Karl Landsteiner Institute
for Neurorehabilitation
and Space Neurology

Die große Herausforderung der Neurotraumatologie – Verletzungen des zentralen und peripheren Nervensystems *Einleitung*

F. Gerstenbrand

Karl Landsteiner-Institute for Neurorehabilitation and Space Neurology, Vienna, Austria

11. Jahrestagung der Österreichischen Gesellschaft für Neurologie

26.März 2014
Salzburg

Die Hirnverletzung Biomechanik, Klassifikation

Einleitende Darstellung

Traumatic brain injury (TBI)

- is a frequent cause of morbidity and mortality in the European countries
- incidence between 229 and 1.967 for 100.000 inhabitants
- highest incidence in men between 15 and 24 years
- most frequent cause of death for humans under 45 years (most frequent cause of death between age of 20 – 35 years worldwide in the male population)

Different types of TBI

- Closed Brain Trauma
  sometimes combined with fracture of skull
- Open Brain Trauma
  by a penetrating object (bullet, etc.)

Patterns of Brain Trauma Acceleration - Deceleration

- Outer brain injury
- Inner brain injury
- Rotational brain injury

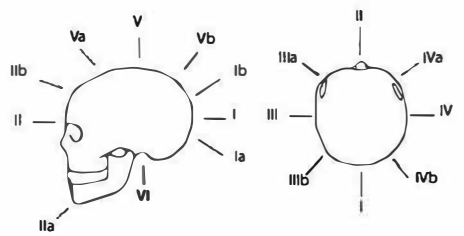
Head Trauma

Impact Scheme modified after Spatz

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

Documentation after Spatz, Innsbruck modified

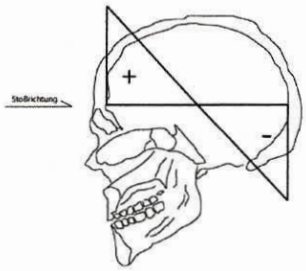
Multiple impacts possible



Different types of head impact

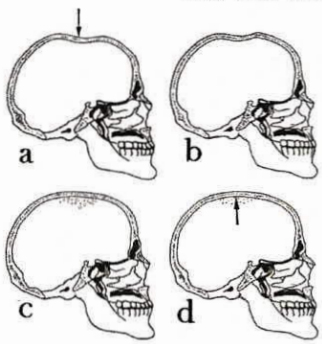
- Translational impact, local
  - Local, brain surface
  - Local, midbrain
- Cavitation trauma
  - Local
  - Periventricular
- Rotational trauma (Pudenz-Shelden)

Biomechanics of Head Impact, Sellier, Unterharnscheidt, 1963



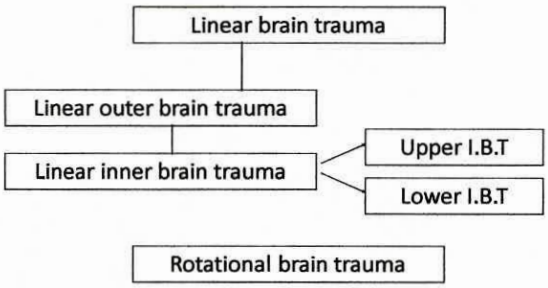
- Positive pressure at the impact pole
- Negative pressure at the counter pole

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



- Lesions on the impact region (b):
  Direct damage due to the impressed skull bone , positive pressure
- Due to snapping back of the elastic skull bone, negative pressure emerges gas bubbles (d)

Different Types of Brain Trauma
Classification by biomechanical analysis

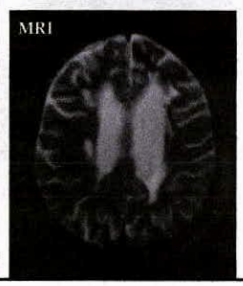


Linear Outer Brain Trauma
(Type I, II, III, IV)

