CSF EXAMINATION: TECHNIQUES AND INTERPRETATION
HISTORICAL BACKGROUND

- 1885 – CORNING – spinal subarachnoid injections of cocaine
- 1891 – QUINCKE – diagnostic LP
- 1903 – FROIN – csf coagulation phenomena
- 1916 – QUICKENSTEADT – manometric findings of spinal subarachnoid block
- 1918 – DANDY – ventricular puncture
- 1920 – AYER – cisternal puncture
INDICATIONS FOR CSF ANALYSIS

- Bacterial, viral, fungal CNS infections
- SAH
- Demyelinating / degenerative disorders
- Primary and metastatic tumors of CNS and meningitis carcinomatosa
- Pressure recordings – pseudotumor cerebri, NPH, head injury
- Suspected cerebral abscess, hemorrhagic infarctions
- Access for neuroradiologic procedures – ventriculography, cisternography, myelography
- Intrathecal administration of drugs
TECHNIQUES OF CSF EXAMINATION

- LUMBAR PUNCTURE
- CISTERNAL PUNCTURE
- LATERAL CERVICAL PUNCTURE
- VENTRICULAR PUNCTURE
- EXTERNAL VENTRICULAR DRAINAGE
- SUBCUTANEOUS CSF RESERVOIR INSTALLATION
LUMBAR PUNCTURE

BACKGROUND AND ANATOMY

- Spinal cord and spinal column are of same length up to 3 months of age
- Cord ends at L1-2 in 51-68%, T12-L1 in 30%, L2-3 in 10% of adults
- Thecal sac ends at S2
- Intercristal line corresponds to L3-4 interspace
LUMBAR PUNCTURE

POSITIONING

- KNEE CHEST
- SITTING
LUMBAR PUNCTURE

SITE

- L3-4 - ADULTS
- L4-5 - CHILDREN
- L5-S1 - INFANTS
LUMBAR PUNCTURE

LP NEEDLE

• TYPE - QUINCKE’S ATRAUMATIC NEEDLE

• SIZE -
  18-20 Gauge - manometry
  22 Gauge - diagnostic tap
  14 Gauge tuohy needle / stamey ureteric catheter for spinal drainage
LUMBAR PUNCTURE

STEPS

• Cleaning and draping
• Infiltration of anesthetic
• Bevel parallel to longitudinal dural fibers
• Trajectory- directed slightly rostrally towards umbilicus
• Confirmation of needle patency
• Connection to manometer – stop if opening pressure is >240 mm H20
• Quickensteadt test in suspected subarachnoid block
LUMBAR PUNCTURE

COLLECTION OF CSF

- 3 Vials for cell count, protein/glucose, gram stain/culture
- 4 vials in suspected traumatic tap
- For cyto pathology 5-10 ml CSF should be sent
- CSF should be sent immediately
- CSF can be preserved at 4 degree Celsius
LUMBAR PUNCTURE

CONTRA INDICATIONS

• Local infection
• Coagulopathy - coagulation disorders, pt on anticoagulant therapy
• Known / suspected increased intracranial pressure due to mass lesion / non communicating hydrocephalus – 1.2% chance of neurological deterioration
• Complete spinal block – 14% risk of neurological deterioration
• Aneurysmal SAH
LUMBAR PUNCTURE

COMPLICATIONS

- Tonsillar herniation - acute / chronic
- Infection
- Spinal headache
- Spinal epidural hematoma
- Spinal epidural CSF collection
- Epidermoid tumor
LUMBAR PUNCTURE

COMPLICATIONS

- Nerve root injury
- Intracranial subdural hygroma / hematoma
- Vestibulo cochlear dysfunction
  - subclinical sudden hearing loss due to decreased perilymph pressure with endolymphatic hydrops
- Ocular abnormalities – abducens palsy
- Dural sinus thrombosis
Post spinal headache

• Occurs in up to 20% cases
• Subsides within 2-5 days, but may persist up to 8 weeks
• Factors
  – Age – young age
  – Sex – females
  – Previous h/o headache
  – Body size – low BMI
  – Pregnancy
Post spinal headache

• Factors
  – Needle size
  – Bevel orientation
  – Replacing stylet before withdrawal
  – Number of Dural punctures
  – Needle type
  – Position of patient after LP
  – Volume of fluid drained
  – Hydration
Post spinal headache

