

Abstracts from 24th Annual Congress 2019

TRAUMATIC BRAIN INJURY. CHANGE OF TREATMENT PARADIGMS

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ABSTRACTS

Oral presentations

Chronic subdural hematomas: pathogenesis and concept of minimally invasive surgery

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Introduction: Chronic subdural hematomas (CSH) are a frequent form of head injury sequelae.

Aim: To study pathogenesis and sanogenesis of CSH and to justify their minimally invasive surgery (closed external drainage).

Material and methods: We analyzed and followed up 538 cases of CSH. The outcomes of open craniotomies with removal of CSH sacs and closed external drainage via burr holes were compared.

Results and discussion: Our study has confirmed that hyperfibrinolysis of blood inside the cavities of CSH is the main cause of their existence and periodical enlargement. The concentration of fibrin split products inside CSH is 6 to 60 times higher than in venous blood of the same patients. In such a situation different external and internal factors can easily provoke bleedings from pathological vessels of CSH sacs into the cavities. The environment inside CSH can be changed by a closed external drainage instead of craniotomy with sac removal.

In most cases patients improved the next day after insertion of a subdural drain. According to CT and/or MRI scans, CSH are fully resorbed within 1.5-3 months after minimally invasive surgery. Postoperative mortality rate in our series was 1%, which is much lower than previously reported mortality after craniotomy for CSH (up to 12-18%) due to brain collapse and intracerebral hematomas.

Conclusions: Study of pathogenesis of CSH helped to make their surgery simpler, less invasive, and to reduce complication rate and postoperative mortality.

Ethical dilemmas in neurotraumatology

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The so-called “principles of medical ethics” (patient’s autonomy, beneficence, non-maleficence and justice) may not be applied to many cases of severe head injury. How to respect the autonomy of a comatose or psychotic patient? What is beneficence for a patient in a posttraumatic vegetative state? Is large decompressive craniectomy ethically (and economically) justified? Is death better than a “life not worth living”? Who is going to answer these questions? A doctor, a patient’s relative, or a hospital administration? In urgent cases we are confronted with: 1) shortage of time in severe TBI; 2) unconscious state of patients; 3) the need for urgent sorting and transportation in natural and man-made disasters; 4) lack of diagnostic and clinical resources.

Ethical dilemmas in neurotraumatology need to be widely discussed in search of their solution.

Stochastic resonance stimulation as a mean to improve proprioception

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Stroke is among the most common causes of acquired disability. Beside of motor disorders, sensory impairment is common. Sensory information is essential for precise and coordinated motor function. Therefore, the focus of rehabilitation after stroke is on measures that promote both, motor skills and body awareness. Proprioception refers to perception of body movement and position in space, or of the position of individual body parts relative to each other. Proprioceptors that respond to the condition and changes in condition of the musculoskeletal system are found in the muscle and tendon spindles. Proprioception not only deteriorates in the course of illness, but also decreases with age. The threshold for perception of sensory stimuli rises, so that the stimuli can no longer be integrated into movement control. This is where stochastic resonance stimulation (SRS) comes in, in which a weak signal is amplified by the presence of noise activity (“stochastic resonance”) such that the signal reaches perception threshold. Interestingly, the effect of SRS increases

with the severity of deficits. Among other things, the stability of movement, balance and tactile sensation at the fingertips of people with impairments (e.g. diabetes mellitus, after stroke) have been improved with SRS. We developed a device where compression pressure (amplitude and frequency) in a silicone membrane can be changed in order to specifically exert SRS on a joint.

We could already demonstrate that wrist proprioception can be improved by SRS with our set-up in older people. The device has the potential to be used in combination with additional rehabilitation interventions and can be applied in psycho-physical experiments. The long-term goal is to integrate SRS into sensorimotor neurorehabilitation.

Differential diagnosis of post-traumatic ventriculomegaly in patients with severe disorders of consciousness

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Introduction: Differential diagnosis of post-traumatic ventriculomegaly in patients with severe disorders of consciousness remains a challenge. Shunting may be a necessary step for the further rehabilitation of these patients.

Material and methods: In the Burdenko Neurosurgical Research Center 23 patients with a diagnosis of probable PTH were recruited in the study. They underwent a unified assessment protocol. MRI included standard sequences, T2 CUBE and MRI cisternography. Patients without intraventricular obstruction underwent pCASL MRI with a lumbar tap-test and a repeated pCASL study in 4-6 hours. Twenty patients were further operated. VP-shunt was placed in 17 cases (one of them with endoscopic assistance), VA-shunts – in 2 cases and one ETV was performed.

Results: MRI cisternography revealed intraventricular obstruction in 17.7% of cases. Significant mental recovery in 12 months post-op was observed in 15 (75%) patients. Unfavorable outcomes were observed in 5 (25%) patients with a mortality rate of 5%. Shunt-infection complicated treatment in three cases (15%).

High resolution MRI revealed various injuries from the brain stem up to sub-cortical and cortical level. A statistically significant association was found between the level of injury and the outcome of shunting. No statistically significant changes were found in the changes of cerebral

perfusion (CBF) measured by pCASL before and after the tap-test.

Conclusions and discussion: Injuries of the brain stem in the acute period of TBI may be considered a predictor of an unfavourable outcome. CBF measured by pCASL MRI in the current study showed no significant changes before and after lumbar tap-test. Proper selection of patients with posttraumatic hydrocephalus for surgery is essential for their mental recovery.

