ANAESTHESIA FOR TRAUMA CRANIOTOMY

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The first known surgery was probably trephining, or drilling the skull. This may have been a cure for headache. The remains of skulls where the hole has healed suggest that some patients even survived the operation!
HISTORY OF TRAUMA CRANIOTOMY

- Annandale - 1894

- Cushing & Kocher - subtemporal/suboccipital 1901-05 to treat elevated ICP

- Rowbotham - 1942 - all trauma where medical therapy ineffective

- Guerra 1999 - 2nd tier therapy in refractory ICP
When a mass expands within the skull compensatory mechanisms initially maintain a normal intracranial pressure. Eventually further small increments in volume produce larger and larger increments in intracranial pressure.
Trauma Craniotomy - DC or not?

- **CRANIOTOMY** – Bone flap returned to original location at surgery- EDH/SDH

- **CRANIECTOMY** – Bone flap not returned- contused/ischemic

- Decompressive hemicraniectomy & durotomy - technique to relieve ICP and large intracranial shifts that occur secondary to mass lesions

- Techniques involves removal of bone and incision of dura to relieve pressure allowing swollen brain to herniate upwards rather than downwards to compress the brainstem

- **IS THAT A GOOD THING???- IS GLASS HALF FULL OR HALF EMPTY**
8 cm craniectomy – 23ml
12 cm craniectomy– 86 mls
superior to ventricular tap – 20 ml
INDICATIONS FOR TRAUMA CRANIOTOMY

Indications

- Severe TBI
  - Heterogeneous lesions in cerebral parenchyma
  - Focal (contusions/hematoma) and diffuse
- Malignant MCA infarction
- Aneurysmal SAH
- Others
  - Central venous thrombosis
  - Encephalitis
  - Metabolic encephalopathies
  - Intracerebral hematoma

guidelines for trauma craniotomy

- **BTF**: specific recommendations based on indications—EDH/SDH/CONTUSIONS consider using DC in severe TBI as first line (bullock 2006)

- **EBIC**: consider for all ages in refractory IC hypertension (Maas 1999)

- **Cochrane review**: ok in children with medical refractory ICP but no evidence to support routine use in adults (Sahuquillo & Arikan 2006)

- **BUT** not many treatment options- BARBITURATE COMA/HYPOTHERMIA for refractory ICP
TYPES OF TRAUMA
CRANIOTOMY

• BIFRONTAL DECOMPRESSIVE - Diffuse post traumatic cerebral edema

• SUBTEMPORAL/FRONTO TEMPORAL PARIETAL- LESIONS Unilateral /Impending Transtenorial herniation
Role of decompressive craniotomy in TBI remains a matter of debate

- DECRA TRIAL - AUSTRALIAN
- RESCUE ICP - UK/EUROPE
- CONTROVERSIES IN TBI MANAGEMENT
- BEST-TRIP- ICP; EUROTERM 3235- HYPOTHERMIA
- ALL RCT’S looking at specific questions at specific time points!!!
- TBI is a continuum – Individualised Therapy
CAN YOU MAKE A DIFFERENCE?

- 2.5 MILLION PEOPLE HAVE TBI
- 1.1 MILLION IN HOSPITAL
- SILENT EPIDEMIC - 75000 DIE
- CENTER TBI - INTBIR
- High ICP are a bad thing, PERIOD.
- ROSE J; BMJ 1977 – Avoidable Factors causing Death after neuro compromise

26% of patients had airway obstruction
22% had SBP < 90 mmHg
SO WHAT ANAESTHESIA DO I PROVIDE?

ANYTHING THAT KEEPS THE BRAIN HAPPY

1. Oxygenation
2. Good CO2 Control
3. Decrease CMR
4. Good CPP/MAP
5. Avoid Hyperthermia/Hyperglycemia/
6. Feed Early/electrolytes
7. Blah..Blah…Blah…
KEY POINTS THAT I FOLLOW

• TRANSFER

1. Patient may be Polytrauma from A&E or ward or from another DGH

2. Going through TRANSFER CHECKLIST ESSENTIAL- MECHANISM OF TRAUMA/GRADE OF INTUBATION ETC ETC...

3. TEAM BRIEF- Imaging /Post op Ccare/ Position /Spine Clearance/ Injuries
SEVERE TRAUMATIC BRAIN INJURY TRANSFER CHECKLIST

Please complete for any INTEBUTED patient with a severe head injury before transferring to Royal Hallamshire Hospital Neurosurgical Unit, Sheffield.

