The Healthy Brain and Effects of Traumatic Brain Injury

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GENERAL OVERVIEW

• The Healthy Brain
  • CNS
  • Brain stem
  • Subcortex
  • Cortex

• TBI and TBI Effects

• Role of the Family
Central Nervous System (CNS)

- **CSN**: brain and spinal cord
- Brain: (a) brain stem; (b) subcortex; (c) cerebral cortex
- Spinal cord: mediator b/t spinal nerves and brain possessing nerve fibers that relay sensory information to brain and motor information from brain to rest of body.
**Corpus callosum**
A large band of nerve fibers through which information flows back and forth between the left and the right hemispheres of the brain.

**Thalamus**
The relay station for most information going into the brain.

**Hypothalamus**
Regulates sex hormones, blood pressure, and body temperature.

**Pituitary gland**
The master gland of the body produces its own hormones and also influences the hormonal production of the other glands in the body.

**Amygdala**
Regulates the heartbeat and other visceral functions and processes the emotion fear.

**Hippocampus**
Helps establish long-term memory in regions of the cerebral cortex.

**Basal ganglia**
A control system for movement and cognitive functions.

**Corpus callosum**
Essential for coordination of movement.

**Pons**
Control of breathing, circulation, heartbeat, and digestion.

**Spinal cord**

**Medulla oblongata**

*Image Description:*
- Cross-section diagram of the brain with labeled parts and functions.
- Detailed explanations of each labeled structure are provided alongside the diagram.
Brain Stem

- Located at top of spinal cord forming three major components
- Medula, pons, midbrain
- **Reticular formation**: runs through entire brain stem creating a network of fibers that mediates communication among spinal cord, cerebellum, cerebral cortex, and other brain structures
- **Reticular activating system (RAS)**: allow alertness to meaningful sights, sounds, or touches in environment. Crucial in maintenance of wakefulness, consciousness, and attention.
Brain Stem: Midbrain

- Visual information is initially relayed to midbrain (where visual reflexes originate). Blinking, dilation, constriction of pupil, and certain eye mvts.
- Hearing reflexes: being startled by loud noise
- Basic mvt patterns: walking and running
Brain Stem: Pons

- Lies just below midbrain
- Regulation of sleep-wake cycle
- Upper portion: wakefulness
- Lower: permits one to fall asleep
- Vital inhibition of motor activity that accompanies certain stages of sleep
Brain Stem: Medulla

- Lowest structure in brain stem
- Regulation of cardiovascular system, breathing, and maintenance of muscular tone in skeletal muscles
- Implicated as mechanism that assist in reducing body’s sensitivity to pain
SUBCORTEX

- Includes cerebellum, hypothalamus, thalamus, basal ganglia, and limbic system viewed as resident to the subcortex

- Arousal, initial filtering of and orientation to sensory stimuli, coordinated stereotypic response patterns (fight or flight), and execution of complex behaviors (including instinctive responses)
SUBCORTEX: Cerebellum

- Not technically subcortical
- Lies behind medulla and lower portion of cerebral cortex
- Diverse motor skills depending on region of cerebellum
- Vermis (middle): postural disturbances and cognitive deficits (learning and memory, executive control, visuoperception).
- Lateral lesions result in difficulty coordination rapid alternating mvts.
- Vertigo and disturbance of eye movements
SUBCORTEX: Hypothalamus

- Basic regulatory functions: thirst, appetite, sexual arousal
- Lesions: diminished drive states, obesity, and loss of decreased temp. regulation
SUBCORTEX: Thalamus

- Lies near middle of brain and composed of two halves
- Station for most sensory pathways to the cerebral cortex, contributing significantly to conscious experience of sensation
- Higher cortical functions such as language (decr verbal fluency, spontaneity of speech, and reduced tone) and memory (retro- and anterograde)
- Emotional alterations such as reduced spontaneity, apathy, or lowered initiative in thalamic lesions
SUBCORTEX: Basal Ganglia

- Lies at base of cerebral hemispheres
- Contains 3 structures: putamen, globus pallidus, and caudate
- Motoric control and voluntary and automatic mvts
- Translates cognition into action
- Contributes to learning, memory, receptive, and expressive language.
Several structures that add to regulation of emotions

Includes hypothalamus, cingulate, septal region, hippocampus, fornix, and amygdala

Regulate and adjust emotional tone that accompanies behavior and contributes to motivational aspects of behavior and learning and memory

**Cingulate lesions**: amotivational or akinetic syndrome: no initiation of behavior and will at times simply sit for hours
**SUBCORTEX: Limbic System**