Effect of facilitation of endogenous revascularization on secondary injury development and promotion of neural regeneration following traumatic spinal cord injury

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Introduction: Following traumatic spinal cord injury (SCI), profound vascular changes occur in the traumatized spinal cord. Following rapid changes in microvasculature and a traumatic disruption of the blood-spinal cord barrier (BSCB) due to primary injury, inflammation and endothelial cell death occur, spreading the secondary injury through mechanisms which include but are not limited to the resultant hypoxic environment. While endogenous revascularization including angiogenesis and vasculogenesis occur within the first days following SCI, the extent of spontaneous repair of the microvasculature is insufficient to promote neural tissue repair and regeneration. We hypothesize that facilitation of endogenous revascularization after acute SCI will attenuate the secondary injury and promote neural repair and regeneration.

Material and methods: We conducted a systematic review of the literature, using the established databases. Main terms examined in these articles were vascular changes, hypoxia, blood-spinal cord barrier disruption, inflammation and endogenous revascularization following SCI.

Results: Endogenous revascularization occurs within the first seven days following SCI. These sprouting vessels are of inferior functional capacity, with a dysfunctional neurovascular unit due to an incomplete BSCB. We review potential mechanisms to ameliorate these endogenous repair mechanisms, to establish a functional neurovascular unit in growing blood vessels to diminish hypoxic environment spreading secondary injury to surrounding healthy spinal cord regions.

Conclusions: Ameliorating the deficient neurovascular repair by endogenous revascularization following spinal cord injury will diminish secondary injury development and lead to enhanced neural repair and regeneration.

Reevaluation of penetrating midface injury after removal of metallic foreign body

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Traumatic injuries of the midface can be life-threatening. Due to close anatomic proximity of vital structures and sensory systems, penetrating injuries of the skull base, the eye ball or the olfactory region can result in grave consequences. A timely diagnosis and treatment of such injuries is of the utmost importance. I report the case of a 64-year-old man presenting in the emergency room with a saucepan protruding from his right orbit. An initial CT-Scan was performed and showed multiple fractures of the midface.

However, due to the presence of stainless steel and the resulting artefacts the assessability of soft tissues was greatly compromised and an intracranial bleeding or laceration of the ocular globe could not be confidently ruled out. After surgical removal of the saucepan a second CT-scan revealed neither apparent damage to the ocular globe nor intracranial bleeding.

Three days after admission a surgical reconstruction of the orbital floor and a neurolysis of the infraorbital nerve were performed. The patient suffered no loss in eyesight or motility and was discharged on the 8th day.

TBI treatment change of paradigms: decompression after evacuation of acute epidural hematoma in deep coma

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Aim: To compare outcome at discharge following osteoplastic or decompressive craniotomy for treatment of acute epidural hematoma across similar comatose patient groups.

Material and methods: There were 292 patients operated for acute epidural hematoma in the period of 2007-2018 years in Department Neurosurgery of Kaunas University of Health Sciences Hospital. The mortality was 8.9%. We had analysed 60 patients selected from prospectively organized trauma patient base. They had been operated in deep coma (GCS 3-5). The group of 31 patient (52%) needed decompression during primary surgery or some time after it and 29 patients (48%) had epidural hematoma, evacuated by osteoplastic craniotomy only.

Results: Decompressive and osteoplastic craniotomy group patients were similar, according to mean age (40.9 ± 13.1 and 40.6 ± 12.5), GCS score before surgery (3.9 ± 0.9 and 4.2 ± 0.8), hematoma thickness, according to CT (3.44 ± 1 and 3.36 ± 1.6 cm) and midline dislocation (1.4 ± 0.8 and 1.37 ± 0.9 cm). Unfortunately, mortality was greater in decompression group (45.2 and 13.8%; $p = 0,008$) and GOS was worse too – 2.26 ± 1.5 and 3.45 ± 1.5 ($p = 0.003$) in comparison with osteoplastic surgery group.

Conclusions: Need for decompression after evacuation of acute epidural hematoma in deep coma (GCS 3-5) suppose worse results in comparison with osteoplastic craniotomy. We suggest to monitorize ICP after osteoplastic craniotomy and evacuation of epidural hematoma, if coma persist after surgery and only in resistant uncorrectable conservatively intracranial hypertension to solve the problem of secondary decompression. The problem needs prospective randomized trial verification.

Mental recovery in patients with severe traumatic brain injury

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Introduction: Recovery of mental activity after coma is one of the most important goals of rehabilitation in patients with severe traumatic brain injury (sTBI).

Aim: To reveal clinical, pathogenetic, prognostic and rehabilitation patterns of mental recovery in patients with sTBI.

Material and methods: 163 patients with sTBI were studied. All patients were examined clinically with a total registration of psychopathological symptoms from the acute phase to follow-up.

Results: All of revealed clinical symptoms were divided to: 1) signs of deficiency, 2) preserved or recovered functions, 3) additional productive disturbances, including agi-

tation, automatisms, false judgments, illusions, hallucinations, and affective disorders.

Changes in hemispheric interaction and cerebral neurotransmitter landscape appeared to be the most important in pathogenesis and sanogenesis of brain damage.

The prognosis of mental recovery after sTBI was dependent on many factors, primarily on level of brain damage, presence of arterial hypotension and hypoxia in the acute period of injury, secondary effects as hydrocephalus and atrophy of brain tissue.

The revealed multivariate determined the need for broad spectrum not standard but optional treatment and rehabilitation based on the individual choices of drug therapy (neurometabolic, anticonvulsant, neuroleptic, antidepressant, anxiolytic), parameters of brain stimulation, psychotherapeutic interventions, social work.