- Coup lesions, contre-coup lesions
  - Cortical, sub-cortical, meningeal damage, crater-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

- Lesions on the surface of the brain, cortical-subcortical meninges (funnel-shaped)



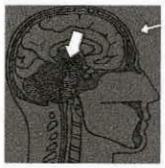
Linear Inner Brain Trauma

- 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) cavitation trauma

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



Linear Inner Upper Brain Trauma
N. Grcevic

Impact type IIb, Ia, (II)

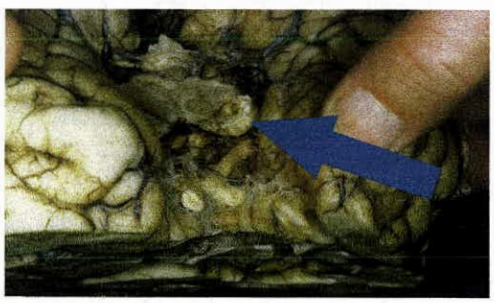
Main lesions, periventricular

Partly lesions hippocampal area, frontal

Linear Inner Upper Brain Trauma
Type Ib

Frontal white matter, periventricular damage

Linear Inner Lower Brain Trauma (Type Va)
Combination with Rotational Trauma (IVa)
Uncal Tentorial Herniation

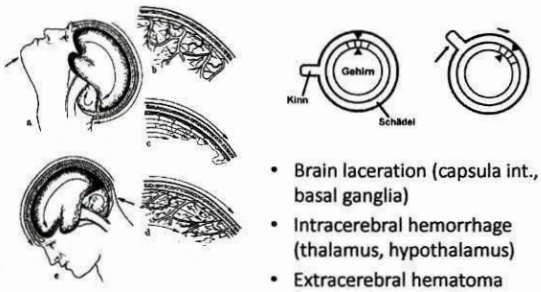


Direct lesion in the upper midbrain, indirekt lesion after uncal herniation (arrow)

Rotational Trauma
(Pudenz-Shelden)
Type Ia, Ib, IIa, IIb, IIIa, IIIb, IVa, IVb, VI

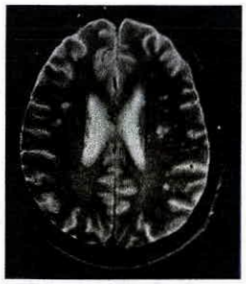
- Intracerebral laceration (basal ganglia, capsula interna)
- Intracerebral hematoma (thalamus, hypothalamus)
- Extracerebral hematoma (subdural, epidural)

Rotational trauma – Scheme
Pudenz-Shelden



- Brain laceration (capsula int., basal ganglia)
- Intracerebral hemorrhage (thalamus, hypothalamus)
- Extracerebral hematoma (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
- Quartary lesions
  hydrocephalus occlusus, meningoencephalitis, brain abscess
- Complications
  joint contraction, periarticular ossification, decubitus, pressure lesion of peripheral nerves

Classification of Head Trauma

- Head Injury (HI)
- Brain Injury (TBI)
  - Mild Traumatic Brain Injury (mTBI)
  - Post Concussion Syndrome (PCS)
  - Moderate Traumatic Brain Injury
  - Severe Traumatic Brain Injury
  - Severest Traumatic Brain Injury
- Combined Traumatic Brain Injury with cervical injury (Whip Lash Injury)

Mild Traumatic Brain Injury Symptoms
(P. Vos et al)

- Loss of consciousness (LOC), 5-15 min., max. 20 min.
- Post Traumatic Amnesia (PTA), shorter then 20 min.
- Lack of neurological deficits
- Admission Glasgow Coma Scale (GCS) 13-15
- Head Trauma impact scheme, mostly type I, II

