



# 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 H<sub>2</sub>O
- 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 co operative 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 2.5-3cm 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

	<b>NEW BORN</b>	<b>1-10YRS</b>	<b>ADULTS</b>
TOTAL VOLUME (ML)	5		150ML (50%CRANIAL,50% SPINAL)
FORMATION RATE	25 ML / DAY		0.3-0.35 ML /MIN
PRESSURE (mm H <sub>2</sub> O)	90-120	<150	70-150

# 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

$$\text{WBC} = \text{WBC (F)} - \frac{\text{WBC (B)} \times \text{RBC(F)}}{\text{RBC(B)}}$$

# 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 glycorrachia – 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
  - $\gamma$ -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

feature	Traumatic tap	SAH
RBC count and gross appearance of bloodiness	decreases	Little change
WBC/RBC	Similar to peripheral blood	leucocytosis
supernatant	clear	xanthochromic
Clotting of fluid	Clots if RBC count >200,000/cumm	Does not clot
Protein conc.	Rise 1mg/1000 RBC	>1mg/1000RBC
Repeat LP at higher level	clear	Remains bloody
Opening pressure	normal	Usually elevated

# D/D

	OP(CM H2O)	APPEARANCE	CELLS	PROTEIN (MG%)	GLUCOSE	MISC.
NORMAL	7-18	CLEAR	0-5WBC	45	50	
ABM	INCREASED	TURBID	20-20000	100-1000	<20	GS/CS+/-
PARAMENINGEAL INFECTION	INCREASED	NORMAL	0-800	INCREASED	NORMAL	
POST OP CHANGES	INCREASED/ NORMAL	NORMAL/ SANGUINOUS	100-500	INCREASED	NORMAL	
POST OP MENINGITIS	INCREASED	OPALASCENT	>500	INCREASED	<40	GS/CS+/-



# D/D

	OP(CM H20)	APPEARANCE	CELLS	PROTEIN(MG%)	GLUCOSE	MISC.
FUNGAL MENINGITIS	INCREASED	OPALASCENT	30-300 (LYMPHO)	100-700	<30	+INDIA INK IN CRYPTO.
TB MENINGITIS	INCREASED	OPALASCENT WITH CLOT	50-500LYMPHO	60-700	20-40	ZN STAIN +/-AFB CS +
BRAIN ABSCESS	INCREASED	CLEAR/TURBID	INCREASED	INCREASED	NORMAL / DECREASED	LESS SENSITIVE

# 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  $>4\text{mmol/l}$  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 fetoprotein – 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  $> 100\text{mg/dl}$
- $> 100$  PMN /cumm
- Froin syndrome



- **THANK YOU**