Conclusions: Due to the multivariate process of mental recovery, the complexity of the clinical picture and the pathogenesis of posttraumatic mental disorders, polyfactorial prognosis, patients with severe traumatic brain injury require individual choice of a multimodal rehabilitation measures.

Talking heads: What the mouse model of traumatic brain injury can say about the size of craniectomy?

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Decompressive craniectomy is the most effective method of reducing intracranial pressure (ICP). However, its effects on functional outcome after head trauma are still matter of debate. For instance, the question of optimal cranial window size remains controversial. On the one hand, oversized craniectomy may provoke syndrome of the trephined; on the other hand, small decompression may be not effective in lowering ICP. To analyze this problem, we have used a translational approach, modeling different craniectomy sizes in animal experiment.

Male mice ($n = 7$ each group) were subjected to severe closed head injury. Thereafter, the microsurgical decompression was implemented. One group received large craniectomy, involving parietal and squamosal bone, while in the second group only parietal bone was removed. During the procedure, ICP values were recorded. At 24 h post injury, functional tests and radiological assessment (CT and MRI) were performed. T-test was used for statistical analysis.

Despite significantly different surface of decompression, trauma produced similar amount of brain edema in both groups. This resulted in external brain herniation in animals treated by small craniectomy. Accordingly, this group demonstrated poorer neurological performance. Paradoxically, the ICP-lowering properties of small craniectomy were not affected.

In mouse model, small-tailored craniectomy resulted in additional damage due to external herniation, even without significant ICP increase. This phenomenon is important as potential cause of mechanical brain injury in craniectomy subjects and as a possible explanation for negative results of clinical trials. Our model allows estimating the consequences of small craniectomy that cannot be tested in clinical setting due to ethical considerations.

The Kernohan's phenomenon revisited: what does it mean in MRI era

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Kernohan's phenomenon is a false localizing sign following brain herniation, producing a paresis on the same side as the mass effect. The diagnosis of this syndrome is based on clinical findings and on MR-based imaging, including diffusion tensor tractography, documenting localisation of the lesion contralaterally to the clinical signs. We present a series of three patients with Kernohan's phenomenon following intracranial mass lesion, where the performed imaging studies revealed damage to the left-sided tracts, accompanied by oedema-related hyperintensity in T2-weighted imaging and hypointensity in T1-weighted imaging.

Post traumatic non-acute hydrocephalus: profile of CSF dynamics

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Aim: To assess and interpret differences in CSF compensatory profiles between post-traumatic non-acute hydrocephalus (pTH) and idiopathic normal pressure hydrocephalus (iNPH) and compare them to patients considered as presenting with normal CSF compensation.

Material and methods: Computerised infusion tests performed in Hydrocephalus Clinic were audited anonymously. Patients with post-traumatic non-acute hydrocephalus (dilated ventricles, atrophic changes, diminished GCS, without open craniotomy; $N = 33$) were compared to patients classified as typical iNPH ($N = 81$). Baseline ICP, pulse amplitude of 1st harmonic of pulse wave (peak-to-peak), slope of amplitude-pressure line, resistance to CSF outflow, elasticity and RAP index of compensatory reserve were evaluated.

Results: Baseline ICP was normal and almost the same in both groups (cumulative 9.7 ± 4.8 mmHg). Pulse amplitude was significantly greater in iNPH than in pTH (4.5 ± 3.1 mmHg; 2.28 ± 2.9 kg, $p = 0.0001$). Resistance to CSF outflow was higher in iNPH (17.6 ± 5.6 mmHg/(ml/min)) than in pTH (13.4 ± 6.1 mmHg/(ml/min)). Slope of amplitude-pressure line was greater in iNPH (0.55 ± 0.2) and significantly lower ($p < 0.002$) in pTH (0.28 ± 0.18). Elasticity was slightly elevated but not different between two groups (cumulative 0.25 ± 0.15 1/ml). However, RAP index suggested better compensatory reserve in pTH (0.62 ± 0.1) than in iNPH (0.82 ± 0.11) ($p < 0.002$).

Conclusions: CSF compensation in post-traumatic hydrocephalus is generally better than in iNPH. Post traumatic hydrocephalus can be conceptually placed between iNPH and patients with normal CSF dynamics. However post-traumatic hydrocephalus is very heterogenous.

Stratification of results of infusion tests with aetiology and co-morbidity is necessary.

How does early decompressive craniectomy influence the intracranial volume relationship in traumatic brain injury (TBI) patients?

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Introduction: Decompressive craniectomy (DC) is a common neurosurgical procedure involving the removal of part of the skull vault combined with subsequent duroplasty. The goal of DC is to produce extra space for the swollen brain and/or to reduce intracranial pressure. In the present study, DC was performed in order to create space for the swollen brain.

Aims: 1) to compare the volume alteration of selected intracranial fluid spaces before and after DC, 2) to evaluate the volume of post-decompressive brain displacement (PDBD) and the largest dimension of oval craniectomy (LDOC), and 3) to assess the early clinical effects of DC.

Results: The mean volume of extra space filled by the swollen brain was 42.2 ± 40.7 ml. The best early treatment results were achieved in patients under the age of 55.

Conclusions: DC has limited effectiveness in patients aged over 70 years. In every patient with clamped basal cisterns, a skin incision enabling appropriate LDOC should be planned before surgery. DC should be as large as possible, and the limits of its dimensions should be the limits of anatomical safety.

