Concussion Recovery and Prevention: Neuroplasticity, Normal Concussion Course vs. Complicated Course

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• Dr. Perrine receives compensation as a consultant for the New York Jets and the New York Islanders
"Voila! ... Concussion-proof!"
Topics

• Neurological substrate of recovery
• Neuroplasticity concepts
• Normal concussion course (recovery)
• Complicated concussion recovery
Neurologic Substrate of Recovery

• Biochemical cascade:
  1. Immediate release of neurotransmitters
  2. Acute hypermetabolism
  3. Refractory hypometabolism

Biochemical Cascade of Concussion: Stage 1

Immediately following concussion:

- Disruption of neuronal membranes
- Stretching of axons
- Wave of neural excitation
- Followed by wave of neuronal suppression
  - Could explain loss of consciousness, amnesia, being dazed
- Reduced blood flow to the brain
Biochemical Cascade of Concussion: Stage 2

Hypermetabolism follows Stage 1:

- The brain tries to restore balance, requiring use of energy (glucose)
- Use of energy results in lactate production
- Blood flow to the brain remains reduced
  - Problematic because blood supplies glucose to the brain
Biochemical Cascade of Concussion: Stage 3

- Glucose use is decreased by 1 day post injury
- Low levels of glucose use (hypometabolism) can remain for days to weeks
- Reduced blood flow may last for days

* Post-injury hypometabolism not related to * level of consciousness
Neuroplasticity

What is neuroplasticity?

• Structural or functional reorganization of nervous system

• Important in recovery from brain injury: stroke, surgery, TBI
Neuroplasticity & Concussion

• “Concussion” generally does not include major structural damage to the brain
• However, changes at the cellular level do occur (biochemical cascade)
• Recovery from these changes is considered neuroplasticity
• Neurons can generally recover after initial concussion
• BUT second concussion during the recovery period may lead to cell death
Neuroplasticity and Concussion

- Neurotransmitters, lactate, glucose, neuroinflammatory processes and other functions gradually return to normal states.
- The brain has a natural response to disruption and spontaneously heals itself when damage is not severe.
- Neural networks damaged by the biochemical cascade can be compensated for by new neural networks serving the same function.
Recovery

• Most uncomplicated concussions resolve in 1-2 weeks
• If more than a few symptoms are present at 4-6 weeks, or some severe, consider evaluation at a concussion clinic
• COMPLETE cognitive and physical rest is no longer considered appropriate
• Tailor rest to symptoms— if activity produces/exacerbates symptoms, back off
• As recovery progresses, increase activity
Recovery after Moderate to Severe TBI

Never reaches plateau—Recovery continues for years
Recovery after Uncomplicated Concussion

![Graph showing percent recovery over days post-injury. The percentage increases over time, reaching completion by 24 days.](image-url)
Well-Intentioned Exacerbation

• Internist or other health care provider advises complete rest; no computer, cell, video, reading
• Advises no work for xx days/weeks
• No other medical disorder advises complete rest– surgery, back pain, etc.
• There is NO research showing that complete rest improves or speeds up recovery
• Can result in the injured person inadvertently assuming a “sick role”
Risk Factors for Extended Recovery

- History of:
  - Prior concussions (LOC not that predictive)
  - Learning disabilities
- Post-traumatic Amnesia
- Younger age—white matter tracts not fully myelinated yet
- Still “foggy” at one week
- Absence of practice effect on testing
Other Factors Affecting Cognition and Return to Normal Functioning

- Severity of concussion
  - Loss of consciousness
  - Retrograde Amnesia
  - Post-Traumatic Amnesia (most important!)

- Pre-morbid (injury) factors
  - Baseline cognitive functioning
  - Personality style
  - Occupation, responsibilities
  - Family (support, responsibilities)
Functional Disability Long after mTBI

- Neurological factors
  - Nerve injuries or other longer-lasting symptoms
- Physical factors
  - Orthopedic or other non-neurologic injuries
- Psychological factors
  - Strongest cause of prolonged/incomplete recovery
- Personality factors
  - Pre-morbid personality style
- Psychosocial factors
- Litigation
Psychological factors

- Cognitive compromise (attention, mental efficiency, learning & memory)
- Cognitive symptoms create frustration, emotional distress, & “shaken sense of self”
- Anxiety & avoidance of anxiety provoking situations
- May result in depression
- Anxiety & depression cause further cognitive problems, which create more anxiety & depression
- Psychological overlay accumulates & intensifies
- May become more disabling than the injury
Other Psychological Factors

• Personality styles:
  – Overachiever
  – Dependent
  – Insecure
  – Grandiose
  – Borderline Personality characteristics

• Emotional significance of the injury
  – Sense of self
  – Setback to lifelong goal
Long-Term ( > 6 weeks ) Symptoms

- “Post-Concussion Syndrome”
- Psychosocial and psychiatric condition related to aforementioned features
- Patients often invested in believing “it’s my brain” rather than accepting psychosocial factors
- Cognitive symptoms can last for years, and are REAL for the patient
- Best treated by psychotherapy or, better yet, cognitive remediation
  - Helps remediate perceived deficits in attention, concentration, memory, executive functions
  - Teaches coping strategies for symptoms
  - Compensatory strategies
  - Relaxation training
- Referral to neurologist trained in concussion can help with residual headaches and sleep problems