- **Treatment**
  - Horizontal position, bed rest
  - Adequate hydration
  - Mild analgesics
  - IV caffeine sodium benzoate
  - Epidural blood / fibrin patch
LATERAL CERVICAL PUNCTURE

- **INDICATIONS**
  - CSF specimen is required but access via LP is difficult / contra indicated
  - To determine the rostral extent of sub arachnoid block

- **CONTRA INDICATIONS**
  - CHIARI malformation
  - Low incidence of spinal headache
  - Safer than cisternal puncture
LATERAL CERVICAL PUNCTURE

- STEPS
  - With / without fluoroscopy
  - 20 gauge spinal needle
  - Under local anesthetic in cooperative patients
  - Patient positioned supine without pillow, looking up, avoiding head rotation
LATERAL CERVICAL PUNCTURE

**STEPS**

- ENTRY POINT lies 1 cm below and behind mastoid tip
- Trajectory is perpendicular to the neck and parallel to the bed
- Frequent removal of stylet
- Subarachnoid space is 5-6 cm deeper
- For cervical myelogram 5 ml of 180 mg% IOHEXOL is used
LATERAL CERVICAL PUNCTURE

- COMPLICATIONS
  - Puncture of anomalous vertebral artery
  - Penetration of spinal cord / medulla
  - Tonsillar herniation
CISTERNAL TAP

- Sub occipital access to cisterna magna
- 22 gauge spinal needle with mark at 7.5 cm
- Position – sitting
- Entry point – in midline between inion and C2
- Trajectory – towards glabella
- Walking down the occiput
- Distance between – skin to cisterna magna is 4-6 cm, dura to medulla is 2.5 cm
- Dural tenting occurs during procedure
CISTERNAL TAP

- COMPLICATIONS
  - Hemorrhage
  - Injury to medulla – vomiting, respiratory arrest
  - Positioning may compromise blood flow in elderly patients
VENTRICULAR CATHETERIZATION

POINTS AND TRAJECTORIES OF ACCESS TO VENTRICLES

- Kocher’s point – 3 cm lat to midline and 1 cm ant to coronal suture
- Keen’s point 2.5 -3 cm above and 2.5-3 cm behind pinna
- Dandy’s point – 3 cm above inion and 2 cm lateral to midline
- Frazier’s point - 6 cm above inion and 4 cm lat to midline
- Orbital point – 1-2 cm behind superior orbital rim
- Supra orbital – 4 cm above orbital rim in midpupillary line
OTHER METHODS

- Tapping a ommaya reservoir / shunt chamber
- External ventricular drain
## Physiological Parameters of CSF

<table>
<thead>
<tr>
<th></th>
<th>New Born</th>
<th>1-10 yrs</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Volume (ML)</strong></td>
<td>5</td>
<td></td>
<td>150 ML (50% Cranial, 50% Spinal)</td>
</tr>
<tr>
<td><strong>Formation Rate</strong></td>
<td>25 ML / day</td>
<td></td>
<td>0.3-0.35 ML / min</td>
</tr>
<tr>
<td><strong>Pressure (mm H20)</strong></td>
<td>90-120</td>
<td>&lt;150</td>
<td>70-150</td>
</tr>
</tbody>
</table>
CELLULAR COMPONENTS

• Normally RBC’S are absent
• WBC- up to 5/cumm
  PMN- <2 / cumm
• In the absence of RBC’S , 5-10 WBC’S are suspicious and >10 WBC ‘S are abnormal
• Pleocytosis
  – Mild-5-50
  – Mod.-50-200
  – Severe- >200
CELLULAR COMPONENTS

- TRAUMATIC TAP
  - Subtract 1 WBC / 700 RBC’s
  - FISHMAN formula

\[
WBC = WBC (F) - \frac{WBC (B) \times RBC(F)}{RBC(B)}
\]
BIOCHEMICAL PARAMETERS

• GLUCOSE
  Glucose transferred to CSF through carrier mediated diffusion
  Normal CSF/PLASMA glucose is 0.6-0.8 in premature infants >0.8
  lag period of 2 hrs after iv glucose load and 6 hrs for peak value to return to normal
  