Assessment of conservative and operative treatment of supratentorial hematomas in Neurosurgery Department, Copernicus Hospital Gdansk between 2006 and 2018

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Supratentorial hematoma is the most common mass lesion found in traumatic brain injury (TBI) and is associated with high mortality and disability rates. The annual incidence of the aforementioned is 20 cases per 100,000 populations.

We have retrospectively analyzed a database of patients with a diagnosis of epidural hematoma and subdural hematoma between 2006 and 2018. Keywords for searching were ICD-10 and ICD-9 codes.

Between 2006 and 2018 we operated 1225 patients, 39 patients were treated conservatively. 201 were diagnosed with acute epidural hematoma (AEH), 544 had acute subdural hematoma (ASH), 480 presented chronic subdural hematoma (CSH). In the AEH group; mean hospitalization time was: 7.8 ± 11.0 days; 25 patients (Pts.) died during hospitalization (12.44%); 2 Pts. were re-operated due to recurrence of hematoma (1.0%) (2). For the ASH group mean hospitalization time was: 7.5 ± 10.6 days; 101 Pts. presented fatal outcome (18.57%) (101); 46 were re-operated (8.46%). For the CSH group mean hospitalization time was: 7.6 ± 10.7 days; 75 Pts. died during the course of hospital stay (15.63%); re-operated were 90 Pts. (18.75%).

The conservative treatment group comprised of CSH diagnosis, the mortality was 0%.

The results we have obtained are comparable to the previously collected and described in the literature. Methods of selection of group designated for conservative treatment that we use were: diagnosis of CSH; 15 pts in Glasgow Coma Scale and the elderly age. A key to good clinical outcomes in supratentorial hematomas is an immediate decision of operative treatment and high quality neuro-anesthesiological care. In a selected group of patients, conservative treatment of supratentorial hematomas is a safe and efficient method.

The reorganization of functional connectivity under transcranial magnetic stimulation in unconscious patients with severe brain injury

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The study aimed to reveal changes of functional connectivity after transcranial magnetic stimulation (TMS) in unconscious patients with severe brain injury. The features of wavelet-synchrony and Granger causality were analyzed in 14 patients with severe traumatic brain injury (sTBI). The patients were in an unresponsive state (vegetative state) or minimally conscious state.

The study of resting-state EEG and ERPs for simple tones and naturalistic stimuli (music) was conducted before and after the diagnostic and therapeutic rhythmic TMS of the premotor cortex area. In some cases, additional studies were carried out after 3rd and 5th sessions of stimulation. The duration of a TMS course was determined by a neurologist and did not exceed 10 sessions. A total of 38 studies of biopotentials were analyzed.

EEG and ERPs were recorded from 32 electrodes. Functional connectivity was calculated based on wavelet analysis and the Granger causality method using the Brain Connection (Russia) and Brainstorm (Matlab). The obtained data were compared to the results of patients' clinical examination.

Negative clinical dynamics after therapeutic TMS concurred with decreasing wavelet synchrony and emerging "short" connectivity between the frontal pole and neighbouring areas.

Positive neurological changes concurred with increasing wavelet synchrony and emerging "long" intra- and inter-hemispheric connectivity between the anterior (frontal and temporal) and posterior (parietal and/or occipital) areas of the cortex. We suppose that it is one of the necessary conditions for restoring a higher-level consciousness and for recovering voluntary types of mental activity in patients.

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Somatic stem cells in regeneration of CNS injuries

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Nowadays, the stem cells (SC) most frequently used in clinical practice are mesenchymal stem cells (MSC) derived from various somatic tissues. Their usefulness, apart from typical stemness properties, is due to relative easy accessibility and high biological safety due to the lack of tumorigenesis or teratoma formation.

Moreover, undifferentiated "pre MSCs" yet, similarly to ESC or iPS, can give rise cells belonging to all tri germ layers. However, unquestionable therapeutic success of MSCs, including a wide range of CNS diseases, is not accompanied by our understanding of mechanistic aspects of their regenerative action. Two hypotheses are currently proposed to explain this phenomenon: strong adjuvant influence of transplanted MSCs on the host tissue or their intrinsic ability to functional integration and repopulation of damaged tissues.

Available studies, rigorously performed during the last 20 years, do appear to confirm (by action potentials, ion channels, neurotransmitter release, network of signaling integration etc), that at least some of MSC subpopulations can differentiate into neural phenotypes. Hypothetically, such stem cells with the novel ecto-mesenchymal properties may originate from a Neural Crest – the peculiar structure transiently formed in developing vertebrate embryos as a separate, fourth, germ layer. On the basis of the recent data or own experiences we postulate that various somatic SC niches may contain remnants of these transiently produced, evolutionarily more primitive than classic MSC cells.

They may play crucial role as a specific cellular back-up of tissue regeneration by their potentially triploblastic properties being reactivated by injury.

Neurotrauma Register: concept of a nationwide continuous improvement of management of TBI

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Introduction: TBI is the fifth most frequent diagnosis in Germany. Within the last years, there has been an increase in fatal domestic accidents among the elderly people in Europe. Therefore and in order to fight against this effectively, new systematic approaches are required. One possibility is the establishment of a Neurotrauma Register, aiming to get a realistic view of the efficiency of our everyday management. Within the quality management systems, the register plays an essential role.

Material and methods: In Germany, there has already been a general trauma register organized by the German Trauma Society (DGU). Based on this register, a team was formed in a common initiative of the DGU and the Neurosurgical Society. Together with a dozen participating hospitals, they are working on a web-access based data bank. First of all, a set of data was chosen regarded as important and relevant for the clinical course and outcome.

