CSF EXAMINATION : TECHNIQUES AND INTERPRETATION

Presented By : DR. PRASAD R G

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

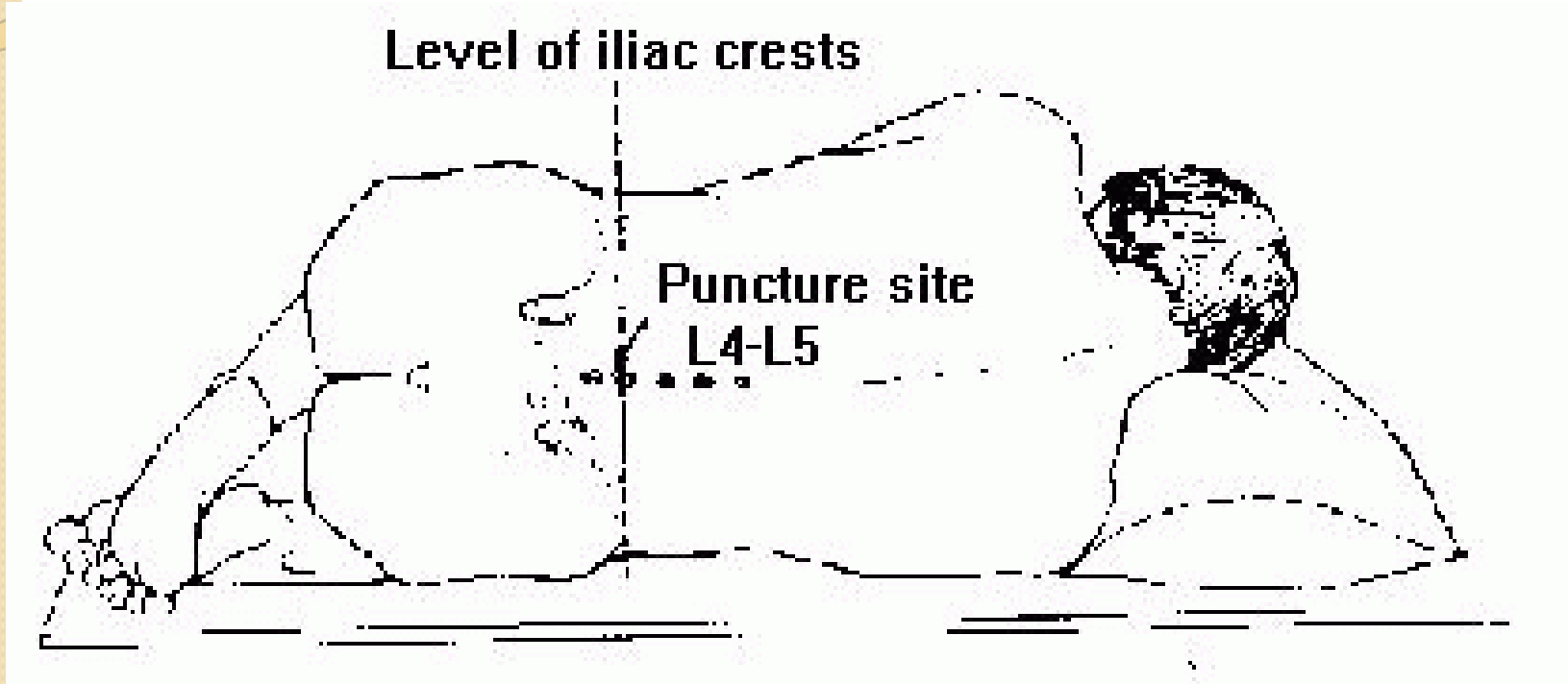
- Spinal cord and spinal column are of same length up to 3 months of age
- Cord ends at L1-2 in 51-68%, T12-L1 in 30%, L2-3 in 10% of adults
- Thecal sac ends at S2
- Intercristal line corresponds to L3-4 interspace

