Karl Landsteiner Institute for Neurorehabilitation and Space Neurology

Biomechanics of a Traumatic Impact on the Head and Clinical Sequences

F. Gerstenbrand [1),2)], W. Struhal [3)], S. Golaszewski [1),4)], A. Kunz [1),4)]

[1)] Karl Landsteiner-Institute for Neurorehabilitation and Space Neurology, Vienna, Austria
[2)] Department of Neurology, Medical University Innsbruck, Austria
[3)] Neurological Department, General Hospital, Linz, Austria
[4)] Neurological Clinic, University Salzburg, Austria

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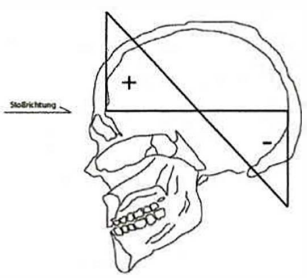
Impact on the Head Acting Forces

- Intensity of the Force
- Direction of the Force
- Localisation on the Head
- Movement of the Head
- Acceleration / Deceleration Impact

Sequences of an Impact on Head

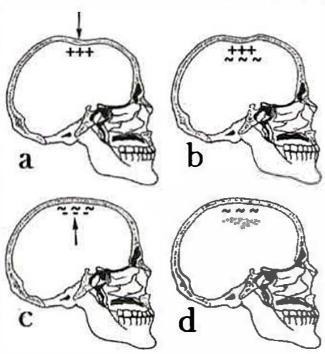
- Positive pressure at impact pole
  negative pressure at contre coup pole
- Traumatic damage of brain tissue in pressure region
- Traumatic damage of vessels in pressure region
- Cavitation effect in impact region

Biomechanics, physical analysis
Sellier, Unterharnscheidt, 1963



- Positive pressure at the impact pole
- Negative pressure at the counter pole

Biomechanics, cavitation trauma
after A.G. Gross, 1958



•Lesions on the impact region(a)

(b): direct damage due to impressed skull bone , positive pressure leads to lesions on the brain surface, cortical region, overpressure

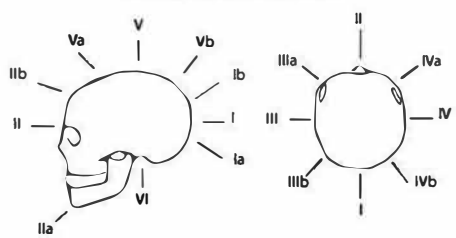
• Due to snapping back of the elastic skull bone (c), negative pressure emerges gas bubbles (d), cortical lesions

Impact scheme in closed skull trauma

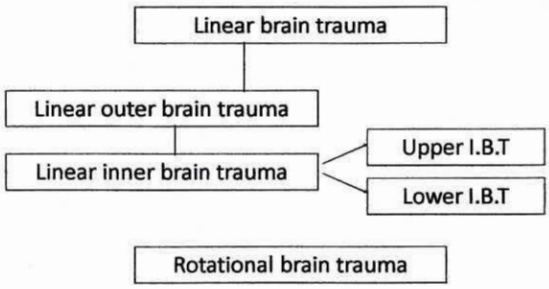
Brain tissue damage depends on
- Direction, form of impact
- Location of impact
- Intensity of the force

Documentation after Spatz, Innsbruck modified

Multiple impacts possible



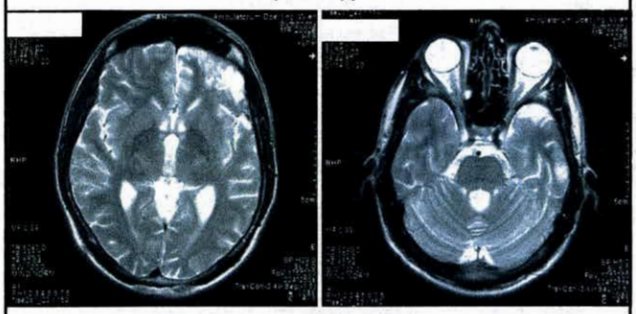
Different Types of Brain Trauma
Classification by biomechanical analysis



Linear Outer Brain Trauma
(Type I, II, III, IV)

- Coup lesions, contre-coup lesions
  - cortical, subcortical, meningeal damage, funnel-shaped
    - Type I severe lesions fronto-temporal contre-coup negative pressure
    - Type II minor lesions frontal force absorption by facial skeleton
    - Type III, IV mostly combined with rotational brain trauma