The data include kind and mechanism of accident, rescue and transport system, medical care as well as rehabilitation and reintegration. There is a follow-up after 6 and 12 months. Both data acquisition and data protection including the guarantee of keeping the patient anonymous are implemented by an external team according to the EU-legislation. Each hospital participating has to get a votum of the corresponding ethic commission.

Results: So far, the data pool has been agreed upon and evaluated. Since the beginning of 2019, patients have been included. First results are supposed to come out after one year.

Conclusions: The main purpose of a nationwide register is to cover as many centers as possible. The evaluation of all data is supposed to be the basis of a continuing improvement of an everyday management of TBI.

A new meta-analysis of the STICH trials: identifying those patients who would benefit from craniotomy

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Introduction: The STICH Trials randomised patients with spontaneous intracerebral haemorrhage (ICH) to early surgery or initial conservative treatment. The STICH(TRAUMA) Trial randomised patients with traumatic ICH in an identical fashion. Data from a total of 1608 patients were available for analysis. All 3 trials had neutral results, although there was a significant reduction in mortality in the craniotomy group from the STICH(TRAUMA) Trial. This may be because surgery has a minimal effect on recovery, or because surgery has benefit in some cases and detriment in others. We compare these competing explanations for the neutral results, introduce a new non-parametric method of analysis and apply the indication from this method back to the data.

Material and methods: Data from 1541 patients from the 2 STICH trials and 167 from the STICH(TRAUMA) Trial were analysed using:

1. Standard meta-analysis of prognosis-based dichotomised outcome and pre-specified standard subgroups of Glasgow Coma Score (GCS): 3-8, 9-12, 13-15;
2. New non-parametric regression of ranked Extended Glasgow Outcome Scale (GOSE) against ranked GCS and ranked volume;
3. Repeat standard meta-analysis using the subgroup coding identified by 2.

Results: Standard meta-analysis of STICH I and II showed more favourable outcomes, although non-significant, with surgery if the presenting GCS was 9-12 (OR 0.70, 95% CI: 0.48, 1.03; $p = 0.07$). In the STICH(TRAUMA) Trial there were also more favourable outcomes, although non-significant, with surgery if the presenting GCS was 9-12 (OR 0.48, 95% CI: 0.18, 1.26; NS). The ranked analysis suggested that initial conservative treatment was better for patients at the extreme ends of the GCS and that sur-

gergy was better if the presenting GCS was 10-13. Surgery was harmful for small lesions but showed increasing benefit for larger volume lesions.

Meta-analysis from the 2 STICH Trials with GCS 10-13 confirmed that surgery was beneficial with OR of 0.71 (95% CI: 0.51, 1.00; $p = 0.05$). The effect in the GCS 10 to 13 subset was even greater and more significant for the STITCH (TRAUMA) Trial with an OR of 0.16 (95% CI: 0.05, 0.51; $p = 0.002$).

Because the Glasgow Coma Score is heavily dependent upon the verbal response, we have separately analysed patients with left and right hemisphere lesions to see if this slight shift in the maximum beneficial effect was different between the left and right hemispheres. This analysis has shown that patients with dominant (left) hemisphere lesions were more likely to benefit when the presenting Glasgow Coma Score was lower (9-12). By contrast, patients with right hemisphere lesions were more likely to benefit when the Glasgow Coma Score was 10-13 ($p < 0.05$). This effect of dominance of the hemisphere on measurement of consciousness by the Glasgow Coma Score has not previously been shown in patients undergoing surgery for ICH. When pre-specifying outcomes in future trials, we hypothesise that the surgical benefit will be greater in left hemisphere ICH patients with a slightly lower Glasgow Coma Score than those with a non-dominant hemisphere lesion.

This new non-parametric analysis was not prespecified but does indicate that greater benefit for surgery occurred when patients presented with coma scores of between 10 and 13. This categorisation also appears to apply to traumatic ICH. It may be that this applies particularly to right hemisphere clots, while for left hemisphere clots a GCS of 9 to 12 leads to greater benefit.

Is there an indication for pre-hospital trepanation in patients having a TBI?

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Traumatic brain injury (TBI) can be a severe injury. In case of a severe traumatic brain injury the patient should arrive in a trauma center within 60 minutes. Computed tomography scan of the brain has to be performed quickly in order to assess the extent of intracranial injury.

In case of posttraumatic unconsciousness, direct transport to a trauma center with neurosurgical care is recommended. If required after the computed tomography an operation should be performed.

Glasgow-Coma-Scale (GCS) under 9, intubation and ventilation should be performed.

Sometimes there is a discussion if pre-hospital trepanation or exploratory burr hole should be performed.

The authors illustrate with clinical cases, that there is no indication for pre-hospital trepanation in military missions or in the civilian emergency medical service. Trepanation without diagnostic is life-threatening for the patient. Critical bleeding of the scalp must be stopped in pre-hospital settings.

Treatment of traumatic fractures of vertebral bodies with percutaneous vertebral augmentation system SpineJack

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Aim: Clinical and radiological evaluation of percutaneous vertebral augmentation system SpineJack used along with high-viscosity polymethylmethacrylate (PMMA) cement.

Material and methods: Between May 2014 and March 2019 there were 126 patients treated. They presented traumatic fracture of: Th8 (7), Th9 (12), Th10 (5), Th11 (7), Th12 (14), L1 (54), L2 (7), L3 (21) vertebral bodies. The aforementioned fractures were classified according to AO Spine classification: A1 (75), A2 (7), A3 (40), B2 (5). B2 type fractures were additionally fixed with transpedicular stabilization. All of the patients were operated with the assist of O-ARM 3D navigation system.