LUMBAR PUNCTURE

POSITIONING

- KNEE CHEST
- SITTING

LUMBAR PUNCTURE



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

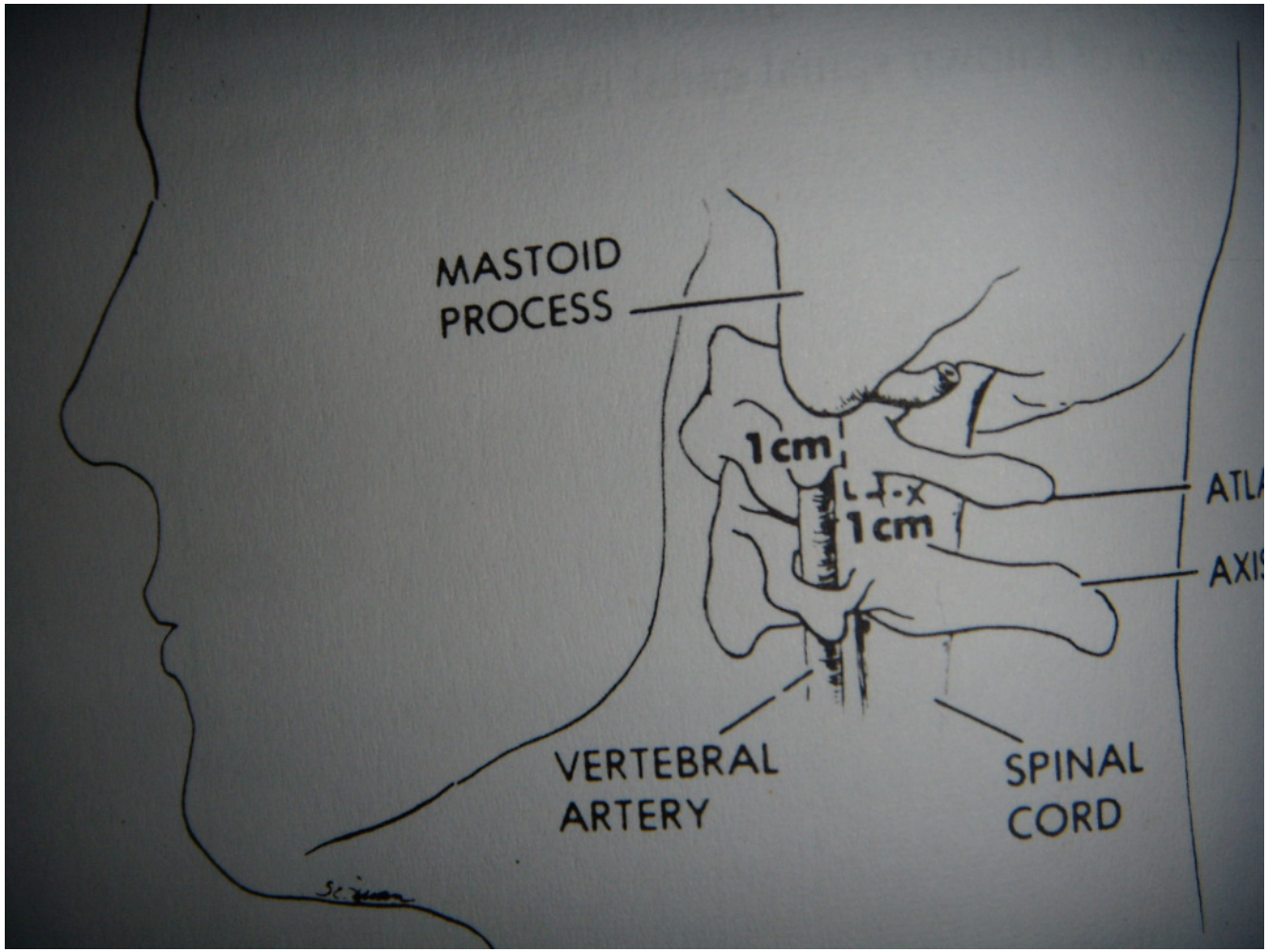
- INDICATIONS
  - CSF specimen is required but access via LP is difficult / contra indicated
  - To determine the rostral extent of sub arachnoid block
- CONTRA INDICATIONS

  CHIARI malformation
- Low incidence of spinal headache
- Safer than cisternal puncture

