Disclosures

• I have no financial disclosures to discuss
• I have no non-financial disclosures to discuss
• It has been decided that the new median salary medical Speech-Language Pathologists will be $3,141,592,653 for all that we are required to know and a separate bonus for every time we hear from our patients “but there’s nothing wrong with my speech so why do I need Speech Therapy?” OR from one of our dear nurses that “they swallow fine, they aren’t coughing”
Course Outline

- Embryology and Neural Development
- Neural Protection
- Neuroanatomy
- Vascular Supply to the Brain
- Cranial Nerves

Early Mitosis

- Zygote
- Blastocyst
- Bilaminar germ disc
- Trilaminar germ disc
  - ectoderm
  - mesoderm
  - endoderm

Neurulation

- Flat neural plate formed
- Crest, folds, and groove
- Neural tube
- Primary vesicles form
  - Prosencephalon
  - Mesencephalon
  - Rhombencephalon

Congenital Anomalies

- Anencephaly
- Spina bifida
- Microcephaly
- Agenesis of the corpus callosum
- Cleft lip and palate

Cephalic Structures

- Prosencephalon
  - Diencephalon
  - Thalamus
  - Hypothalamus
- Telencephalon
- Hemispheres
- Mesencephalon
- Midbrain
- Rhombencephalon
- Metencephalon
- Pons
- Cerebellum
- Myelencephalon
- Medulla oblongata

Neural Migration

- Neurons
  - Unipolar, bipolar, multipolar
  - Pyramidal
  - Purkinje
- Neuroglia
  - Oligodendrocytes and Schwann cells
  - Microglia
  - Ependymal cells
  - Astrocytes
- Synapses
Central Nervous System
- Cerebrum
- Spinal Cord

Peripheral Nervous System
- Spinal Nerves (31 pairs)
- Cranial Nerves (12 pairs)

Motor Pathway

Sensory Pathway
Defying Gravity…

• Brain weighs about 1400 grams in air
• Ventricles, bone and meninges protect us from bumps and gravity
• Cerebrospinal fluid gives buoyancy to the brain so it weighs only 50 grams in the skull

Ventricular System

• Interconnecting chambers in the brain
  • Choroid plexus
  • Lateral Ventricles
  • Foramen of Monro
  • 3rd Ventricle
  • Aqueduct of Sylvius
  • 4th Ventricle

Hydrocephalus

• Enlargement of the ventricles
• Due to:
  • Excess production of CSF
  • Blockage within system
  • Failure of CSF to re-absorb
Bony Protection

- Skull
  - Cranial bones
  - Facial bones
- Spinal column
  - Cervical
  - Thoracic
  - Lumbar
  - Sacral
  - Coccygeal

Skull

- Foramen ovale
- Stylomastoid foramen
- Internal acoustic meatus
- Jugular foramen
- Hypoglossal canal
- Foramen magnum
Spinal Column

- Cervical
  - C1
  - C2
  - C3
  - C4
  - C5
  - C6
  - C7
- Thoracic
- Lumbar
- Sacral
- Coccygeal

Meningeal Protection: “PAD” the Brain!

- Pia
- Arachnoid
- Dura

Pia Mater = Tender Mother

- Tissue paper-like covering of the CNS
- Fibers anchor the arachnoid to the pia so there is no movement
- Conforms to the sulci and gyri
- Only one cell layer thick but is effective barrier to infection
Arachnoid = Spider’s Web

- Gives appearance of a cobweb
- Highly vascularized
- Subarachnoid space
  - CSF circulates through the space
  - Arachnoid villi help drain CSF

Dura Mater = Tough Mother

- Epidural space
- Subdural space
- Falx cerebri
- Tentorium cerebelli
Vascular Supply!

- Carotid system
- Vertebrobasilar system

Carotid System
- Internal carotids
  - ACA
  - MCA
- External carotids
Vertebrobasilar System

- Vertebral arteries
- PICA
- Basilar artery
- PCA
- Anterior inferior cerebellar arteries
- Superior cerebellar arteries

Circle of Willis

- Connect carotid and vertebral systems
- AComm
- PComm
- Safety net for disrupted blood supply if the lesion is below the circle
Cerebrum
- Hemispheres
- Central sulcus
- Motor
- Sensory
- Longitudinal fissure
- Corpus callosum

Corpus Callosum
- Rostrum
- Genu
- Body
- Splenium
Frontal Lobe
• Precentral gyrus
• Damage:
  • motor impairments to contralateral side
  • cognitive impairments
  • non-fluent aphasia with or without acquired apraxia of speech, transcortical motor aphasia, Broca’s aphasia
  • spastic dysarthria if both hemispheres affected
  • dysphagia
  • unilateral upper motor neuron dysarthria
  • lower facial paresis on contralateral side of damage
  • lingual paresis on contralateral side of damage