Results: Pain presented at the time of diagnosis was assessed with Visual Analogue Scale. VAS before and after treatment lowered from 7.87 to 2.73. Oswestry Disability Index (ODI) was reduced from 77.33 preoperative score to 22.33 postoperative score. Mean return of a height of the vertebral body was 22.33% (min 4.09%, max 42.35%).

Asymptomatic leak of cement was radiologically noted in 26 cases (48.15%).

Conclusions: Percutaneous vertebral augmentation system SpineJack used along with high-viscosity polymethylmethacrylate (PMMA) cement is a safe and efficient method of restoration of the vertebral body height.

Neuroprotective role of sphingosine-1-phosphate receptors agonists and modulators in neurodegenerative disorders

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Bioactive sphingolipids such as: ceramide (CER) and sphingosine-1-phosphate (S1P) are intensively studied in relation to cell fate. While increased CER levels are mostly associated with activation of apoptosis, S1P is recognized as a pro-survival sphingolipid which acts through S1P receptors (S1PRs) and its decrease correlates with many neurodegenerative diseases.

Fingolimod (FTY720, modulator of S1PRs) is the first, oral medication approved by the FDA for the treatment of relapsing-remitting multiple sclerosis that reduces inflammatory cascade and myelin destruction. Recently, the study focused on the application of FTY720 in therapy of neurodegenerative disorders. Promising results have been observed in Alzheimer's (AD), Parkinson's and Huntington disease models, where FTY720 improved memory, motor activity and promoted pro-survival signaling pathway.

In our study we have observed the reduction of pro-survival sphingosine and ceramide kinases, S1PR1 and anti-apoptotic Bcl-2 mRNA levels in 12-month old AD mice brain (A β PP (V717I) model). These changes were similar to the observed in the human sporadic AD hippocampus. The FTY720 treatment had beneficial effect through increased mRNA levels of sphingosine and ceramide kinases as well as Bcl-2 in AD mice.

Moreover, in cellular model of CER toxicity we have observed that exogenous S1P activates pro-survival PI3-kinase/Akt signaling as well as expression and immunoreactivity of anti-apoptotic BCL-2 protein. The similar effect was also observed with tested agonists of S1PRs. Our results indicate that the balance between S1P/CER plays pivotal role in regulation of neuronal cell's fate. Moreover, modulation of S1P signaling may offer a promising strategy in treatment of diseases that are characterized by elevated CER levels.

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The role of purinergic signaling in synaptic dysfunction, inflammation and neuronal death in CNS disorders: a novel direction of therapeutic strategy

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The growing body of evidence indicates that extracellular ATP-mediated signaling is involved in CNS development, injury and repair. Activity of ATP is mediated by the purinergic P2 receptors, which based on pharmacology are divided into two subtypes – ionotropic (P2X) and metabotropic (P2Y). In pathological conditions, not only the extracellular release of ATP may be significantly elevated, but also the expression of P2 receptors and the activity of extracellular ectonucleotidases may undergo certain changes. The elevated extracellular ATP activates different cell types within the brain, leading to complex danger response signaling in CNS disorders like traumatic brain injury (TBI), neurodegeneration, autism, etc.

The ATP-mediated danger signaling involves activation of microglial purinergic receptors, leading to release the reactive oxygen species (ROS) and pro-inflammatory cytokines. In turn, in neuronal cells activation of P2 receptors results in elevated calcium influx, oxidative stress, mitochondrial failure and activation of cell death signaling. The long-term effects of purinergic signalling deregulation include disruption of synaptic structure and neurotransmission. Additionally, the ATP-induced intracellular calcium wave throughout the astrocytes, is believed to affect the activity of neural circuits distant from the primary site of brain injury. Finally, treatment with various centrally penetrant and highly specific P2 receptor antagonists were shown to improve histological and behavioral outcomes in a preclinical models of CNS diseases, including TBI.

Taken together those reports indicate the anti-purinergic therapy might be an effective treatment against various complex brain disorders.

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TBI trigger or aggravating factor in Alzheimer's disease?

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Systemic inflammatory response Moto: "We cannot solve our problems with the same thinkind we used when we created them" – Albert Einstein, Nobel Laureate (Physics, 1921)

Introduction: Alzheimer disease (AD) is a neurodegenerative disorder marked by cognitive and behavioral impairment that significantly interferes with social and occupational functioning. AD is an incurable disease with a long preclinical period and progressive course. Alzheimer disease (AD) is the most common form of dementia. In the United States alone, approximately 6.08 million Americans had either clinical AD or mild cognitive impairment due to AD in 2018.

Alzheimer's disease (AD) is the scourge of the century. AD has varied etiology, dichotomized by genetic contribution. Familial AD (FAD), caused bu coding region mutations in three genes, is quite rare and characterized as a Mendelian form. The vastly more prevalent late onset AD (LOAD), is genetically complex and also implicates non-genetic factors as etiologic contributors. Some studies have reported a higher risk of AD in women than in men other studies, however, including the Aging, Demographics, and Memory Study, found no difference in risk between men and women (over 50 years no more estrogen protection).

A continuum exists between the pathophysiology of normal aging and that of AD. Next elements take a part in the pathophysiology: cholinergic neurotransmission, amyloid hypothesis and Tau hypothesis. Other hypothesis involve granulovacuolar degeneration and neuropil threads, oxidative stress and damage, clusterin, presenilins, estrogen loss and inflammatory reactions.