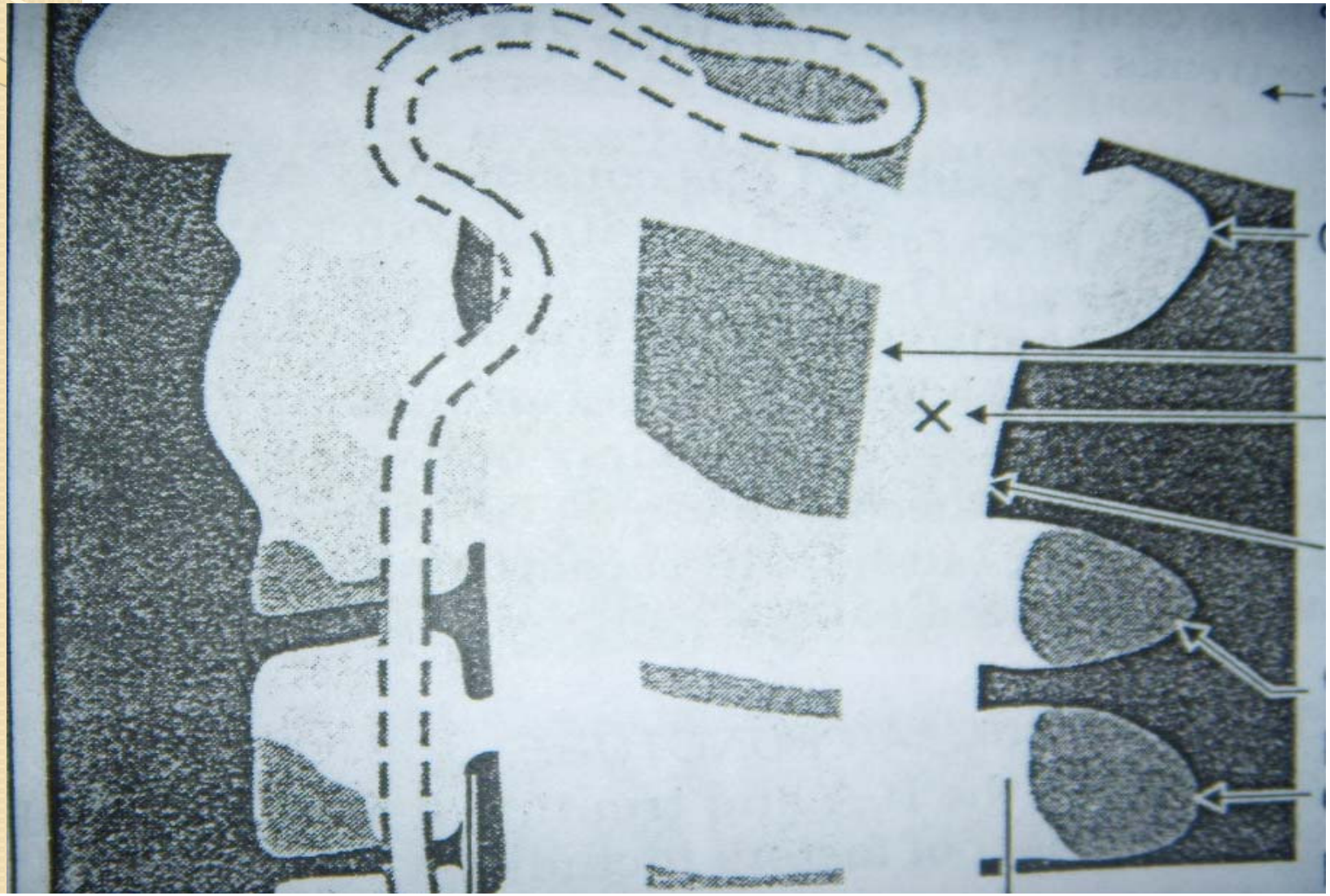
LATERAL CERVICAL PUNCTURE

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

LATERAL CERVICAL PUNCTURE



LATERAL CERVICAL PUNTURE



LATERAL CERVICAL PUNCTURE

- STEPS
  - ENTRY POINT lies 1cm 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

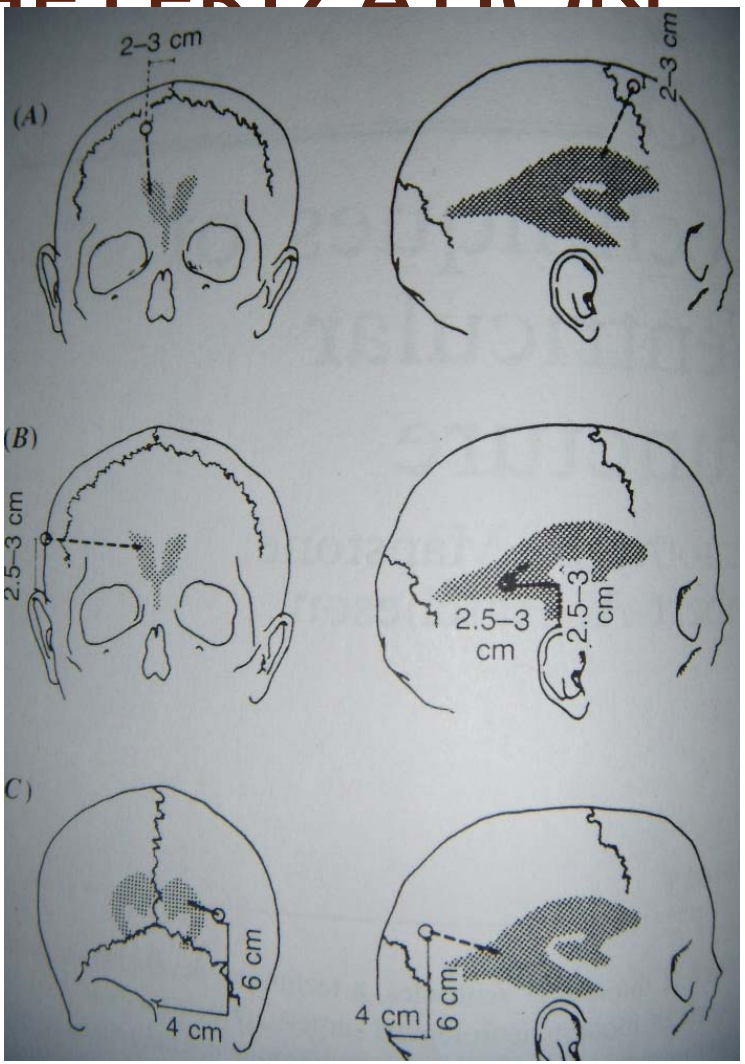
- COMPLICATIONS
  - Hemorrhage
  - Injury to medulla – vomiting , respiratory arrest
  - Positioning may compromise blood flow in elderly patients