Doctor to complete before transfer and handover on arrival

A. AIRWAY
- Secured with ETT
- C-spine immobilisation
- Log rolling

B. BREATHING
- SpO2 monitoring
- Adequate oxygenation (PaO2 > 13 kPa)
- End-tidal CO2 monitoring
- Optimal ventilation (PaCO2 4.5 - 5.5 kPa)
- Chest drain inserted (only if indicated)

C. CIRCULATION
- HR < 100 / min
- Mean arterial BP > 80 mmHg
- Arterial line monitoring
- Central line (only if indicated)
- Bladder catheterisation

D. DISABILITY
- Adequate sedation
- Neuromuscular blockade
- Pupillary response checked
- Seizure control (only if indicated)
- Mannitol given (only if indicated)

E. EXPOSURE
- Temperature checked?
- Blood glucose checked?

Date: .... / .... / ........ Your grade: ..............

Destination: Theatre (A floor via PACU) □ K floor (NITU) □

Contacts:
Royal Hallamshire Hospital: 0114 2711900
Neuroanaesthetic req: bleep 2577
Neurosurgical req: bleep 2883
Neurocritical care co-ord: bleep 2018 / ext. 12437

RHH via short code: BDGH #6170
CRH #61039
DRI #6335
RDGH #82000
NGH 77340

Indications for intubation in head injury:
- GCS <8
- In GCS by 2 points or more
- Hypoxia / hypercarbia
- Seizures / combative / agitation
- Cerebral bleeding into mouth
- Loss of protective bronchial reflexes
- Spontaneous hyperventilation causing PaCO2 <4.0

Triple’ C-spine immobilise/log roll all major trauma patients
- Check ETT position and tube tied

Insert arterial line and take ABG (this can be undertaken after imaging)
- Check PaCO2 before departure and adjust ventilation accordingly
- Manage chest injuries that may cause deterioration en-route, e.g.: tension pneumothorax / massive haemothorax / cardiac tamponade

Ensure good venous access
- If evidence of hypovolaemia consider further intervention prior to transfer

Aim for consistent MAP > 80 mmHg (>90 if evidence of raised ICP)
- Peripheral vasodilators (e.g. labetalol) or if MAP < 80 mmHg
- Central line insertion if patient requiring intravascular fluids or poor venous access
- Femoral access is OK
- Ensure blood tests are sent (FBC, U&E, clotting, Group & save, ABG)

Correct coagulopathy
- Consider BeneFix to reverse warfarin (discuss with haematologist)

Sedation must be sufficient to confer neuro-protection
- Propofol and alfentanil infusions; vasodilators may be required, see above
- Full neuromuscular blockade is required throughout transfer
- Control seizures (Lorazepam 4mg +/- IV Phenytoin 15mg / kg loading dose)
- If raised ICP, consider bolus dose of 2.5ml / kg of 20% mannitol
- Hyperventilation (PaCO2 < 4.5 kPa) only in the setting of a time critical transfer

Resuscitation is the priority over transfer
- Secondary survey should ideally be performed without delaying transfer
- Imaging should include CT head/neck +/- trauma series way (or CT from head to pelvis)
- Aim for temperature between 35°C and 37°C, avoid hypothermia
- Aim for blood glucose between 4 and 11 mmol/l, avoid hypoglycaemia
AIRWAY & BREATHING
POSITIONING & PRESSURE POINTS

1. If in non supine postion consider **FLEXOMETAL LIC TUBE-KINKING-HYPOXIA** but remember to change to ‘High volume Low Pressure’ tube for ICU-PAO₂>11 KpA, SaO₂>97% PEEP UPTO 10 CMS OK