Material and methods: Mild to moderate traumatic brain injury (TBI) appears to underline some later forms of cognitive impairment and dementia and neuropathologically define chronic traumatic encephalopathy (CTE). While both AD and CTE share beta-amuloid deposition and tauopathy, the anatomic distribution are distinct.

The authors studied in the same hospital unit (Sanador Medical Hospital): 29 patients all over 65 years

old, patients following up the period 1st January 2013 – 1st January 2019. The cohort age is between 65 years old – 86 years old. All the patients, had minor craniocerebral trauma with Glasgow Coma Scale Scores between 14 and 12 pt.).

Associated pathology: coronary ischemic disease (21 cases), HTA (24 cases), diabetes (19 cases), dyslipidemia and hypercholesterolemia (19 cases), obesity (16 cases).

Gender distribution: 16 women and 13 male.

None of the patients had clinical AD phenomena at first clinical examination.

The monitoring on clinical bases and neuroimaging (MRI 3 TESLA: Nativ, T2, FLAIR, angiMRI) with special hippocampal sequence. AD in clinical status (18 cases – 62%), Parkinson disease (3 cases – 10.3%), mixt dementia (2 cases – 6.8%). These cases performed in the same health unit revealed the occurrence of AD phenomena, which was confirmed in time by the neuroimaging changes, due to the hippocampal modifier.

Conclusions: Any kind of trauma in people aged over 65 can cause or aggravate the neurodegenerative AD phenomenon by passing from the preclinical phase to the clinical phase. Under these conditions, we consider that all AD connections and trauma are perfectly correlated.

TBI belongs to the group of etiopathogenic diseases of AD (DZ, HTA, atherosclerosis). Our advice is that all patients with TBI should undergo careful and accurate monitoring and to initiate AD prevention in time.

Poster presentations

Treatment of injuries of the craniospinal junction. Tricks and tips. Present limits of practice

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Treatment of injuries to the cranio-spinal junction. Tricks and tips in pursuit of motion preservation. Present limits of practice.

Cranio-spinal junction contributes in a very high degree to head and neck mobility.

Approximately 50% of the range of antero-posterior head movement is dependent on the flexion-extension in C0-C1 (atlanto-occipital) joint, while approximately 50% of head rotation range is dependent on the rotation in C1-C2 (atlanto-axial joint).

Thus the treatment of injuries to the cranio-spinal junction should be aimed predominantly to spare the range of movement of these two cardinal joints- as the first choice.

Contemporary surgical techniques, including minimally invasive screw fixation allow us to spare the movement of these two joints in most cases. There are also special techniques, enabling us to avoid any postoperative bracing. This is especially important in elderly patients, and noncompliant patients, who are not candidates to withstand postoperative bracing. (The eldest patient, successfully operated by the author due to C2 dens fracture was 97 years old, at the age of surgery, with uneventful postoperative course and last follow up at the age of 100 years old.)

Surgical interventions leading to permanent limitation of the range of movement in these two cardinal joints of the cranio-spinal junction complex, should be regarded as the second choice, and should be limited only to the cases in which none of the motion sparing techniques can be applied.

Vasopressin-associated acute hyponatremia impairs the regulation of intraparenchymal cerebral arterioles of the rat

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Introduction and aim: Hyponatremia (a decrease of serum sodium ion concentration below 135 mM) is a water-electrolyte disorder often diagnosed in patients with neurological diseases such as brain trauma, ischemic stroke or subarachnoid hemorrhage and is known to result in a longer hospital stay, in increased morbidity. In majority of cases, hyponatremia proceeds from inappropriate secretion of vasopressin (AVP) or natriuretic peptides. The effects of acute hyponatremia, especially the one associated with AVP, on cerebral vasculature are largely unknown. Therefore, the aim of this study was to determine the effect of acute hyponatremia associated with AVP on the responses of the isolated rat's middle cerebral artery (MCA) and intracerebral arterioles (PA) to acidosis, nitric oxide (NO) donor (SNAP) and to endothelium-dependent vasodilator adenosine triphosphate (ATP).

Material and methods: The isolated vessels were placed in a physiologic buffer in an organ chamber in which they were perfused at the pressures, similar to that measured at *in vivo* conditions.

The changes in the diameter of the vessels were monitored using a video camera attached to reversed microscope and a monitor.

Hyponatremia was induced *in vitro* by lowering Na⁺ concentration from 144 to 121 mM in intra- and extravascular fluid in the presence of AVP. AVP was applied at a concentration corresponding to the level of this hormone in the blood plasma of SAH patients. The reactivity tests were performed one hour after induction of hyponatremia.

Results: Both PA and MCA constricted in response to acute hyponatremia associated with AVP. Interestingly however, disordered regulation of vascular tone was observed in PA but not in MA. The abnormalities in the regulation comprised a significant reduction of PA response to an increase in hydrogen ion concentration and the absence of the response to the administration of SNAP or ATP.

Conclusions: Vasopressin-associated acute hyponatremia leads to constriction and dysregulation of intracerebral arterioles which may be an overlooked cause of adverse effects of hyponatremia in patients with neurological diseases.

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Systemic inflammatory response syndrome after traumatic brain injury

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Aim: Systemic inflammatory response syndrome (SIRS) is one of the complications in patient following traumatic brain injuries increasing the risk of complications and death. While the prevalence of SIRS in trauma patients including traumatic brain injury is well described, the predictors are poorly defined. We decided to analyze which common variables present on admission could be used as a positive predictors of developing SIRS after isolated traumatic brain injury.