Linear outer brain trauma, impact type I



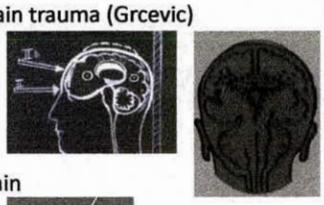
Severe lesions frontal, temporal, minor lesion cerebellar

Linear Inner Brain Trauma
Primary Lesions

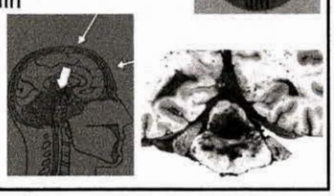
- Inner upper brain trauma (Grcevic)
  - Lesions periventricular (butterfly type): corpus callosum, septum pellucidum, fornix, thalamus, hypothalamus, cingulum
- Inner lower brain trauma (Lindenberg)
  - midbrain-pons lesions (substantia nigra, perirubral zone, crura cerebri, tegmentum, periaqueductal gray, upper pons),
  - surrounding brain regions (perihippocampus, uncus amygdalae, cerebellum)

Linear Inner Brain Trauma

- a) Linear inner upper brain trauma (Grcevic) butterfly lesions
  Type IIb, Ia (II)



b) Linear inner lower brain trauma (Lindenberg) lesions brain stem, surrounding brain region
Type V, Va



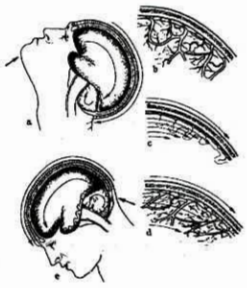
Linear Inner Upper Brain Trauma
Type Ib

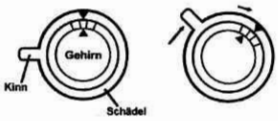
Frontal white matter, periventricular damage

Linear Inner Lower Brain Trauma, Type Va, Primary lesions

Gliotic lesions with haemosiderin deposition, lower midbrain, pons

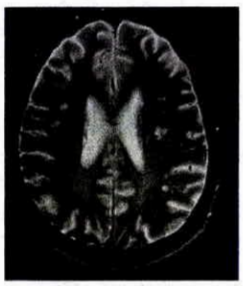
Rotational trauma – Scheme
Pudenz-Shelden



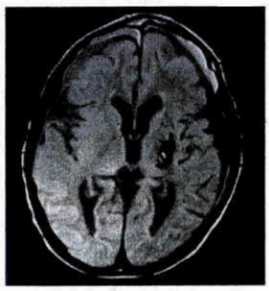


- Laceration (capsula int., basal ganglia)
- Intracerebral haemorrhage (thalamus, hypothalamus)
- Extracerebral haematoma (subdural, epidural)

Rotational Brain Trauma Type IIb

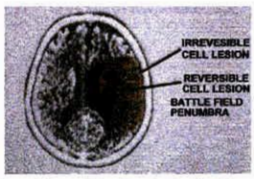


White matter lesions, small hematoma



Lesions: basalganglia, capsula interna

Different forms of traumatic lesions



- Primary lesions (irreversible)
- Secondary lesions (therapeutic battle field) Penumbra, postedemic, posthypoxic, posthypoxemic (diffuse/local)
- Tertiary lesions (malnutrition, malabsorption, avitaminosis, bed rest syndrome, etc.) Encephalopathy, myelopathy, pontine myelinolyse, polyneuropathy
- Quarternary lesions hydrocephalus occlusus, meningoencephalitis, brain abscess
- Complications, Bed Rest Syndrome joint contraction, periarticular ossification, decubitus, polyneuropathy

Type of Traumatic Brain Damage I

- Primary lesions, immediately by impact, mostly irreversible
  - Outer brain trauma
  - Inner brain trauma
  - Rotational brain trauma
- Complications
  - Bed Rest Syndrome

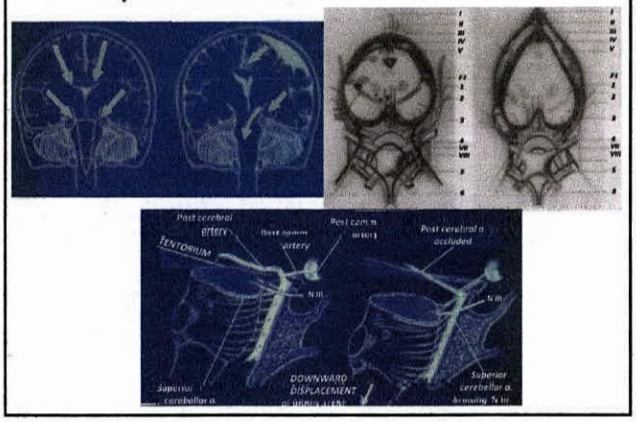
Type of Traumatic Brain Damage II

- Secondary lesions of brain tissue
  1) Umbra/Penumbra, primary impact
     - regional lesions
  2) Non-cerebral disorders caused by hypoxia, hypoxemia, circulatory disturbances
     - local, regional, diffuse lesions
  3) Tentorial herniation

     a) local damage due to tentorial edge
     - local lesions (upper brain stem, medial temporal lobe)
     - regional lesions due stenosis of A.cerebri posterior

