

## Neurosurgery Learning Objectives:

### Hydrocephalus

#### 1. Explain the definition of hydrocephalus

Hydrocephalus = pathological accumulation of intracranial CSF, usually but not always within the cerebral ventricles. Subdivided into obstructive (impairment in circulation or absorption of CSF) and non-obstructive (relative enlargement of ventricular system and CSF spaces due to loss of brain, i.e. ex vacuo hydrocephalus).

#### 2. Distinguish between communicating and non-communicating hydrocephalus

Communicating - subdivision of obstructive hydrocephalus, hydrocephalus due to blockage outside the ventricular system, communication w/ subarachnoid space intact. More common, often due to processes that scar the subarachnoid space. Non-communicating-hydrocephalus due to blockage within ventricular system that prevents communication w/ subarachnoid space.. Examples include aqueductal stenosis and 'ventricular tumors'

#### 3. Estimate the incidence of uncomplicated hydrocephalus

isolated hydrocephalus = 1 to 1.5 per 1000 births

Hydrocephalus associated w/ other disorders = 3 or 4 per 1000 births

#### 4. Review the history of hydrocephalus research

Nulsun and Spitz - 1949 placed first valved ventricular shunt

Hippocrates - 5th century BC, recognize head could swell w/ accumulation of water

Galen - understood brain immersed in CSF and described choroid plexus

Willis - recognized choroid plexus secreted CSF and that CSF drained into venous side

Pacchioni - described arachnoid granules/villi

Key and Retzius - described the pathway of CSF movement

Quinke - described lumbar puncture as treatment for hydrocephalus

Kausch - placed first ventriculoperitoneal shunt

Lespinasse - first choroid plexus coagulation and first use of endoscope in neurosurgery

Dandy - attempted to coagulate and avulse choroid plexus endoscopically

Mixter - first endoscopic 3rd ventriculostomy, fenestrate the floor of 3rd ventricle, treatment for non-communicating hydrocephalus

Holter - created better slit valve for shunt (replace ball valve)

#### 5. Describe non-surgical treatments of hydrocephalus

(a) Meds to decrease CSF production and reduce intracranial pressure (acetazolamide, furosemide).

(b) Meds to reduce intracranial pressure (mannitol, glycerol, urea, isosorbide)

(c) Meds to promote CSF absorption (hyaluronidase, heparin, urokinase)

(d) Intermittent CSF removal (serial LP).

#### 6. Discuss techniques for ventricular shunting~ and associated complications

Place proximal catheter in CSF space before site of obstruction (i.e. lateral ventricle for ventricular shunt or lumbar thecal sac for subarachnoid space shunt), have shunt valve that produces unidirectional flow of CSF (valves pressure regulated).

Complications - (a) shunt malfunction from underdrainage - shunt system gets obstructed or disconnected due to debris or movement, underdrainage also occurs w/ loculation within the ventricular system, ventriculoatrial shunts high rate of malfunction because distal end migrates out of atrium w/ growth of child.

(b) shunt malfunction from overdrainage - upright position creates negative pressure that overcomes shunt valves, most common symptom is headache, overdrainage HA worse in upright position, improved lying down, once in upright position for extended periods Headache abates, persistent headache may be something more dangerous like subdural hematoma. Slit ventricle syndrome = intermittent headache suggestive of underdrainage shunt malfunction, intracranial pressure elevated, shunted as small kids, shunt valve refills slowly, get papilledema or CN abnormalities, HIN, bradycardia.

(c) shunt infection - 2-10% of cases have infection, ventriculitis adversely affects intelligence, Staph epidermidis is most common organism, majority of infections occur w/in 2 months of shunt insertion, likely due to intraoperative contamination

#### 7. Explain alternative surgical treatments, specifically endoscopic third ventriculostomy

Endoscopic third ventriculostomy - use to bypass obstruction of aqueduct of Sylvius or 4th ventricle in non-communicating hydrocephalus, use coronal burr hole, endoscope into lateral ventricle then thru foramen on Monro into 3rd ventricle, then puncture floor of third ventricle anterior to mammillary bodies, use catheter to enlarge fenestration, CSF enters subarachnoid space, works for non-communicating hydrocephalus not communicating. Choroid Plexus Coagulation - used sometimes, but poor results, goal is to decrease CSF pressure by reducing CSF production, limited because not all CSF made by choroid plexus.

