Patient Positioning in Neurosurgery and Principles of Making a Craniotomy

Presenter: Dr. Shashank Ramdurg
Introduction

• Patient positioning critical and vital
• Control of bleeding and ventilation
• Sir Victor Horsley in 1906 used ‘fork rest of professor Frazier’
• Head rest- an extension attached to the operating table
• Horsley and Krause also proposed the use of lateral position for posterior fossa surgeries
• Schede in 1905 used sitting position with patient leaning far forward
• de Martel in 1913 used sitting position and took credit for its routine use in posterior fossa surgeries
• He introduced a special chair and head fixation holder
• Theoretical advantage of lowering ICP and venous bleeding with risk of syncope and the inability to disarrange the draping from this position

- Bailey
The correct position
• In early years - trial and error
• Today though standardized, not absolute
• Factors associated:
  1. Age
  2. Site and nature of lesion
  3. Head position in relation to heart
  4. Position of anesthesiologist/ nurse
  5. Microscope and other imaging equipment
• Pediatric patients present a different set of considerations
• Some operations have more than one acceptable position
Supine
Indications

- Most of the cranial procedures
- Anterior cervical spine
- Anterior approaches to the lumbar spine
- Carotid endarterctomies
- Head: 0-45 degrees
- Neck rotation > 45 degrees - raise shoulder
- Head beyond table
- Upper extremities - adducted
- Head elevation: reverse Trendelenburg, flex table
- Head rest: horse shoe, cupped, three or four pronged head fixation
- Knees flexed - sciatic nerve injury
- Compressive stocking - sequential compression
Positioning

• Extreme turning of head causes:
  - vertebral compression - brainstem ischemia
  - jugular compression - raised ICP, brain swelling an bleeding

• Pressure on the ulnar nerve least in supine position

• Avoid prolonged pressures, stretching
• Pin sites not on sinus regions, with at least one dependant
Lateral position
Indications

- Temporal craniotomies
- Skull base procedures
- Posterior fossa explorations
- Lateral approaches to the cervical spine
- Trans thoracic and retroperitoneal approaches to the thoracic and lumbar spine
- Extremely obese or kyphotic patients
- Unilateral herniated discs- offending side up
- Lumboperitoneal, syringoperitoneal shunts
Patients' trunk support: tapes, brace, straps

- Pillow positioned between legs
- Hand in hanging or ventral position

Three point fixation

- Shoulder/elbow abducted and flexed respectively, resting on a pillow or padded board

Dependant extremity
- Axillary artery
- Brachial plexus injury

Dependant leg flexed: avoid pressure
- Fibular head and peroneal nerve

Operating table flexed, kidney rest

Horse shoe rest: axillary role
Positioning

• Dependant portion outstretched in front of patient
• Upper arm on a pillow or air-plane arm rest, or along the upper torso with shoulder taped- park bench position
• This position advocated by Dr. Cone

Prone position
Indications

• Posterior fossa surgeries
• Sub-occipital regions
• Posterior approaches to the spine
Technique

- Femoral, distal pulses checked
- Genitalia should lie free
- Extremes of head rotation and neck extension to be avoided
- In cases cord compromise- patient may be placed in halo frame before turning him
Kneeling position

- Advantage:
  IVC pressure lowest in kneeling position

- Disadvantages:
  More time to position
  Mechanical injuries
  Difficulty in changing curvature
  Hypotension

- Rarely: DVT
  Pulmonary embolism
  Renal failure
  Post operative pain
Concorde position

Variant of prone position

Occipital trans-tentorial, supra cerebellar infra-tentorial approach

Less venous embolism

Fatigue

Complications as in prone

Head higher than heart

Three point fixation

Head flexed with extension of thoraco-lumbar region
Sitting position
Indications

- Posterior fossa
- Cervical cord
- Sub temporal approaches
Monitoring: Doppler, TEE, CVP, fraction excretion of nitrogen capnography, continuous capnography, per-cutaneous oxygen measurement

Somato sensory monitoring
Advantages and Disadvantages

• Advantages: Midline lesions
  Low ICP
  Improved venous drainage
  Drainage of blood and CSF
  Unobstructed view of patients face
  Less cerebellar retraction

