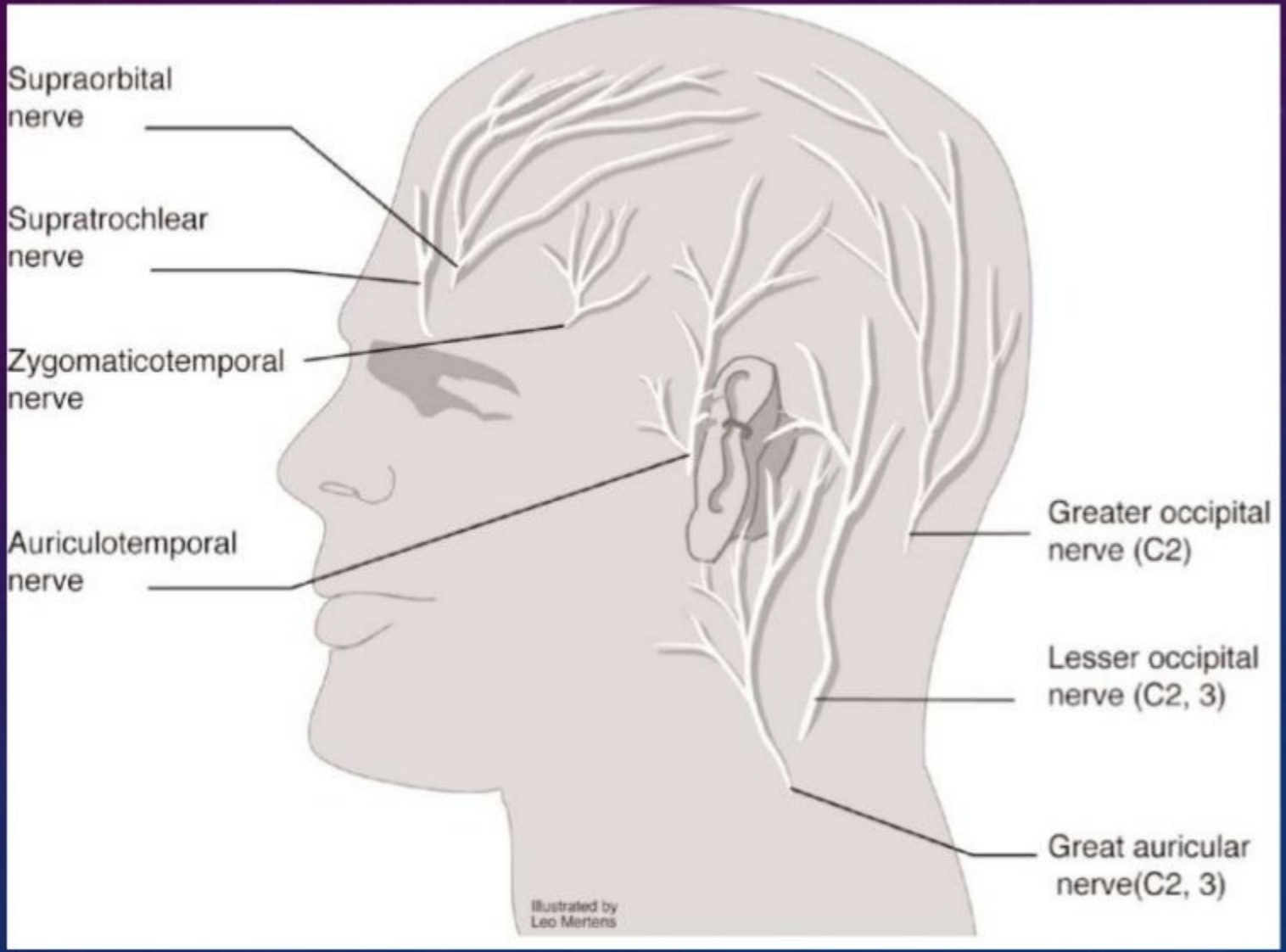
- Benzodiazipines (e.g. midazolam)
- Anticholinergic (e.g. glycopyrrolate, atropine)
- Antiemetics : Metoclopramide, Ondansetron, Droperidol, Dexamethasone
- Antacids : Ranitidine
- Opioids : fentanyl, remifentanil

- NSAID's (e.g diclofenac or acetaminophen)
- α- 2 adrenoceptor agonists (e.g. Clonidine, demedetomidine)
- Antiepileptics as per the treatment protocol of the patient
- Any other medications patient is taking for any other systemic manifestation
- Most important of all : thorough explanation of the procedure