- **Septal regions**: expression of intense anger or rage
- **Hippocampus**: learning and memory. Consolidates new info and contributes to transition of ST to LT memory formation
- **Fornix**: originates in hippocampus and is critical interconnection for neurocircuitry w/in system
- **Amygdala**: expression of emotional responses and participates in laying down of new learning, especially those with emotional component.
**CROSS SECTION**

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**Medulla oblongata**
Spinal cord
CEREBRAL CORTEX

- Newest and most developed portion
- Participates in highest level of cognitive processing
- Contributes to aspects of personality and social interaction
- 2 hemispheres and 4 lobes – occipital, parietal, temporal, and frontal
CORTEX - Hemispheres

- Left (in most right-handed):
  - Language abilities
  - Verbal Memory
  - Seeing the details
  - Right-sided sensory / motor movements
CORTEX - Hemispheres

- Right:
  - Visual Spatial Abilities
  - Control of left side of body
  - Memory for visual objects
  - Attention
  - Awareness
  - Seeing the Big Picture
  - Understanding subtleties of speech
CORTEX – Occipital Lobe

- Location in back of brain
- Integration of visual stimuli
- Visual info travels from retina → thalamus → OL
- Info then passes to parietal lobe: plays role in visuospatial location or object position
- Info passes to temporal lobe: provides object recognition and analysis of form and shape
- **Lesions**: deficits in object location, double-vision, blurred vision,
CORTEX – Parietal Lobe

- Located on top and in posterior part of brain

1. Visuospatial location or object position

2. Processes sensory and tactile information

3. Some aspects of language (3 R’s)
CORTEX – Parietal Lobe

- Lesions:
  - Deficits in body sense, touch, pressure, pain
  - Anomia
  - Alexia
  - Agraphia
  - Acalculia
  - Attentional problems of opposite side (esp w/right-sided lesions)
  - Visual spatial neglect or inattention
CORTEX – Temporal Lobe

- Located near the temples

1. Processing auditory information
   - Heschyl’s gyrus: primary auditory area where info is initially integration

2. Comprehension of speech with unawareness of deficit (Wernicke’s aphasia)

3. Memory. Transforms short-term info into long-term storage. Located within hippocampus / dentate gyrus
Lesions

- Difficulties with audition or hearing
- Learning new information or recalling previously learned information (retrograde vs anterograde amnesias)
- Problems understand what others are asking and responding as if you understood
CORTEX – Frontal Lobe

- Executor of the brain: highest level of cognition
  - Judgment
  - Planning
  - Inhibition
  - Problem-solving
  - Initiation
  - Impulsivity
  - Cognitive flexibility vs. perseveration
  - Confabulation
  - organization
4 major anatomical areas including

- **primary motor cortex**: motor functioning, executive function deficits, perseveration, stimulus-bound behavior, diminished verbal fluency
- **dorsolateral prefrontal cortex**: disinhibition, inappropriate affect, impaired judgment and insight, distractibility
- **lateral orbital cortex**: disinhibition, inappropriate affect, impaired judgment and insight, distractibility
- **anterior cingulate cortex**: apathy, mutism, lower extremity paresis, incontinence
Lesions

- Solving problems and planning appropriately
- Abstract reasoning: Seeing the big picture
- Initiation: Getting tasks started and keeping them going
- Making proper decisions and using good judgment
- Being able to stop from “acting without thinking”
- Having awareness of our actions and consequences of them
- Mental flexibility: Being able to be flexible in our thinking and not “stuck” on one idea
CORTEX – Frontal Lobe

- Frontal lobes also responsible for:
  - Movement of certain body parts
    - Lesions: paralysis or weakness on one side
  - Controls expressive speech
    - Lesions: ability to speak fluently or Broca’s aphasia (paraphasias, dysnomia, semantic aphasias)
CORTEX – Frontal Lobe

- Frontal lobes also responsible for:
  - Aspects of Attention
    - Lesions: Paying attention for a long time and doing several things at once
  - Controls emotional responses and personality
    - Lesions: May experience more emotional “ups” and “downs”
Parts of the brain and what they do

FRONTAL LOBE
- Thought
- Reasoning
- Behaviour
- Memory

PARIETAL LOBE
- Sensory perception
- Spatial relations
- Hearing
- Left - speech, motion, sensation*
- Right - abstract concepts*

TEMPORAL LOBE
- Smell
- Vision Pathways
- Emotion

TEMPORAL LOBE
- Pons
- Medulla

OCCIPITAL LOBE
- Vision

* - For right handed individuals
Traumatic Brain Injury

- Occurs when a sudden trauma causes damage to the brain.

- Can result when the head suddenly and violently hits an object, or when an object pierces the skull and enters brain tissue.
Traumatic Brain Injury

- Leading causes of TBI are motor vehicle accidents, acts of violence, falls, sports and recreational injuries, lightening strikes, electric shocks, and blows to the head.