• Complications: air embolism, hypotension, postoperative tension pneumocephalus, sub dural hematoma, quadriplegia and discomfort in upper extremities
Other complications

• Both brain and spinal cord at increased risk of cerebral ischemia in the presence of mass lesions —Ernst PS et al intracranial and spinal cord hemodynamics in the sitting position in dogs in the presence and absence of ICP: Anesthesia analgesia: 1990

• Precautions: echocardiography, CVP, slow positioning, antigravity suit inflated with air

• Other rare complications: supra tentorial hematoma, cerebellar hemorrhages, peripheral nerve palsies, traumatic elbow dislocations
Three quarter prone
Indications

• AKA semi prone/ lateral oblique
• Parieto occipital regions
• Posterior fossa/ CP angle
• Pineal and vermian region
• Advantage: comfortable for the surgeon with less risk for embolism, Less retraction
Brachial plexus

- Supine in semi sitting/semi Fowler’s position
- Head turned to opposite side
- Ipsilateral arm - patients side, abducted 50 deg, arm rest
- Place roll beneath medial aspect of scapula
Trans- sphenoidal procedures

- Supine- horse shoe rest, c-arm fluoroscopy, head tilt of 15-20 degrees
- 10 degree head elevation with indwelling LP drain

## Complications

<table>
<thead>
<tr>
<th>Position</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supine</td>
<td>excessive head rotation, pressure sores, alopecia</td>
</tr>
<tr>
<td>Prone</td>
<td>pressure sores, vascular compromise, brachial plexus injuries, stretch injuries, blindness, embolism, anesthetic problems</td>
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<tr>
<td>Concorde</td>
<td>same</td>
</tr>
<tr>
<td>Three quarter prone</td>
<td>same</td>
</tr>
<tr>
<td>Lateral</td>
<td>brachial plexus injuries, stretch injuries, pressure palsies</td>
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<tr>
<td>Awake</td>
<td>aspiration, asphyxiation, pressure palsies</td>
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## Sitting vs Prone Position

<table>
<thead>
<tr>
<th><strong>Sitting</strong></th>
<th><strong>Prone</strong></th>
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</thead>
<tbody>
<tr>
<td>Advantages:</td>
<td>Easy to position</td>
</tr>
<tr>
<td>Low ICP</td>
<td>Good access to lesion</td>
</tr>
<tr>
<td>Improved venous drainage</td>
<td>Comfortable</td>
</tr>
<tr>
<td>Drainage of blood and CSF</td>
<td>Less complications</td>
</tr>
<tr>
<td>Unobstructed view of patients</td>
<td></td>
</tr>
<tr>
<td>Less cerebellar retraction</td>
<td></td>
</tr>
<tr>
<td>Complications: air embolism (30-60%)</td>
<td>pressure sores, vascular compromise, brachial plexus injuries, stretch injuries, blindness, embolism (&lt;5%), anesthetic problems</td>
</tr>
<tr>
<td>hypotension, postoperative tension</td>
<td></td>
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<tr>
<td>pneumocephalus, sub dural hematoma, quadriplegia and discomfort in upper extremities</td>
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Craniotomy principles
Skin flaps- historical perspective
Skin flaps

- Neolithic period in 2000 B.C
- Trepanations made followed by scrapings of the skull till holes
- 19th century- trephines
- 1889 Wagner first osteoplastic bone flap
- Gigli saw for craniotomy- Obalinski in 1897
- Electric and gas powered high speed drills
Anatomic and neurovascular considerations

- 5 layers of scalp:
  - Skin
  - Subcutaneous tissue
  - Galea
  - Loose areolar tissue
  - Periosteum
Land marks

• Nasion
• Bregma
• Lambda
• Inion
• Pterion:
  Middle meningeal artery
• Asterion:
  Transverse sigmoid junction
Nerves

• Fronto- temporal branch:
  anterior branch
  middle branch
  posterior branch

• Middle division: 1 cm anterior to superficial temporal artery, subgaleal pad of fat
  *dissect between superficial and deep layers of superficial temporalis fascia*
Blood supply

