Brain Anatomy
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Objectives

• Describe the basic anatomical structures of the brain and some of their functions
• Explain the differences between the anterior and posterior circulation systems
• Discuss the brain anatomy in relationship to area affected based on stroke symptoms
What makes the brain so important?

• The brain is 3 lbs of tissue but the most perfusion-sensitive organ
• It receives ~20% of cardiac output and consumes 25% of available glucose
• The brain depends on a constant level of perfusion ~750ml/min
• The brain is made of approx. 75% water
• Receives and transmits both sensory and motor information to the body
• Brain grows in size but the number of cells stays the same
Brain

- Major Brains Divisions
  - **Cerebrum** - composed of right and left hemispheres and largest part of the brain
  - **Cerebellum** - located under the cerebrum and coordinate muscle movements, maintains posture and balance
  - **Brainstem** - acts as a relay center connecting the cerebrum and cerebellum to the spinal cord; controls autonomic functions

https://www.youtube.com/watch?reload=9&v=h5f56Ynb01E
Right Brain-Left Brain

- Cerebrum is divided into two halves (right and left)
- Each hemisphere is connected by the corpus callosum as the base of the fissure
  - Used for transmitting messages from one side to the other
- Each hemisphere controls the opposite side of the body
- Left hemisphere is dominate in hand use (right handed) and language in about 92% of people
- Not all function of the hemispheres are shared
  - Left controls speech, comprehension, math, and writing
  - Right controls creativity, spatial ability, art, music
• Precentral gyrus is located on the posterior surface of the frontal lobe in front of the postcentral gyrus which are separated by the central sulcus
• Precentral gyrus controls motor function
• Postcentral gyrus controls sensory function
Cerebrum

- Largest part of the brain
  - 83% of total brain mass
- Performs higher functions such as interpreting touch, vision, hearing, speech, reasoning, emotions, learning, and fine control of movement
  - Sometimes called “Executive function”
- Composed of the right and left hemispheres
- Cerebral Cortex (grey matter)-2-4mm thick
  - Surface of the cerebrum with a folded appearance that covers the entire brain there are called (gyri) and grooves (sulci)
  - Folding of cortex allows increased brain surface area allowing more neurons to fit enabling higher executive functioning
Cerebrum

• Deep structures (white matter)
  • White matter tracts- connects other areas of cortex to each other
  • Hypothalamus- controls autonomic system (hunger, thirst, sleep, emotions, body temp, BP)
  • Pituitary Gland- “master gland”; controls hormones
  • Pineal gland- regulates body’s internal clock and circadian rhythms by secretin melatonin
  • Thalamus- relay station for brain; plays role in pain sensation, attention, alertness & memory
  • Basal ganglia- works with cerebellum to coordinate fine motions, such as fingertip movements
  • Limbic system (amygdala, hypothalamus, hippocampus)- center of our emotions, learning, memory
Lobes of the Brain

- Lobes are divided by fissures in the cerebral hemispheres
- Each hemisphere has four lobes
  - Frontal Lobe
  - Parietal Lobe
  - Occipital Lobe
  - Temporal Lobe
- Important to understand that each lobe of the brain does not function alone
  - Complex relationships between each other and hemispheres
Frontal Lobe

• “Makes us human”-Controls personality, behavior, emotions, judgement, problem solving, intelligence, concentration
• Frontal lobes compose 2/3 of the human brain
• Broca’s area located here to transform thoughts into words
• Fully developed in early twenties
  • “mature as you age” come from
• Frontal lobotomy considered treatment for major suicidal depression, schizophrenia, chronic pain in 1940-1950s
Parietal Lobe

• Sensory (vision, hearing, motor, sensory and memory) and numerical processing
• Visuo-spatial information  
  • Movement, depth perception, and navigation
• Senses of touch/pain/temperature (sensory strips)
• Dysfunction s/s-clumsy, hemineglect, decreased sensory functions, dyslexia, reoccurring injury
Temporal Lobe

• Contains the primary auditory cortex for processing of hearing speech and memory
• Hippocampus (long term) and amygdala (short term) memories are located here are stored here
• Understanding and processing speech (Wernicke’s area)
• Sequencing and organization
• Dysfunction leads to difficulty
  • in recognizing words and remembering verbal material (left side)
  • Difficulty in recognizing visual content and tonal sequences
Occipital Lobe

• Interprets vision (color, light, movement) so that we can understand it
• Light enters eyes, and it is transmitted by nerves to the occipital lobe where the image is interpreted
• Eyes are hardwired to the brain via nerve fibers that connects it to the occipital lobes
• Disorders can cause visual hallucinations and illusions
• Injury can cause visual field loss that affects one or both eyes
Cerebellum

• Located under the cerebrum and accounts for 10% of total brain size BUT contains approx. 50% of nerve cells in the brain
• Functions to coordinate muscle movement, maintain posture, and balance
  • Connected to the inner ear
• Supplied by the posterior circulation
Brainstem