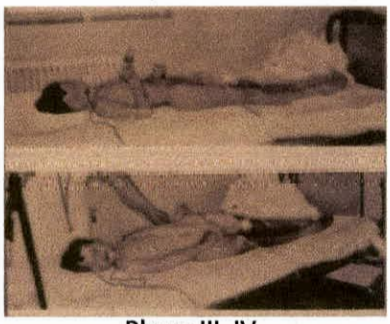
     b) Downwards displacement of brain stem
     - local lesions due arterial and venous stenosis
     - brain nerve lesions (N.oculo-motorius

Supratentorial volume increase



Acute secondary midbrain syndrome

Brain edema, tentorial herniation

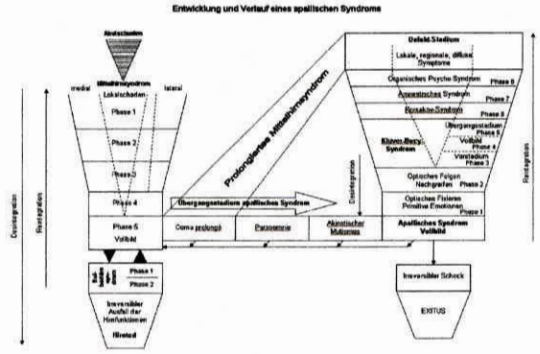


Phase III, IV

Severe Brain Trauma

further course

F. Gerstenbrand, 1967, 1977, F. Gerstenbrand, E. Rumpl, 1983



Apallic syndrome, pat. E.S., 19ª

traumatic brain injury, 1992

Modern treatment program in special center for apallic syndrome patients

No tertiary lesions, minimal complications

Remission after 5 months to minimal defect state

Prognosis of Traumatic AS

- Within the first 6 weeks in severe and severest cases of traumatic brain injury no prognosis is possible
- Within the first 6 months no decisions about ongoing of active treatment program possible
- 80% of the patients with a traumatic apallic syndrome develop remission
- 25% of the patients with a traumatic apallic syndrome can be reintegrated in normal life
- 60% of the patients with a hypoxic apallic syndrome develop remission, but mostly with severe defects

Classification of brain trauma

- Mild traumatic brain injury
  (brain commotion, Commotio Cerebri, Hirnerschütterung)
  Glasgow Coma Scale (GCS) = 13 – 15
- Moderate traumatic brain injury
  (brain contusion, Contusio Cerebri – mild degree)
  GCS = 9 – 12
- Severe traumatic brain injury
  (brain contusion, Contusio Cerebri – severe degree)
  GCS = 5 – 8
- Severest brain injury – brain stem symptoms (acute midbrain syndrome, acute bulbar brain syndrome)
  GCS < 5

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SELBST HILFE GRUPPE SCHÄDEL HIRN TRAUMA

Trauma Österreichische Gesellschaft für Schädel-Hirn-Trauma

BIENNIAL CONFERENCE of the BRAIN INJURY AND FAMILIES / EUROPEAN CONFEDERATION (BIF)

Programme

Last Updated on Monday, 14 September 2015 12:35

	Friday, 18th Sept.
09:00-10:15	**OPENING CEREMONY** *Dr. Nikolaus Steinhoff, General Secretary of BIF* *Mr. Hans Grugger, Austrian Ski Champion* *Univ. Prof. Dr. F. Gerstenbrand:* Biomechanics of a Traumatic Impact on the Head and Clinical Sequences *Evelyn Vincent, President of BIF*
10:15-10:30	Coffee break
10:30-12:00	**Panel session 1 - Acute Management after TBI** Chair: A. Brazinova Multicenter study of prehospital and early in-hospital TBI care in Austria *A. Brazinova* Role of computed tomographic scanning in pediatric head injury:A case series study of 60 patients *P. Sharma* „I didn't really know what was going on": Sibling experiences and needs after brain injury *A. Tyerman*
12:00-13:00	Break for Lunch

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