• Hypo glycorrhachia – hypoglycemia, neoplasia, inflammatory conditions, SAH, chemical meningitis
BIO CHEMICAL PARAMETERS

- Increased lactate levels are suggestive of anaerobic glycolysis
- Rise of lactate to more than 4 mmol/l and increased lactate/pyruvate ratio is suggestive of hypoxia, SAH, ischemia, seizures, non viral meningitis
BIOCHEMICAL PARAMETERS

• CSF PROTEIN
  – <0.5% OF PLASMA
  – І- GLOBULIN –is increased in central inflammation/ demyelination
  – IgG-ALBUMIN INDEX is elevated in infection / inflammation
  – True protein level in traumatic tap is obtained by subtracting 1mg/dl for every 1000 RBCS
  – Raised protein indicates pathological process and increased endothelial permeability
<table>
<thead>
<tr>
<th>feature</th>
<th>Traumatic tap</th>
<th>SAH</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC count and gross appearance of bloodiness</td>
<td>decreases</td>
<td>Little change</td>
</tr>
<tr>
<td>WBC/RBC</td>
<td>Similar to peripheral blood</td>
<td>leucocytosis</td>
</tr>
<tr>
<td>supernatant</td>
<td>clear</td>
<td>xanthochromic</td>
</tr>
<tr>
<td>Clotting of fluid</td>
<td>Clots if RBC count &gt;200,000/cumm</td>
<td>Does not clot</td>
</tr>
<tr>
<td>Protein conc.</td>
<td>Rise 1mg/1000 RBC</td>
<td>&gt;1mg/1000RBC</td>
</tr>
<tr>
<td>Repeat LP at higher level</td>
<td>clear</td>
<td>Remains bloody</td>
</tr>
<tr>
<td>Opening pressure</td>
<td>normal</td>
<td>Usually elevated</td>
</tr>
<tr>
<td></td>
<td>OP(CM H20)</td>
<td>APPEARANCE</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>NORMAL</td>
<td>7-18</td>
<td>CLEAR</td>
</tr>
<tr>
<td>ABM</td>
<td>INCREASED</td>
<td>TURBID</td>
</tr>
<tr>
<td>PARAMENINGEAL INFECTION</td>
<td>INCREASED</td>
<td>NORMAL</td>
</tr>
<tr>
<td>POST OP CHANGES</td>
<td>INCREASED/ NORMAL</td>
<td>NORMAL/ SANGUINOUS</td>
</tr>
<tr>
<td>POST OP MENINGITIS</td>
<td>INCREASED</td>
<td>OPALASCENT</td>
</tr>
<tr>
<td>Condition</td>
<td>OP(CM H2O)</td>
<td>APPEARANCE</td>
</tr>
<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>Fungal Meningitis</td>
<td>INCREASED</td>
<td>OPALASCENT</td>
</tr>
<tr>
<td>Tuberculosis Meningitis</td>
<td>INCREASED</td>
<td>OPALASCENT WITH CLOT</td>
</tr>
<tr>
<td>Brain Abscess</td>
<td>INCREASED</td>
<td>CLEAR/TURBID</td>
</tr>
</tbody>
</table>
POST OP MENINGITIS

- Gram stain – 60-90% accurate
- Polymerase chain reaction for bacterial DNA
- C reactive protein levels – strong negative predictive value
- Latex agglutination – sensitive test for partially treated patients
- Lymulus lysate levels
- Lactate levels >4mmol/l s/o post op meningitis
- Csf pro calcitonin levels
- S-100 protein levels
- TNF –ALFA/IL6 levels
OTHER CONDITIONS

**MENINGEAL CARCINOMATOSIS**
- 25% of CNS malignancy has positive cytology
- 60% with lepto meningeal involvement is +
- Repeated sampling is necessary
- Immuno cyto chemical methods improve sensitivity
OTHER MARKERS IN CSF

- CSF HCG - Central chorio carcinoma
- CEA - breast, lung bladder mets in CNS
- Alfa feto protein – germ cell tumors, metastatic testicular and hepatic ca.
- Spermidine – meningiomas
- Poly amine in leukemia
- Desmosterol in gliomas
- beta glucuronidase in leptomeningeal involvement
SPINAL CORD TUMORS

- Increased protein > 100mg/dl
- >100 PMN /cumm
- Froin syndrome
• THANK YOU