- Small component of brain as approx. 2.6% of total brain mass
- Controls the flow of messages between the brain and the rest of the body
- Brainstem is made up of three parts
  - Midbrain, pons, medulla oblongata
- 10 of the 12 CN come from here
- Performs many “automatic functions”
  - Breathing, heart rate, body temperature, wake and sleep cycles, digestion, sneezing, coughing, vomiting, and swallowing.
Ventricles and Cerebrospinal Fluid

• There are four ventricles which are hollow fluid-filled cavities within the brain
• Lining the inside of the ventricles is called a thin structure called the choroid plexus that makes CSF
• CSF flows within and around the brain and spinal cord to protect if from injury through tracts
• CSF is constantly being absorbed and replenished to maintain a balanced cerebral perfusion pressure
Cranium

- **Cranium (skull)-hard container**
  - Bony structure that protects brain from injury
  - 8 bones that have fused together along suture lines
  - All arteries, veins and nerves exit the base of the skull through holes called foramina
  - Foramen magnum is where the spinal cord exits
Cranial Nerves

- The brain communicates to the body via 12 cranial nerves & spinal cord
  - 10 of the 12 CN control hearing, eye movement, facial sensation, taste, swallowing and movement of the face, neck, shoulder and tongue muscles originating from the brainstem
  - 2 of the 12 CN control smell and vision which originates from the cerebrum
- Consist of sensory and/or motor functions

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Function</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>olfactory</td>
<td>smell</td>
</tr>
<tr>
<td>II</td>
<td>optic</td>
<td>sight</td>
</tr>
<tr>
<td>III</td>
<td>oculomotor</td>
<td>moves eye, pupil</td>
</tr>
<tr>
<td>IV</td>
<td>trochlear</td>
<td>moves eye</td>
</tr>
<tr>
<td>V</td>
<td>trigeminal</td>
<td>face sensation</td>
</tr>
<tr>
<td>VI</td>
<td>abducens</td>
<td>moves eye</td>
</tr>
<tr>
<td>VII</td>
<td>facial</td>
<td>moves face, salivate</td>
</tr>
<tr>
<td>VIII</td>
<td>vestibulocochlear</td>
<td>hearing, balance</td>
</tr>
<tr>
<td>IX</td>
<td>glosopharyngeal</td>
<td>taste, swallow</td>
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<tr>
<td>X</td>
<td>vagus</td>
<td>heart rate, digestion</td>
</tr>
<tr>
<td>XI</td>
<td>accessory</td>
<td>moves head</td>
</tr>
<tr>
<td>XII</td>
<td>hypoglossal</td>
<td>moves tongue</td>
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Meninges

- 3 layers that are cloth-like which covers the brain and spinal cord
  - DAP (dura, arachnoid, pia)
  - Dura mater - lines the inside of the skull
  - Arachnoid mater - web-like membrane that covers the entire brain; elastic tissue; space between dura and arachnoid membranes is subdural space
  - Pia mater - hugs the surface of the brain following all folds and grooves; space between the arachnoid and pia is the subarachnoid space
Brain Blood Supply

- Most complex circulatory system in the body
- 10 seconds of interruption in blood flow leads to unconsciousness
- The brain consumes 20% of entire oxygen used by the body
- Most neurologic disorders are due to vascular lesions
- The brain, face, and scalp supplies by two major sets of vessels
  - Internal carotid arteries
  - Vertebral arteries
Cerebral arteries

- Common Carotid artery courses up neck and divides into the internal and external carotid arteries
  - Brain’s anterior circulation is fed by the internal carotid arteries
  - Brain’s posterior circulation if fed by the vertebral arteries
  - Internal carotid and vertebral arteries pass through the skull and connect together to form the Circle of Willis
- Anterior circulation supplied by the internal carotids to perfuse the lobes of the majority of the cerebrum
- Posterior circulation supplied by the vertebral arteries to perfuse the cerebellum, brainstem, and underside of the cerebrum
Anterior Circulation

- Arteries involved in the anterior circulation:
  - Anterior Cerebral Artery (ACA)
    - Perfuses frontal lobes
    - Controls logic and personality
  - Middle Cerebral Artery (MCA)
    - Most often occluded in strokes and affects speech
    - Perfuses portion frontal lobe, lateral surface of temporal and parietal lobes
    - Small, deep penetrating arteries that branch from MCA and when occluded are called lacunar strokes
  - ACA and MCA join the posterior circulation to form the Circle of Willis
Posterior Circulation

- Right and left vertebral arteries join together to form the basilar artery, the basilar artery then joins with the internal carotid arteries to make the Circle of Willis.
Circle of Willis

• Formed by the joining of the anterior and posterior circulation made from the internal carotid and vertebral arteries.
• The joining of these two major arterial systems provides a safety mechanism for the brain
  • If one of the major vessels becomes blocked, the collateral flood flow from the other system can prevent brain damage
• Complete Circle of Willis is only seen in 20-25% of individuals
  • Posterior circulation anomalies are more common
References


• University of Miami Gordon Center for Research in Medical Educational. (2013). About the MEND. Accessed online at http://www.asls.net/mend_about.php