2. Unless lungs are shot -**USE VOLUME CONTROL**- PACO₂ 4.5-5.0 KpA
   NO PLACE FOR HYPERVENTILATION unless impending herniation and surgery

3. Use **ANCHORFAST TM /TAPES- NEVER TIES** FOR ET tubes

4. Keep a **DISTANCE OF ATLEAST 2 FINGER BREADTH** Between Chin/Chest to prevent
   Hyperextension/Hyperflexion/Lateral Rotation

   SAFE ROTATION 0-45 DEGREES if Spine Clear
AIRWAY & BREATHING
POSITIONING & PRESSURE POINTS

- EYES- TAPED/PADDED- CORNEAL ABRASION- Look at Pupils before

- JOINTS- NEUTRAL/SLIGHT FLEXION- Never Extended
  Lots of Padding/Pillows under Knee / Abdomen free if Prone- decrease PEEP

- Don’t forget HEAD END UP/ Thromboembolic Prophylaxis

- Beware of Pressure Points / Axillary roll if Lateral

- TRAUMA POSITION- IF Spine not clear –Discuss with surgeon - LATERAL POSITION WITH MAYFIELD CLAMP
WHAT ABOUT HYPNOTIC/RELAXANTS/ANALGESICS?

- Patient may already be on Propofol/Opioid TIVA - CONTINUE WITH BIS MONITORING - around 40
- Paralyse with NDMB’s - Rocuronium - NM TOF MONITORING
- IF Patient needs Intubating - PREFER ROCURONIUM TO SUX - UNSTARVED
- I Prefer TIVA - LESS CEREBRAL UNCOUPLING - GOOD WAKE UP PROFILE
- Make sure surgeon tells you about Clamping - BOLUS OF HYPNOTIC/OPIOID
- IF USING VOLATILES - TITRATE MAC<1 WITH OPIOIDS
- Don’t forget Analgesics/ antiemetics if planning to Wakeup Patient
SO WHICH AGENTS ARE BEST???
ANAESTHESIA 2009
PATEL PM & DRUMMOND FC

1. Propofol and thiopentone (& etomidate) maintain coupling of CMR and CBF

2. Ketamine only iv agent to cause uncoupling- increases CMR

3. All volatile agents apart from xenon cause uncoupling- increase CBF

4. Sevoflurane/ Isoflurane cause least uncoupling
WHAT ABOUT FLUIDS/BP

• MONITORING

1. IA BP- MAP/ABG/GLUCOSE

2. DEBATE ABOUT CENTRAL LINE- Prone/ bifrontal craniectomy/ Prior Hemodynamic Instability

3. ICP MONITORING- GCS<9; POSTURING; SBP, 90mmHg;

   CT SCAN - discuss KEEP ICP<20

• BP/CPP/MAP TARGETS- EBIC/AAGBI/BTF

• Avoid SBP<90 mmHg’ MAP>80; CPP>60 MMHG

• FLUIDS - warm, non glucose isotonic / isomolar fluids- NS/PLASMA

• role of colloids controversial

• VASOPRESSORS- Noradrenaline / Peripheral Metaraminol (50 MGS IN 250 MLS @ RATE 0-30 MLS/HOUR) but make sure patient is euvolemic
what do you do if ICP high and not surgically decompressed?
(or extra cranial surgery with ICP monitoring)

• **RULE 1**- Always assume ICP at least 20 if no ICP monitor in situ

• **Recheck basics**- po2,pco2, MAP- volume/vasopressors, free venous drainage ; adequate anaesthesia-BIS around 40, may need paralysis with TOF monitoring<2

• **Option 1: Hyperosmolar therapy**

  1. 20% mannitol 3 ml/kg- 200 ml for 70 kg- give & dispose; ensure serum osmolarity <320 mmol/l; beware hypovolemia

  2. 2.79% hypertonic saline if mannitol ineffective ;check Na<155;
     3ml/kg- 200 mls of 2.79% saline for 70 kg individual