Mild Traumatic Brain Injury
Diagnostic program

- Hospital admission obligatory, min. stay 24 hrs., Traumatic Brain Centre desirable
- Neurological examination obligatory
- Accurate history, including accident witnesses, head trauma scheme
- Additional examinations, risk cases, CT, EEG
  alcohol, intoxication, children, age more then 65
- Consequent controls by experienced medical personal during hospital stay
- Neurological controls, repeated during hospital stay
- Documentation, check list

Mild Traumatic Brain Injury Treatment

- Admission to hospital care obligatory, min. stay 24 hrs.
- Consequent bed rest
- Medicaments for pain, if necessary
- After discharge, period of rest for 3 days necessary

Post Concussion Syndrome Symptoms

- Loss of Consciousness (LOC) 10 – till 30 min.
- Post Traumatic Amnesia (PTA) shorter then 1 hr., mostly retrograde, anterograde possible
- Physical symptoms: nausea, vomiting, dizziness, head aches
- Neurological deficits: particular frontal, temporal
- Alteration in mental state: dazed, confusion, disorientation
- Emotional disturbances: disinhibition, lability
- Cognitive deficits: impaired cognition, slowed cognitive processing, impaired concentration
- Admission Glasgow Coma Scale 13-14
- Head Trauma impact scheme, mostly type I, II

Post Concussion Syndrome Diagnostic program

- Hospital admission obligatory, traumatic Brain Center desirable, min. stay 48 hrs.
- Neurological examination obligatory
- Accurate history including witnesses
- Additional examinations: CT obligatory, EEG facultative
- Consequent controls by experienced medical personal during hospital stay
- Regular neurological controls, 3 hours period during hospital stay
- Documentation, check list

Post Concussion Syndrome Treatment

- Admission to hospital care obligatory, min. stay 48 hrs.
- Consequent bed rest
- Medicaments for pain, headaches
- Discharge to home with instructions
- After discharge, period of rest for 10 days necessary
- Neurological control after 3 weeks