- Superficial temporal artery
- Occipital artery
- Posterior auricular artery
- Supra orbital and trochlear vessels
Planning

• Position of lesion
• Position of important structures
• Contingency plan for enlarging incision
• Obtain adequate closure
Principles

• General principals:
  1. surgical exposure of the lesion
  2. neuro vascular supply
  3. cosmetic effect

• Types: Random pattern
  Based on named vessel

• Length not > 1.5 times base
• Integrity of major vascular flap to be maintained
• Incision in hair containing region
• No crossed incisions
Principles

- Skin incised with galea
- Pressure over the scalp
- Periosteum raised with scalp or separately
- Raney’s clips, bipolar, Dandy’s clamps
- Adequate retraction
- Inner surface protected with moistened gauze
- Roller gauze
- Dissect in interfascial fat which is encountered in 4 cm of orbital rim
Bicoronal/ Souttar flaps
Bicoronal/ Souttar flaps

- Large exposures of anterior cranial fossa and sella
- Fronto temporal lesions and cranial base
- Superior to zygomatic arch, 1 cm anterior to tragus- extends over the bregma to the corresponding site on the opposite side
- Reflect up to orbit rim
- Supraorbital/ trochlear vessels
Frontal flap

- Exposes anterior frontal lobe
- Begins along coronal suture and curves anteriorly along the midline preferably ending at hair line
Temporal flap

- Anterior temporal lobe and sub temporal access
- Based on zygoma
- Goes behind the ear
- Extends anteriorly just behind the superior temporal line to the hair line
Fronto-temporal flap

- Used for most pterional craniotomies
- Combines frontal and temporal skin flaps
- Extends from zygoma to 1-2 cm off the frontal midline following a curve behind the natural hair line
- Temporalesis muscle either dissected or reflected as a separate layer
- In the later instance a cuff is left superiorly so as to suture it
Question mark skin flap

- Cranial trauma
- Exposure to whole hemisphere
- Based on zygoma
- Blood supply from superior temporal and supra orbital vessels
- Curves around 3.5 cm posterior to external auditory meatus
- Anterior limb extends to hair line
Horse shoe skin flap

- Expose any portion of cerebral convexity
- Inverted “U” shaped with base directed towards vascular supply
- Subtemporal exposure: anterior limb 1 cm anterior to the tragus
- For anterior transcallosal approaches: over coronal suture
Mitre skin flap

- Mitre hats worn by bishops
- Occipital lobe, posterior falx and superior tentorial surface
- Inion to vertex: vertical limb
- Upper limb then falls over posterior parietal region towards the ear
- Blood supply from the occipital artery
Linear and curvilinear incisions

- Limited exposures
- Simplicity
- E.g.: MLSOC
  - RMSOC
  - Hockey stick incisions
    - Linear incisions for temporal lobe and sub temporal access
Principles of craniotomy

- Preoperative review of patient
- Preparation of scalp
- Positioning of patient on the table
- Scalp toilet
- Marking of the incision
- Draping
Types of craniotomies

• Flap craniotomy
• Trephine craniotomy

• Flap craniotomy: Osteoplastic
  Free bone flap
Bone flaps

- Most direct access to target
- For cerebral convexity directly centered over the lesion
- Skull base lesions should be at the cranial base
- Number of burr holes varies
- Separation of underlying dura
- Beveling effect
• If dura is lacerated during cutting, saw should be turned off and removed backwards via entrance hole
• Air cells opened: remove the mucosa pack with betadine soaked spongstan pack with bone wax cover it up with vascularized tissue
- Proposed bony cuts over the sinuses should be done last-
  vascularity
  adherence
- Cut sinus can be sewn/ tamponade
- Bony bleeds stopped with bone wax
- Penfield’s retractors to separate dura
- Epidural tacking sutures to control epidural bleeding
  before opening dura
- Others don’t in order to protect cortical blood vessels with
  an intervening brain spoon
- Tailor to avoid dural venous channels
Opening of Dura mater