Temporal Lobe
• Primary auditory cortex
• Damage:
  • fluent aphasia
  • transcortical sensory aphasia or Wernicke’s aphasia
  • memory
  • recognition
  • processing
Parietal Lobe
- Postcentral gyrus = _______
- Damage...
  - visual neglect
  - sensory impairments
  - conduction aphasia
  - anosognosia
  - prosopagnosia
  - asteereognosia
  - right/left discrimination
  - agraphia
  - acalculia

Occipital Lobe
- Primary visual cortex
- Damage....
  - cortical blindness
  - attention
  - reading
  - symbolic recognition
**Cerebellum**
- Coordination, balance
- Damage...
  - ataxia
  - dysdiadochokinesia
  - dyssmetry
  - intention tremor
  - disequilibrium
  - nystagmus
  - dysphagia
  - ataxic dysarthria

**Diencephalon**
- Thalamus
- Hypothalamus
- Epithalamus/pineal gland
- Damage...
  - thalamic pain syndrome
  - sensory processing disorders
  - dysphagia

**Limbic System**
- Amygdala
- Hippocampus
- Cingulate gyrus
- Damage...
  - memory
  - encoding/learning
  - retrieval
  - emotions
  - fear
  - behavior
Basal Ganglia

- Caudate nucleus
- Putamen
- Globus pallidus
- Subthalamic nucleus
- Substantia nigra
- Damage
  - Chorea
  - Hyperkinetic dysarthria
  - Athetosis
  - Ballismus
  - Tremor
  - Bradykinesia
  - Hypokinesia
dysarthria

Brainstem

- Midbrain (CN III, IV)
- Pons (CN V, VI, VII, VIII)
- Medulla oblongata (CN IX, X, XII)
- Damage
  - Sight, smell, hearing, taste
  - Disequilibrium
  - Nausea
  - Coma
  - Dysphagia
  - Flaccid dysarthria

Mnemonics

- Oliver the optimistic octopus triumphantly about facing
  audiences glossily vaguely spinning hippocas.
- On Old Olympus’ Towering Top A Fin And German Viewed Some Hops
CN I: Olfactory

- Sensory nerve
- Smell
CN II: Optic

- Sensory nerve
- Vision
  - Info from left visual field goes to right occipital lobe and vice versa

Sensory: Neuron Order

- First order neuron
  - Photons of light converted to electrical signals in retina. These photoreceptor cells are the rods and cones. They in turn synapse with the optic nerve
  - Rods
  - Cones

- Second order neuron
  - Optic nerve leaves retina and joins the other optic nerve at the optic chiasm traveling then to respective thalamic nuclei

- Third order neuron
  - From lateral geniculate nucleus in thalamus to the occipital cortex for interpretation

- Left and right optic nerves exit via optic canal and join together at the optic chiasm
- Optic chiasm
  - ½ of fibers from each nerve cross midline and exit chiasm in opposite optic tract
  - ½ of fibers stay on the same side optic tract
Vision deficits

- Damage to retina or nerve itself = blindness in that same eye/ipsilateral
- Loss of peripheral vision of both eyes = damage to medial aspect of chiasm = bitemporal hemianopia
- Damage to lateral aspect of optic chiasm = decreased vision of one eye’s peripheral vision
- Damage posterior to chiasm = loss of input from contralateral visual fields of both eyes
- Damage to optic tract = loss of contralateral visual fields in both eyes = homonymous hemianopia

CN III: Oculomotor

- Motor nerve
- Eye movement and pupil dilation
CN IV: Trochlear
- Motor nerve
- Eye movement

CN V: Trigeminal
- Both sensory and motor
- Somatosensory info from the face/ head and motor for mastication
- Origin: Pons
- Termination:
  - Ophthalmic branch
  - Maxillary branch
  - Mandibular branch

CN V: Trigeminal
- Symptoms
  - Facial numbness
  - Reduced facial sensation
  - Jaw weakness/chewing
- Test
  - Close/open jaw
  - Light touch to parts of face
Sensory: Neuron Order

- **First order neuron**
  - From sensory receptors in face (three branches)
- **Second order neuron**
  - From sensory nuclei of CN V in pons to contralateral thalamus
- **Third order neuron**
  - From thalamus to ipsilateral postcentral gyrus for interpretation

Motor: Neuron Order

- **First order neuron/UMN**
  - From precentral gyrus to nuclei in pons
- **Second order neuron/LMN**
  - Exits via foramen ovale to synapse with muscles on ipsilateral side for chewing (masseter and temporalis)

CN V: Trigeminal

- UMN damage - min. unless bilateral
- LMN damage - wasting, weakness, jaw deviation
- Trigeminal neuralgia
CN V: Trigeminal

Motor nerve
Lateral eye movement

CN VI: Abducens

- Motor nerve
- Lateral eye movement

CN VII: Facial

- Sensory and motor nerve
- Contralateral innervation to lower face
- Bilateral innervation to upper face
- Facial expression
- Origin: Pons
- Termination:
  - 5 branches
CN VII: Facial

Sensory: Neuron Order

- First order neuron
  - From chemoreceptors/taste buds on anterior 2/3 of tongue
- Second order neuron
  - From sensory nuclei of VIII in pons up to the contralateral thalamus
- Third order neuron
  - From thalamus to ipsilateral postcentral gyrus for interpretation