# LOCAL ANAESTHESIA

- Anaesthetic care always includes scalp block
- A 40 to 60 mL of local anaesthetic volume is used for infiltration
- High local anaesthetic volume and well-vascularized areas may predispose to anaesthetic toxicity
- The use of adrenaline (5 µg/mL, 1:2,00,000 dilution) both minimizes acute rises in plasma anaesthetic concentration and maximizes the duration of the block

- Clinical vigilance is particularly indicated within 15 minutes after scalp block.
- With regards to toxicity, ropivacaine and levobupivacaine appear to be safer than bupivacaine
- Despite this difference, bupivacaine is the most commonly used local anaesthetic in the literature


Supraorbital nerve
Supratrochlear nerve
Zygomaticotemporal nerve
Auriculotemporal nerve
Greater occipital nerve (C2)
Lesser occipital nerve (C2, 3)
Great auricular nerve(C2, 3)
Illustrated by Leo Mertens

# NERVES BLOCK

1. Auriculotemporal nerve (mandibular branch of trigeminal nerve): infiltration over zygomatic process and distal temporal artery.
2. Zygomaticotemporal nerve (zygomatic nerve's terminal root that originates from maxillary branch of trigeminal nerve).
3. Supraorbital nerve (root of frontal nerve which originates from ophthalmic branch of trigeminal nerve): infiltration from the nasal root to the midpoint of the eye.

4. Supratrochlear nerve (root of frontal nerve which originates from ophthalmic branch of trigeminal nerve): infiltration together with supraorbital nerve.
5. Greater occipital nerve (posterior ramus of C2): infiltration about 2.5 cm lateral to the nuchal's median line, directly medial to occipital artery.
6. Lesser occipital nerve (anterior branches of C2 and C3): infiltration 2.5 cm lateral to greater occipital nerve one.

# NEED FOR NERVE BLOCK????





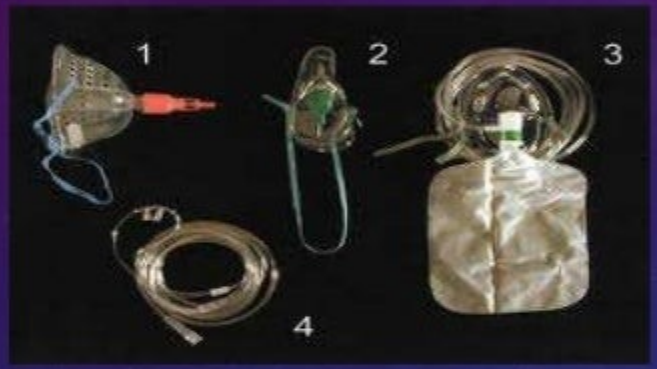
# MAINTANENCE OF ANAESTHESIA

- **Propofol: Widely employed for neurosurgical anesthesia (and awake craniotomy) due to:**
  - **Easily titratable sedative effect**
  - **Rapid recovery with clear-headedness**
  - **Decreased CMRO2**
  - **Reduced ICP**
  - **Potent anti-convulsant properties**
  - **Antiemetic properties**

- **Remifentanil: Ultra short-acting opioid, is becoming more popular:**
  - **Rapid onset of action**
  - **Remifentanil has an ester linkage which undergoes rapid hydrolysis by non-specific tissue and plasma esterases. This means that accumulation does not occur with remifentanil and its context-sensitive half life remains at 4 mins after a 4 hr infusion**
  - **Rapid awakening for neurologic testing**
  - **Smoother hemodynamic profile**

- **Dexmedetomidine: Alpha-2 adrenoceptor agent**
  - **Sedative, anxiolytic & analgesic properties**
  - **Imidazole derivative, greater specificity for the α-2 adrenoceptor**
  - **Distribution half life of 6minutes, with complete biotransformation by the liver & very little unchanged excreted in urine & faeces**

