Traumatic Brain Injury

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Topics

• Impact and inertial damage
• Risk of epilepsy
• Further Cognitive Decline
• Risk of neurodegeneration and dementia
• Loss of Consciousness and PTSD
Site of injury

TBI very frequently affects the *frontal lobes*, both directly, (coup and contrecoup), and by white matter disconnections (known as diffuse axonal injury).

cf. Mood, Impulse Control, Personality, and Executive Functioning.
Frontal and Temporal Involvement

“Due to excessive tissue strain in areas where the brain is confined by ridges of the inner skull, focal contusional damage in TBI predominates in ventral and polar frontal and lateral anterior temporal lobe regions” (Gentry, Godersky, & Thompson, 1988; Holbourn, 1943).
Inertial Damage

Stretching and tearing, particularly if the primary injury is on a side of the head, caused by rotational forces, tend to cause widespread disturbance of neuronal connections, so-called *diffuse axonal injury (DAI)*.
Frontal and Temporal Involvement

Diffuse axonal injury (DAI) resulting from acceleratory/deceleratory forces, is more ubiquitous and leads to white matter atrophy and deafferentiation of widespread axonal projections, including those from and to frontal and temporal brain regions."

Inertial Damage

"Diffuse Axonal Injury (DAI) is the predominant mechanism of injury in 40% to 50% of traumatic brain injuries (TBIs) requiring hospital admission in the United States. A component of DAI is believed to be present in all motor vehicle crashes where the patient has lost consciousness."

Visualisation

• CT
• MRI (cf. power of magnet)
• Diffusion Tensor Imaging DTI

Diffuse axonal injury is becoming more commonly observed with research tools, such as diffusion tensor imaging, which may be used to map and characterize the three-dimensional diffusion of water as a function of spatial location.
Visualisations

These are probably restricted and unavailable for distribution.
Severity

Russell’s original scheme remains the usual way of relating the period of post-traumatic amnesia to severity of brain injury. It continues to be commonly used by clinicians and in the scientific literature.

• Mild less than 1 hour;
• Moderate 1-24 hours;
• Severe 1-7 days;
• Very Severe more than 7 days
Severity

"Duration of PTA (post-traumatic amnesia) was predictive of functional outcome in 276 TBI (traumatic brain injury) patients admitted to a level I trauma centre (Zafonte et al 1997). Duration of PTA was even more predictive of disability rating scale and Functional Independence Measures scores with PTA".

Complications in retrospectively assessing the duration of PTA

• Opiods
• Sedatives
• Analgesics
• General anaesthetic(s)
## Glasgow Coma Scale

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<tr>
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<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>Eye</td>
<td>Does not open eyes</td>
<td>Opens eyes in response to painful stimuli</td>
<td>Opens eyes in response to voice</td>
</tr>
<tr>
<td>Verbal</td>
<td>Makes no sounds</td>
<td>Incomprehensible sounds</td>
<td>Utters inappropriate words</td>
</tr>
<tr>
<td>Motor</td>
<td>Makes no movements</td>
<td>Extension to painful stimuli (decerebrate response)</td>
<td>Abnormal flexion to painful stimuli (decorticate response)</td>
</tr>
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<tr>
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<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye</td>
<td>Opens eyes spontaneously</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Verbal</td>
<td>Confused, disoriented</td>
<td>Oriented, converses normally</td>
<td>N/A</td>
</tr>
<tr>
<td>Motor</td>
<td>Flexion / Withdrawal to painful stimuli</td>
<td>Localizes painful stimuli</td>
<td>Obeys commands</td>
</tr>
</tbody>
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Glasgow Coma Scale

• Severe Head Injury    GCS score of 8 or less
• Moderate Head Injury  GCS score of 9 to 12
• Mild Head Injury      GCS score of 13 to 15

(Adapted from: Advanced Trauma Life Support: Course for Physicians, American College of Surgeons, 1993).

(Unless invalidated by factors such as intoxication, sedation, and systemic shock.