Motor: Neuron Order

- First order neuron/UMN
  - From precentral gyrus down through the internal capsule to ipsilateral and contralateral for upper face and just contralateral for lower face
- Second order neuron/LMN
  - From nuclei in pons exiting ultimately through the stylomastoid foramen to all muscles of facial expression
CN VII: Facial

- Symptoms
  - Facial weakness
  - Decreased taste to anterior 2/3 of tongue
- Test
  - Smile
  - Pucker lips/whistle
  - Puff out cheeks
  - Raise eyebrows/wrinkle

UMN Damage

- Marked facial asymmetry
- Atrophy of facial muscles
- Eyebrow droop
- Smoothing of forehead and nasolabial folds
- Drooping of mouth corner
- Cannot close eye
- Poor lip seal

LMN lesion - Bell’s Palsy

- Marked facial asymmetry
- Atrophy of facial muscles
- Eyebrow droop
CN VIII: Auditory

- Sensory nerve
- Bilateral innervation
- Hearing and balance
- Origin: Pons
- Termination:
  - Auditory
  - Vestibular

CN VIII: Auditory

- Symptoms
  - Dizziness
  - Vertigo
  - Test
    - Ticking watch

CN IX: Glossopharyngeal

- Sensory and motor nerve
- Bilateral innervation
- Swallowing
- Origin: Medulla
- Termination:
  - Pharynx
  - Larynx
  - Parotid gland
  - Tongue
Sensory: Neuron Order...

- First order neuron: From receptors in upper pharynx and posterior 1/3 of tongue to sensory branches of IX
- Second order neuron: sensory branches of IX in brainstem up to thalamus
- Third order neuron: From thalamus up to postcentral gyrus for interpretation
- **Responsible for the afferent part of the gag reflex**
- **Motor portion of the gag is mediated by Vagus/X**

Motor: Neuron Order

- First order neuron/UMN
  - From precentral gyrus through internal capsule to ipsilateral and contralateral IX nuclei in medulla
- Second order neuron/UMN
  - From nuclei of IX in medulla exiting out through the jugular foramen to innervate the stylopharyngeus muscle and smooth muscle glands of pharynx, larynx, and visceral of thorax and abdomen

CN IX: Glossopharyngeal

- Symptoms
  - Dysphagia
  - Increased secretions
  - Taste in posterior 1/3 of tongue
  - Pressure to Eustachian tubes
  - Test
  - Swallowing
CN X: Vagus

- Symptoms
  - Velar weakness
  - Dysphagia
  - Hypernasality
  - Dysphonia
- Test
  - Uvula/palate
  - Swallowing
  - Voice

CN X: Vagus - Wanderer

- Sensory and motor nerve
- Bilateral innervation
- Swallowing and visceral functions
- Origin: Medulla
- Termination:
  - Pharyngeal branch
  - Laryngeal branch

Sensory: Neuron Order

- First order neuron: Receptors within tissue of pharynx and larynx gather info and synapse with sensory branches of nerve
- Second order neuron: branches of X from medulla up to thalamus
- Third order neuron: Thalamus to postcentral gyrus for interpretation
Motor: Neuron Order

- First order neuron/UMN
  - From precentral gyrus through internal capsule to ipsilateral and contralateral X nuclei in the medulla

- Second order neuron/UMN
  - Exit via jugular foramen and then divides into three major branches
    - Pharyngeal branch (motor aspect/gag reflex, elevation of palate, constriction of pharynx)
      - Superior, middle, and inferior constrictor muscles
      - Palatoglossus muscle
      - Palatopharyngeus muscle
    - Pharyngeal branch (all other tongue muscles are XII)
    - Superior laryngeal nerve
      - External laryngeal nerve – cricothyroid
      - Internal laryngeal nerve – sensory nerve
    - Recurrent laryngeal nerve
      - Right recurrent loops around the right subclavian artery then up through groove between esophagus and trachea to innervate intrinsic right vocal fold muscles
      - Left recurrent loops around the arch of the aorta through groove between esophagus and trachea to innervate intrinsic left vocal fold muscles

CN XI: Accessory or Spinal Accessory

- Motor nerve
- Bilateral innervation
- Head movement/shoulders
CN XII: Hypoglossal

- Motor nerve
- Contralateral innervation
- Tongue
- Origin: Medulla
- Termination: Muscles of tongue

Motor neuron order

- First order neuron/UMN
  - From precentral gyrus through internal capsule to contralateral medulla/UMN
- Second order neuron/UMN
  - Exits via hypoglossal foramen
  - Extrinsic muscles – genioglossus, styloglossus, hyoglossus
  - Intrinsic muscles – superior longitudinal, inferior longitudinal, vertical, transverse fibers

CN XII: Hypoglossal

- Symptoms
  - Dysarthria
  - Tongue weakness
- Test
  - Protrude tongue
  - Lateraize tongue
  - Elevate tongue
  - Depress tongue
  - Lingual circumduction
  - Deviation? Atrophy?