VENTRICULAR CATHETERIZATION

POINTS AND TRAJECTORIES OF ACCESS TO VENTRICLES

- Kocher's point – 3 cm lat to midline and 1cm 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

VENTRICULAR CATHETERIZATION



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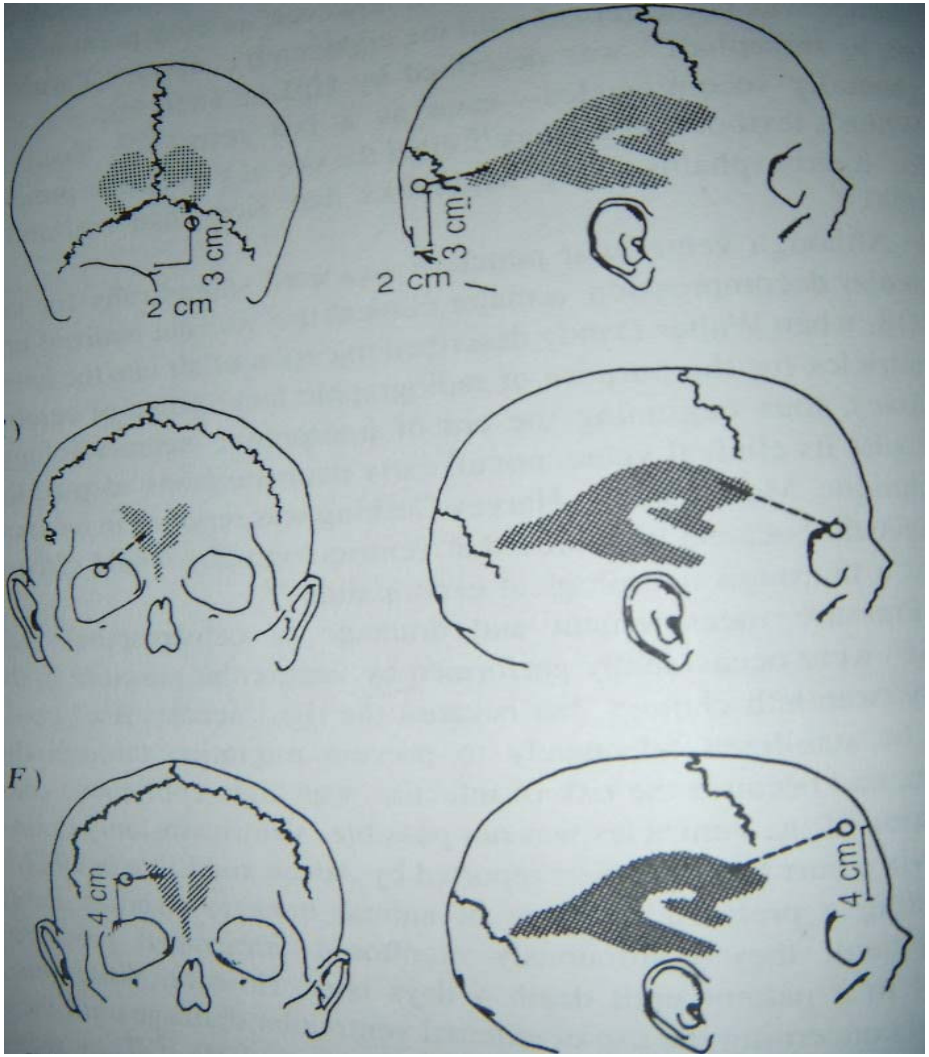

OTHER METHODS

- Tapping a ommaya reservoir / shunt chamber
- External ventricular drain

PHYSIOLOGICAL PARAMETERS OF CSF

	NEW BORN	1-10YRS	ADULTS
TOTAL VOLUME(ML)	5		150ML(50%CRANIAL,50% SPINAL)
FORMATION RATE	25 ML / DAY		O.3-O.35 ML /MIN
PRESSURE (mm H20)	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

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

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
  - Ĭ-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 H20)	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 >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