Because of the delay in attracting help, the initial GCS is unlikely to be available.)
Personal Injury Claims

Extent of brain injury and sequelae

• Cognition
• Personality
• Mood disorder
• Psychosis
• Loss of Consciousness and PTSD
Long term problems

- Further Cognitive Decline and reduced cognitive reserve.
- Risk of epilepsy.
- Increased risk of neurodegeneration (Parkinson's Disease and ALS) and Dementia.
Epilepsy

• In the first 4 years after severe brain injury, the risk of epilepsy was found to be elevated 17 times, declining to 12 times in the period of 5 to 9 years post injury, and to 4 times for a period of 10 years or more.

Epilepsy

The relative risk of seizures was 1.5 (95 percent confidence interval 1.0-2.2) after mild injuries, but with no increase after 5 years; 2.9 (95 percent confidence interval 1.9-4.1) after moderate injuries; and 17.2 (95 percent confidence interval 12.3-23.6) after severe injuries. Significant risk factors were brain contusion with subdural hematoma, skull fracture, loss of consciousness or amnesia of 1 day or more...

We found a strong relationship between severity of TBI and risk of subsequent unprovoked seizures. We also found that severity of injury is correlated with the duration of increased risk after TBI. (Annegers & Coan 2000).
Progressive Damage

Aberrant neuronal sprouting, two nerves communicating with each other via an aberrant connection (synapse) between nerves (ephaptic transmission) after injury, recoating of the nerves (remyelination), and late inflammatory changes are suggested pathophysiological mechanisms for deterioration.
Progressive damage

Recent evidence has identified axonal degeneration in human brain material years following injury, suggesting TBI may precipitate a progressive, long-term neurodegenerative process, in part reflected in axonal degeneration. Of particular note, axonal pathology may have a role in the development of Alzheimer-like pathologies both in the acute phase following injury as well as with longer term survival."

Risk of Early Dementia

"Compelling epidemiological evidence indicates that a single moderate to severe traumatic brain injury (TBI) is associated with increased risk of development of progressive disorders of cognitive impairment leading to dementia."

PTSD

People might understandably regard being rendered unconscious as completely protective against Post Traumatic Stress Disorder. However, the evidence shows that this protection is incomplete. It is thought that in part this is probably because of the *descriptions of the accident* available from others, and that the physical consequences act as a potent reminder.
PTSD

Case studies have described PTSD after severe traumatic brain injury [e.g. Bryant (1996)]. Biological theories propose that a conditioned fear of traumatic experiences can be mediated in subcortical structures that are independent of higher cortical processes

PTSD

96 cases of a severe traumatic brain injury assessed for PTSD 6 months after the injury with a structured clinical interview. PTSD was diagnosed in 26 (27.1%) of the patients (Bryant et al. 2000). The authors suggest that it is possible that the deficient coping skills associated with severe traumatic brain injury resulted in patients who suffered trauma re-experiencing being unable to manage the distress caused by the symptoms.
PTSD


Legal aspects

• There is a potential for exaggeration of the duration of PTA and of symptoms.
• MRI is seldom available on admission.
• On the other hand, individuals who suffer debilitating TBI require rehabilitation and may often require lifelong medical care and support.
Legal aspects

• Alcohol abuse and risk taking may predispose to TBI.
• From a legal point of view, these behaviours can be considered in 2 ways:
  • As contributing to the injury and explaining post injury personality.
  • As psychiatric vulnerability with an egg shell personality.
“We recently reported that 82% of individuals who had just been taken into custody gave a history of TBI at some time in the past, and 65% reported one or more TBIs associated with loss of consciousness. While many prisoners reported receiving treatment for the TBI, over half had unresolved effects from the event, the most common being
Legal aspects/Forensic

• headaches, personality change, anxiety/depression, memory loss, uncontrollable anger, and relationship breakdowns.”

Legal aspects/Forensic

• Methods: A self-report survey of adult, male offenders within a prison. Of 453 offenders, 196 (43%) responded.

• Results: Over 60% reported ‘Head Injuries’. Reports consistent with TBI of various severities were given by 65%. Of the overall sample, 16% had experienced moderate-to-severe TBI and 48% mild TBI. Adults with TBI were younger at entry into custodial systems and reported higher rates of repeat offending. They also reported greater time, in the past 5 years, spent in prison.