- Symptoms of a TBI can be mild, moderate, or severe, depending on the extent of the damage to the brain.
Traumatic Brain Injury

- Closed Head Injury:
  - Occurs when brain is injured without opening of the skull.
  - Damage to the brain is caused by
    - bruising and bleeding within the brain (contusions, hematomas, hemorrhages)
    - tearing and stretching of nerve cells
    - swelling of the brain (edema)
    - Fluid build up causing pressure on the brain tissue
Penetrating (Open) Injury:

- occurs when brain is injured by a sharp object entering the skull and going through the brain tissue.
- Bullets, foreign objects, swords, knives, etc
Primary Factors in TBI

- Acceleration injuries
- Linear and rotational inertia of brain in relation to skull
  - Pt turns reflexively from impact
  - Skull stops, brain rotates
- Areas next to ridges most vulnerable
  - Anterior and inferior temporal lobe
  - Orbitofrontal, ventromedial prefrontal
  - Medial temporal (limbic)
Primary Factors in TBI

- Diffuse Axonal Injury
  - Bony structures carry surface brain tissue forward while deeper brain remains momentarily stationary because of inertia
  - Axons are torn, twisted, or broken
Figure 2–6. Diffuse axonal injury: twisting, tearing, and breaking of axons associated with primary impact damage in traumatic brain injury.
Cognitive Effects of TBI

- Processing speed: Speed of thinking slowed, takes longer to do things
- Attention: Difficulties focusing and paying attention
- Executive abilities: Problems with those “higher-level” thinking abilities
- Memory: Difficulty learning and remembering new information
Behavioral Effects of TBI

- Difficulty getting started on tasks
- More mood swings
- Act before thinking
- Being aware of one’s actions/ strengths/ weaknesses
- Irritability or aggression
Behavioral Effects of TBI

• More of less sleep than usual
• Increased or decreased interest in sexual activities
• Feeling more tired than usual
Emotional Effects of TBI

• Feelings of being “on edge”
• Feeling down and sad
• Feeling nervous and anxious
• Hitting, yelling, or punching
• Appearing as if one “doesn’t care about things”
• Feeling more frustrated and helpless
• Not wanting to live anymore
The brain is a system, each area heavily connected with other areas. Damage to any one area usually causes a variety of difficulties. Most common problems are memory, attention, and higher level thought functions. If a person had problems before with thinking, memory, behavior, etc., it is likely to become worse after an injury.
Importance of Family

- **In the hospital**: Emotional Support, treatment decisions, discharge planning

- **Out of the hospital**: supervision, emotional support, assistance with transitioning back into the community, assistance with self-care activities, becoming a chauffer, financial support
Importance of Family

- How a family member copes can also depend on the characteristics of the survivor:
  - personality changes
  - behavior changes
  - emotional status
  - physical disability
  - cognitive status
Importance of Family

• Research has demonstrated that families’ reports of the greatest amount of caregiver distress are related to personality, emotional, and behavior changes in the patient with TBI (and cognitive changes), rather than severity of injury or physical disability.
Emotional Reactions of Families

- Shock
- Anxiety
- Denial
- Depression
- Anger
Emotional Reactions of Families

- Fatigue
- Mourning
- Frustration
- Concerns about being in a new role
Consider how the follow scenarios from the perspectives of both the family member and the survivor.

- A spouse becoming a caretaker and sometimes a parental figure.
- An adult child is now providing care and supervision for his/her parent
- Empty nesters are having to ask children to live with them once again
- The primary “breadwinner” is now dependent on his/her spouse for financial support
Changes in Roles

Responding to changes in roles:

• It is normal to feel uncomfortable with changes in roles.

• Consider looking at the situation from your loved one’s perspective.

• Individuals often report that they adjust better to these roles changes with support of everyone involved and with good communication.

• Consider involving the survivor in important family decisions and everyday routines, as they still play a significant role and contribution to the overall family functioning.
Common Statements

• I should not take any time for rest.
• It should have been me
• I could have done something to prevent it
• There is nothing I can do to improve this situation
• My loved one just isn’t the same anymore
• I’ve lost the person I once knew
• I know it may not be their fault, but I can’t help but get frustrated.
Common Statements

- Reactions of guilt and sadness after a loved one experiences a brain injury are very common and normal.
- However, if these concerns become severe and are not addressed they can impede recovery.
  - Try seeking support from other family members or friends.
  - Try seeking professional support from a counselor or spiritual leader.
  - Try participating in local support groups or access internet websites to identify more ways of obtaining support.
Family Concerns

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