- Manually palpate the dura
- Dura opened as straight, curved or flap like incisions
- Flaps based towards sinuses
- Opened with sharp hook and knife
- Incision further opened with dural scissors
- Placement of cottonoid along the intended incision
- Suitable cuff of dura around the bone for suturing later
Closure

- Closure in layers
- Check for BP- valsalva maneuver
- Hitch suture
- Water tight but not tension
- Bone flap replacement
- Skin closed in two layers
Frontal/ Bifrontal bone flaps

• Skin incisions: frontal, hockey stick, three quarters souttar
• Suitable for frontal lobe, sub-frontal approaches to anterior skull base, and trans cortical access to ventricles
• Burr holes: key point, anterior midline just above skull base, multiple holes placed close together at midline
• Avoid entering orbit
• If orbit breached: bipolar cautery and close with bone wax
• Last burr hole place posterior to key burr hole
• An extended frontal or bi-frontal craniotomies for exposure of sella, anterior cranial base
• Supine with head extended for these
• Holes placed on either sides of sagittal sinus and intervening bone is removed with rongeurs or drill
• Either removed as single piece or conversion of frontal flap to bi-frontal flap
• Combining a frontal flap with pterional flap
• Goals of surgery dictate the craniotomy
• Bilateral orbital craniotomies may be added to minimize frontal lobe retraction
• Dural openings for a unilateral frontal craniotomy usually consist of flap reflected towards sagittal sinus
• For bi-frontal access transverse incision will suffice
• Superior sagittal sinus will have to be ligated on both sides
Fronto- temporal (pterional) bone flap

- Popularized by Yasargil
- Most useful for aneurysms of anterior circulation, basilar top, also tumors of retro orbital, parasellar and subfrontal areas
- Usually performed through right side
- Supine position with head end elevated to 30 degrees and rotated by the same to opposite side
- Skin incision through standard fronto temporal skin incisions
• Temporalis muscle dissected or reflected
• Bone flap centered over the pterion
• Key burr hole, frontal burrhole, posterio burr hole, last burr hole just above the zygoma
• Further bone may be removed from the inferior temporal squama
• To improve vision, drill the sphenoid ridge
• Dural flap based on the orbit
• Addition of orbito-zygomatic craniotomy will allow for a more lower and anterior approach
• Suited for para-sellar, inter peduncular lesions
• Pterional+ anterior temporal craniotomy= upper basilar aneurysm
“during all operations upon the brain, care must be exercised to avoid undue pressure on the thorax and abdomen which might interfere with respirations. Top of the table must be arranged to allow change of position”

“operating room should be warm”

“while operating on the cerebrum shoulders and thorax too be elevated to little less than 45 degrees. On operating on the side or posterior aspect of the head it is best to posture the patient on his side and allow his head to extend beyond the edge of the table. In all instances the assistant holds the head firmly with the fingers opposed to the jaws and cheeks.”

Surgery of the brain and spinal cord on personal experiences
- In his report to chief surgeon:
  
  "ordinary pillows and sand bags are desirable. In order to get proper elevation of the head so that it can stand free of the surrounding, one or two sandbags, measuring 8*8*3 inches covered with rubber sheet, will be found convenient. A secure arrangement to prevent there slipping in the course of prolonged operation is essential"

- He also used a horseshoe head rest to allow for access to patients head and neck in the prone position
Awake craniotomies
CP angle tumors

- Supine
- Lateral
- Three quarters prone
- Prone
- Sitting
Indications and Technique

- Mapping speech, motor sensory cortex
- Intractable epilepsy
- Tumors in eloquent areas
- Stereo-tactic biopsies, DBS, chronic SDH, thermo-coagulation of brain lesions
Technique

• Simple head rest or pin fixation may be used
• Maintenance of airway paramount importance
• Possibility of venous air embolism
• Monitoring of ETCO2 by nasal catheter
• Appropriate padding
• Catheterization
Nerves

- Occipital branch of posterior auricular nerve- superior nuchal line- no deficits
- Supra orbital nerve- notch
- In 8-53% of patients foramen- open it up
- Supra trochlear nerve
- Temporal scalp supplied by auricular temporal branch of mandibular nerve
- Greater occipital nerve supplies upto vertex
Thank you