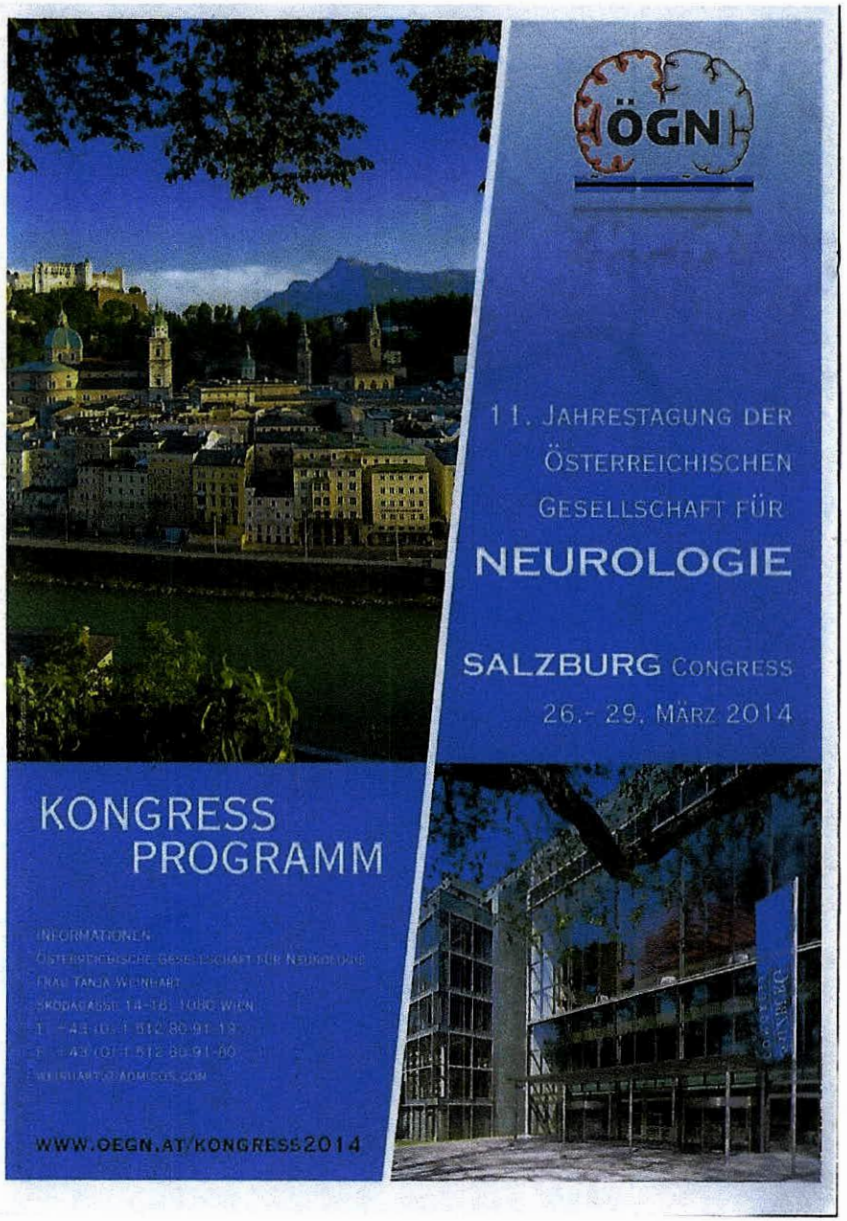
Basic Differences: MTBI, PCS

	MTBI	PCS
neurological deficits	none	possible (frontal, cerebellar)
EEG	normal	abnormal, possible
cCT	no substantial lesions	brain lesions, possible
cMRI	no substantial damage	local brain damage, detectable
legal consequences	none	insurance covered

Conclusion

Mild Traumatic Brain Injury, "Commotio Cerebri" is a transient dysfunction of the brain, no damage of brain tissue. Functional disturbances, without "morphological alterations" (SPATZ). Legally not declared as physical injury.

Brain Concussion Syndrome, symptoms of extended Mild Traumatic Brain Injury, additional physical disturbances (nausea, vomiting, dizziness) and local brain lesions, EEG mostly abnormal, lesions in MRI detectable, in CT particularly. Legally declared as physical injury, forensic and legal consequences, covered by insurance.



MITTWOCH

12:00-13:30 **AG III** **AG GESCHICHTE DER NEUROLOGIE** HOHENSALZBURG
Vorsitz: Franz Gerstenbrand, Wien

Die große Herausforderung der Neurotraumatologie - Verletzungen des zentralen und peripheren Nervensystems
Einleitung:
Franz Gerstenbrand, Wien

Verletzungen des zentralen und peripheren Nervensystems im 1. Weltkrieg
Helmut Gröger, Wien

Diskussion

13:00-14:30 **AG IV** **AG NEUROIMMUNOLOGIE / ARGE LIQUORDIAGNOSTIK / ARGE NMO** TRAKL
„Multiple Sklerose & Neuromyelitis optica: Monitoring des Krankheitsverlaufs und der Therapie"
Vorsitz: Christiane Schmied, Wien; Thomas Berger, Innsbruck

Monitoring mittels MRT - wissenschaftliche Erkenntnisse versus Praxisrelevanz
Christian Enzinger, Graz

Neuromyelitis optica: Monitoring des Krankheitsverlaufs und der Therapie
Wolfgang Kristoferitsch, Wien

Monitoring von Multiple Sklerose Therapien
Michael Khalil, Graz

Potenziell zukünftige Laborbiomarker bei Multipler Sklerose
Harald Hegen, Innsbruck

Diskussion

13:30-15:00 **AG IV** **AG NEUROMUSKULÄRE ERKRANKUNGEN** TRAPP
Vorsitz: Wolfgang Grisold, Wien; Wolfgang Löscher, Innsbruck

Chemotherapy-induced peripheral neuropathy?
Andreas Argyriou, Patras, Greece

Diskussion