#### Central Nervous System Tumors

##### 1. Discuss the epidemiology of CNS tumors

50k cancer deaths/year involve CNS, 8500 deaths/year due to primary brain cancer, for kids, most common solid tumor. Cancer related to cranial radiation and genetic causes.

##### 2. Describe the clinical presentation of brain tumors

Brain tumors present w/ increased intracranial pressure (mass effect, obstruction, HA), seizures, focal neurologic symptoms/signs (speech problems, visual/hearing loss, weakness). Spine tumors present w/ back pain (worse at night), intraparenchymal tumors have no pain, focal neurological symptoms/signs (weakness/numbness, difficulty walking, bowel/bladder dysfunction)

##### 3. Recognize the WHO grading scheme for gliomas .

Grade I (pilocytic) and II (low-grade) are benign, Grade III (anaplastic) and IV (glioblastoma) are malignant Grade I = pilocytic, very benign, occur in kids. Grade II = low grade, slow growing, controlled w/ treatment Grade III = anaplastic, malignant, mitosis and nuclear atypia. . Grade IV = glioblastoma multiforme, malignant, necrosis and

microvascular proliferation. Benign/malignant refers to pathologic appearance, not prognosis, benign histologically could be irresectable and difficult to control w/ chemo

#### 4. Recognize the common brain tumors in adults

Metastatic - 1/4 of patients w/ systemic cancer develop CNS metastasis, occurs as single lesion, multiple lesions or carcinomatous meningitis, common sources = lung, colon, renal, breast, melanoma. Treat w/ surgery and radiation

Gliomas - most common primary, 2/3 are malignant, prognosis depends on patient's age, tumor location/resectability, and neurologic function at diagnosis. Average survival about 1 yr, tend to recur locally and infiltrate.

Meningiomas - occur along skull base, falx, tentorium, and over convexity, usually benign, can invade into bone, course varies, some cured by resection, other recur even w/ surgery and radiation

Schwannomas - nerve sheath tumors, often vestibular nerve, if small treat w/ observation/surgery/sterotactic radiosurgery, larger treat w/ surgery.

Pituitary - classify by size and hormone secretion, macro adenomas (> 1 cm) present w/ pituitary dysfunction or visual symptoms, microadenomas present w/ endocrine symptoms, prolactinomas most common, pituitary apoplexy (hemorrhage into pituitary) cause sudden visual loss and hypopituitarism.

#### 5. Recognize the common brain tumors in children

Adults and kids < 2 years old mostly supratentorial, kids 2-10 mostly infratentorial.

Supratentorial gliomas - 2/3 low grade, Y2 astrocytomas, if resectable may be curable, prognosis depends on histology, location, extent of resection. Malignant tumor w/ maximal therapy survival of 1-3 yrs.

Primitive neuroectodermal tumors - primitive malignant tumors w/ similar histology/prognosis but different names based on location. Medulloblastoma = 4th ventricle, 30% posterior fossa tumors in kids, most common malignant CNS tumor in kids, 5 yr survival improved to 70% w/ complete surgical resection and adjuvant therapy (radiation/chemo)

Juvenile pilocytic astrocytoma - tumor of cerebellar hemisphere, gross total resection can cure 95%, grade I tumor

Brainstem gliomas - diffusely infiltrated unresectable, poor response to radiation and chemo, may cause hydrocephalus, Pontine tumors present w/ long tract symptoms and CN palsies, prognosis dismal, most die < 18 mo of diagnosis

Ependymoma - malignant, often in posterior fossa, extrude from outlets of 4th ventricle encase CN and vessels, present w/ obstructive hydrocephalus, have lower CN palsies after resection, complete resection and radiation survival 40% at 5 yrs, chemo not effective.

#### 6. Contrast the indications for biopsy, subtotal resection and gross total surgical resection

Biopsy = needle biopsy, often use MRI guidance

Subtotal = debulking, decrease mass effect and improve symptoms, may not change prognosis. .

Gross Total = usually improves prognosis, must weigh benefits of tumor control versus minimizing neurologic deficits.

7. Describe the indications for radiation therapy

Cranial- whole brain radiation used for metastatic disease

Focal = limited radiation to involved area, limit microscopic growth while minimizing damage to normal tissue.

Stereotactic = gamma knife, deliver ablative dose to small defined area (<4 cc)

8. Describe the indications for chemotherapy

Highly effective for very few tumors i.e. oligodendroglioma. Use as adjunct for many tumors, but relatively ineffective (i.e. gliomas, lymphoma, medulloblastoma and germ cell tumors)