Functional Neuroanatomy and Traumatic Brain Injury – The Frontal Lobes

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Barrow TBI Symposium
March 23, 2019
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Outline

• TBI
• Mechanisms of Injury
• Types of Injury
• Common Deficits
• Regions of the Frontal Lobe and Their Functions
Definition of TBI

• A TBI is a traumatically induced structural injury and/or physiological disruption of brain function as a result of an external force that is indicated by new onset or worsening of at least one of the following clinical signs, immediately following the event: any period of a loss or decreased level of consciousness (LOC); any loss of memory for events immediately before or after the injury (post-traumatic amnesia [PTA]); any alteration in mental state at the time of the injury (confusion, disorientation, slowed thinking, etc.); neurological deficits (weakness, loss of balance, change in vision, praxis, paresis/plegia, sensory loss, aphasia, etc.) that may or may not be transient; or intracranial lesions.

• US Department of Veteran Affairs and the Department of Defenses Clinical Practice Guidelines For Management of Concussion/mTBI (2009)
Mechanisms of Injury

– **Closed head injury** - trauma as a result of a blow to the head, or a sudden, violent motion that injures the brain by pushing the brain against the inside wall of the skull.

  – Closed head injuries tend to have more diffuse (widespread) effects on the brain.

– **Open head injury** – trauma as a result of an object penetrating the skull and the dura of the meninges.

  – Open Head injuries tend to have more localized (involving only the areas of the brain that were directly injured) effects on the brain.
Types of Injuries

- **Primary Injuries** = damage to the brain that occurs at the time of the TBI
  - **Contusions** = brain bruises
    - caused by brain tissue hitting against the inside of the skull
  - **Hemorrhage/Hematoma** = collection of blood
    - Identified by where the bleeding takes place (i.e., epidural, subdural, subarachnoid, intraparenchymal)
  - **Axon Shearing** = stretching and tearing of the axons of neurons.
    - Diffuse Axonal Injury or Shear Injury
Common Deficits Associated with TBI

• Information Processing Speed*
  • Slow response time

• Attention*
  • Increased distractibility
  • Short attention span
  • Difficulty with divided attention

• Learning & Memory
  • For new information

• Executive functions

* Processing speed and attention are most commonly affected
Frontal Lobes

- Most vulnerable to injury
- Size – largest lobe
- Location – bony projections in skull
Regions of the Frontal Lobe

- Dorsolateral area of Prefrontal
- Orbital area of Prefrontal
- Medial area of Prefrontal
- Motor Cortex
- Premotor Cortex
- Cingulate
Regions of the Frontal Lobe

- **Primary Motor Cortex**
  - Located in the precentral gyrus, rostral to the central sulcus
  - Cortical neurons that project to the brainstem and spinal cord
  - Involved in the cortical control of voluntary movement
  - Damage results in:
    - Contralateral motor deficits
      - Initially a flaccid hemiparesis/hemiplegia
      - Later a spastic hemiparesis/hemiplegia
Regions of the Frontal Lobe

- **Premotor Cortex**
  - Located immediately rostral to the primary motor cortex
  - Assists in the integration of sensory and motor information for the performance of actions
  - Damage results in
    - Apraxia – inability to perform skilled actions that could previously be performed, but without paralysis
    - Deficits in contralateral fine motor control
    - Difficulty using sensory feedback for the control and performance of movements
Regions of the Frontal Lobe

- **Frontal Eye Fields**
  - Located rostral to the premotor cortex
  - Controls voluntary eye movement in the contralateral visual field for the purpose of active visual search
  - Damage results in:
    - Deficits in voluntary eye movements (active visual search), but preserved passive eye movement (the following of a moving object)
Regions of the Frontal Lobe

• Dorsolateral Prefrontal Cortex
  • Makes up the largest portion of the frontal lobe
  • Located rostral to the frontal eye fields and superior to the orbitofrontal cortex
  • Controls executive functions
  • Damage results in:
    • Perseveration
    • Task impersistence
    • Reduced sustained and complex attention
    • Reduced organizational skills
    • Reduced problem-solving, judgement, reasoning, insight
Regions of the Frontal Lobe

- **Orbitofrontal Cortex**
  - Inferior to the dorsolateral prefrontal cortex; most rostral portion of the frontal lobe
  - Controls the modulation of affective and social behavior, working memory, smell discrimination
  - Damage results in
    - Behavioral disinhibition
    - Socially inappropriate behaviors
    - Emotional lability
    - Irritability
    - Explosive outbursts
Regions of the Frontal Lobe

• **Anterior Cingulate Cortex** (Supplementary Motor Area)
  • Located in the medial portion of the frontal lobe superior to the corpus callosum
  • Connections to deep limbic structures
  • Control drive and motivation
  • Damage results in:
    • Reduced initiation
    • Apathy
    • Akinetic mutism
    • Complex attention deficits
Thank You