• **Option 2: rule out seizure activity  (depressed fracture/contusion)**-
Phenytoin 15mg/kg bolus over 1 hour or levetiracetam 20 mg/kg- surgical guidance
So what do you do if ICP high and not surgically decompressed? (or extra cranial surgery with ICP monitoring)

- **Option 3: Temperature control**
  Prevent hyperthermia as increased CMR 7% by 1 Celsius

  Active cooling- hot controversy- EUROTHERM 3235

- **Option 4: Burst suppression:**

  EEG activity- SR on BIS >60% - never aim for 100% isoelectric EEG

  achieved by the administration of 200 mg Propofol or 125 mg thiopentone boluses- BIS around 0 and SR>60

- **Option 5: Hyperventilation:** SHORT TERM measure only to prevent herniation prior to imminent surgery- PaCO2- 4 KpA
RECHECK BASICS SLIDE

Inform Consultant Neuroanaesthetist of all admissions with severe head injury to NITU.

Deviation from guidelines are at discretion of NITU Consultant.

All escalations of therapy for discussion with NITU Consultant.

| Sedation       | Propofol 3--5mg/kg/hr
|                | Alfentanil 0.1--1.5mcg/kg/min
|                | +/- Midazolam 1--2mg bolus. Infusion if high sedation requirement: 0.1 mg/kg/hr
|                | Avoid coughing/fighting ventilator. Consider neuromuscular blockade. |

**Ventilation**

- **SIMV**: TV 6--10 ml/kg IBW Pmax < 25 PEEP +5-10
- SpO₂ ≥ 96%  PaO₂ ≥ 11kPa
- PaCO₂ @ 4.5 - 5 kPa  FiO₂ - 0.4  (PaCO₂ ≠ ETCO₂)
- Temporising hyperventilation to PCO₂ < 4.0 only if surgery imminent.

**CVS**

- Transduce CVP, CPP ≥ 60 (Transducer at level of tragus)
- Repeat fluid challenges (Aim MAP > 90 if no ICP monitoring)
- Aim for neutral fluid balance / 24hr with isotonic crystalloid maintenance. Loop diuretic if balance ++

**GI**

- Enteral nutrition.
- Prokinetics if necessary (see guidelines)
- Stress ulceration prophylaxis (see guidelines)

**Homeostasis**

- Core temp ≤ 37°C. Blanketrol applied from admission.
- Blood Glucose 7–11 mmol (see guidelines)
- Replacement Magnesium, Phosphate (see individual guidelines). Transfuse if Hb < 80 g/l

**Position**

- C-Spine immobilisation/log roll until cleared, CT as soon as possible.
- 30° Head up tilt. Avoid venous obstruction. Head in neutral position.
- Complete cervical spine clearance tab on Metavision.

**CNS**

- Levetiracetam 20mg/kg if indicated. (Depressed fracture/convulsions)
- Obtund stress response to procedures: Lidocaine 1% bolus 1mg/kg or Alfentanil bolus.

**ALWAYS**

- Consider a surgically amenable cause.
- Repeat CT? Expanding haematoma?
- Evolving Contusion?
- CSF drainage? Surgical decompression?
Other issues to consider

- **Glycemic control**: target BM between 4-11 mmol/l; do not aim for intensive insulin/sugar control

- **Steroids**: no role - bad - MRC CRASH trial

- **Transfusion targets**: conflicting evidence - anaemia and RBC transfusion both bad..
  >10gm/dl liberal target not recommended now

- **Coagulopathy**: TBI activates TF - DIC - CRASH 2 - tranexamic acid benefit in trauma;

- CRASH 3 underway

- **High Na on ABG + lots of wee**: ?DI - check serum/urine osmol maintain euvolemia; DDAVP 0.25-0.5 mcg IM
Operation SUCCESS- NOW WHAT??

- **WAKE UP** - AWAKE PATIENT-Best indicator of neurology status

- **ICU** - ET Tube/NG tube/Adequate targets for monitoring ICP/EVD/ Central line etc..

- **DEBRIEF** for adequate handover

- **ANY DOUBTS** - LIASE WITH NEUROANAESTHESIA ONCALL