# AIRWAY DEVICES







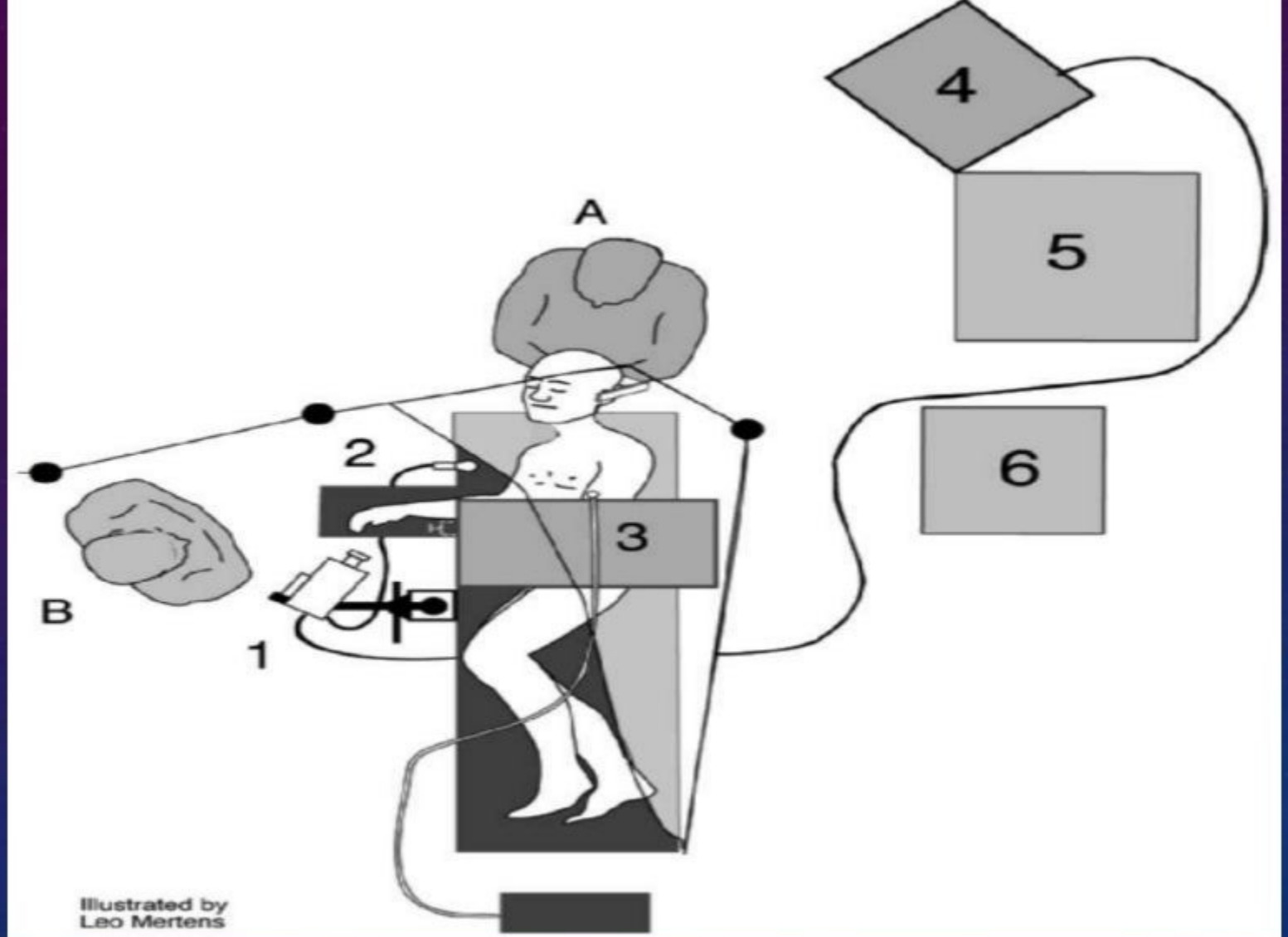





# RECENT AIRWAY DEVICES






4
5
A
6
2
3
B
1
Illustrated by
Leo Mertens

# What are the complications?

# INTRAOPERATIVE COMPLICATIONS : ANAESTHESIA RELATED

- Airway obstruction
- Desaturation/hypoxia
- Brain swelling
- Hypertension/hypotension
- Tachycardia/bradycardia
- Nausea/vomiting
- Shivering
- Local anaesthetic toxicity
- Pain
- Poor cooperation/agitation

# SURGICAL RELATED

- Focal seizures
- Generalized seizures
- Aphasia
- Bleeding
- Brain swelling
- Venous air embolism
- Conversion to general anaesthesia

# CONCLUSION

Awake craniotomy for tumor resection involving functional areas is a surgical approach that offers great advantages with respect to patient outcomes.

This is a complex technique that requires great patient and equipment engagement.

Personal experience, careful planning, and attention are the basis for obtaining good results.



# THANK YOU