Material and methods: We analyzed 177 patients with traumatic brain injury admitted within 24 hours after trauma.

We collected parameters from the patients' medical records. Parameters such as blood pressure, respiratory rate, heart rate, temperature were taken into analysis.

The severity of the injury was assessed based on head CT scans. We used univariate and multivariate logistic regression analysis to determine the possible predictors of SIRS.

Results: A total of 96 patients (54%) developed SIRS during hospitalization. Those patients had higher systolic (150.02 mmHg \pm 28.71 vs. 160.33 mmHg \pm 25.82; $p = 0.024$) and diastolic blood pressure (91.47 mmHg \pm 13.99 vs. 86.75 mmHg \pm 12.52, $p = 0.035$).

Intracerebral hemorrhage (45.68% vs. 22.92%; $p < 0.01$) and traumatic subarachnoid hemorrhage (33.33% vs. 15.63%; $p < 0.01$) were more prevalent in SIRS patients. On multivariate logistic regression analysis traumatic subarachnoid hemorrhage (OR: 2.23; 95% CI: 1.04-4.77; $p < 0.01$) and intracerebral hemorrhage (OR: 2.44; 95% CI: 1.24-4.81; $p < 0.01$) remained independently associated with SIRS.

Conclusions: TBI patients with higher systolic and diastolic blood pressure more often develop SIRS during hospitalization. Presence of tSAH and intracerebral hemorrhage upon admission is independently associated with SIRS.

Bone flap storage procedure after decompressive craniectomy

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Decompressive craniectomy is a lifesaving surgical procedure in acute brain swelling. Cranioplasty is required to avoid the physiological disturbances and for cosmetic reasons. Autologous bone is preferred to allograft due to its perfect match to the bony defect and low cost. Surgical site infection is a feared complication in delayed cranioplasty as much as bone resorption. The aim of standardization of the procedure is to provide secure method that maintain the bone flap sterile and vital.

A total of 21 patients were operated on due to acute brain swelling from 2011 to 2018 at the Department of Pediatric Neurosurgery University Children's Hospital of Cracow. All removed bone flaps were stored. Reimplantation of the bone flap was performed according to the designed protocol in 6 survivals at the age of 8-16 years. Indications for primary craniectomy were head trauma in 5 children and stroke in 1 child.

At the initial craniectomy bone flap was immersed first in sterile saline with Gentamycin and then with Vancomycin. Then it was dried, inserted into the sterile paper-foil sleeve and put into the freezer, where it was storage in freeze with constant temperature (-18°C). Before implantation, bone flap was removed from packaging, then immersed in sterile saline with antibiotics the same way as during initial procedure. Cranioplasty was performed at 7-19 weeks after decompressive craniectomy. No case of bone resorption significant enough to warrant repeat surgical intervention was observed. Up to now, no case of infection following cranioplasty has occurred.

Preservation of autologous cranial bone flap in the freezer with intraoperative use of antibiotics is cheap, safe and effective for cranioplasty with reference to both: infection and bone resorption.

Unilateral fracture of the superior articular process of C7. Minimally invasive transpedicular screw fixation at C6 and C7. Case report

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Approximately 5% of all traumatic cervical spine injuries involve isolated fracture of the articular processes non-displaced or minimally displaced. This case demonstrates an isolated cervical spine facet fracture with C7 radiculopathy treated with minimally invasive spine surgery techniques. A 47-year-old male was admitted to our department due to severe neck pain. The pain was radiating to the right upper extremity along the C7 dermatome. Neck and trunk rotation aggravated the pain. Physical examination revealed hyperesthesia in the right index finger, without any motor deficits. Those symptoms had a sudden onset 4 weeks earlier, after getting up in the morning. Imaging revealed isolated, unilateral fracture of the right superior articular process of C7.

The patient was treated by microsurgical C7 decompression and fusion of C6-7 under neuronavigation guidance. Intraoperative CT scans were performed to evaluate the sufficiency of bone removal. After the surgery, the neck and upper extremity pain subsided.

The patient had returned to his work and sport activities. This case illustrates the value of the neuronavigation and intraoperative CT in the evaluation of bony decompression, anatomy and location of implant.

Klaus von Wild Lecture

Targeted therapies for intracranial brain crisis after severe TBI: where we are?

Jürgen Meixensberger

Professor of Neurosurgery, Department of Neurosurgery, University of Leipzig, Germany

Invited Lectures

Cognitive behavioral therapy (CBT) in post-Traumatic stress disorder (PTSD) recovery. Experience – treatment – recommendations

Agnieszka Popiel

University of Social Sciences and Humanities, Warsaw, Poland

Psychological rehabilitation of post-traumatic stress disorder (PTSD)

Ewa Pragłowska

University of Social Sciences and Humanities, Warsaw, Poland

Complications related to peripheral nerve injury

Lukas Rasulic

European Association of Neurosurgical Societies

Civilian cranial and spinal injuries

Muhammad Tariq Khan

World Federation of Neurosurgical Societies

Decompressive craniectomy – update on surgical indication

Corrado Iaccarino

International Conference on Recent Advances in Neurotraumatology

TBI surgery in the elderly

Corrado Iaccarino

International Conference on Recent Advances in Neurotraumatology

Minimally invasive endoscopic repairment of injuries to the orbit

Tomasz Łysoń

Medical University of Białystok, Poland

