abstracts

INTRACRANIAL ABSCESSES AFTER ENDOSCOPIC ENDONASAL PITUITARY SURGERY

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Introduction. Intracranial abscess is a rare but potentially lethal complication after transsphenoidal surgery of pituitary adenomas.

Objective. To better determine the salient signs and symptoms of such abscesses and to evaluate the effectiveness of surgical and antibiotic treatment, we conducted a review of patients treated for intracranial abscesses after transsphenoidal pituitary surgery at the N.N. Burdenko neurosurgical institute.

Methods. We present the analysis of the 3730 patients who underwent removal of pituitary adenomas by endoscopic endonasal transsphenoidal approach in the N.N. Burdenko neurosurgical institute in the period of 2005-2016 yy. We analyzed the risk factors, diagnostic methods, tactics and results of treatment of these patients.

Results. In four cases the postoperative period was complicated by intracranial abscesses (0,01%). MRI in T1, T2 and DWI modes was used for differential diagnosis. One patient underwent endoscopic transsphenoidal drainage of the abscess, and three patients were treated exclusively with antibiotics. After surgical and antibiotic therapies all patients fully recovered.

Conclusion. Intracranial abscess after endoscopic endonasal pituitary surgery is a rare disorder with nonspecific presenting manifestations, often making a correct diagnosis difficult.

ENDOSCOPIC NEUROSURGERY HAS BEEN INTRODUCED RELATIVELY RECENTLY FOLLOWING THE WIDESPREAD APPLICATION OF ENDOSCOPIC TECHNIQUES IN OTHER SURGICAL SPECIALTIES

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Spinal endoscopic approaches has been pioneered by P. Kambin, A. Yeung, T. Hoogland et others in the late '90, however it has been growing rather significantly in the last five years due to improvement in instrumental technology. Thoracic disk endoscopic removal has been introduced and utilizes the bi-portal technique as in abdominal surgery. Endoscopic lumbar disk surgery has been proposed with mono-portal technique, by using either interlaminal, either lateral transforaminal approach.

A mayor problem in lateral transforaminal spine endoscopy is the fact that disk space is located lower than the foramina, so its endoscopic visualisation can be a real problem. However, improvement in instrumental technology allows solving this problem by enlarging the neural foramina which are approached by an outside-to-inside direction.

Endoscopic method using the TESSY's instrumentarium has the advantage of using a series of peculiar "rimmers" (technical solution which allows enlarging the foramen while protecting in the same time the exiting nerve root) for enlarging the neural foramina.

This method, together with the use of dedicated instruments, can allow exposing in the same time the affected nerve root, the herniated disk and the disk space which can in this way be emptied and coagulated after obtain neural decompression.

We present here our initial experience with 40 cases of lumbar herniated disks and or foraminal stenosis operated on with this technique in a-12-months period with a minimum follow up of 3 months.

The clinical diagnostic protocol, some operative videos to demonstrate the technique and post operative results are presented and discussed.

COMPARISON BETWEEN MODIFIED NEUROENDOSCOPY AND CRANIOTOMY EVACUATION OF SPONTANEOUS INTRA-CEREBRAL HEMORRHAGES: STUDY OF CLINICAL OUTCOME AND GLASGOW OUTCOME SCORE

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Background and purposes. Stroke is still one of a leading health-care problem in industrial country and in the developing country. Spontaneous Intra-cerebral Hemorrhage accounts for 30-60% of all stroke admissions into a hospital and considered to be a poor prognostic factor. While the craniotomy procedure failed to show more benefits over functional outcome, a less invasive and quicker surgical decompression might improve the outcome. Neuroendoscopy is one of promising optional on minimal invasive treatment for spontaneous intra-cerebral hemorrhage.

Material and methods. Randomized control trial was conducted to evaluate Glasgow Outcome Score and clinical outcome of patients with Spontaneous Intra-cerebral Hemorrhage who underwent modified neuroendoscopic surgery and craniotomy. The removal

of intra-cerebral hemorrhage was done by a modified neuroendoscopic transparent sheath made of silastic material, derived from pieces of thoracic tube No. 21F as a conduit working channel.

Results. 43 patients were enrolled which 25 patients treated with neuroendoscopy surgery and 18 patients with craniotomy. We analyzed statistically, clinical outcome assessment and Glasgow Outcome Scale 6 months post operative follow-up period. The mortality rate was significantly higher by Pearson chi-square methods, in craniotomy group n=12 (63.2%) compared with neuroendoscopy group, n=7 (36.8%) (p<005). Patients with Glasgow Outcome Scale score 3-5 was higher in neuroendoscopy group, n=18 (75%) compared with craniotomy group n=6 (25%). The survival rate analyzed by Kaplan Meier methods, found that patients in the neuroendoscopy group were a significantly longer survival rate compare with the craniotomy group during 6 months post operative follow-up period.

Conclusions. Treatment of spontaneous intra-cerebral hemorrhage with modified neuroendoscopy procedure was faster in action,safer and had significantly higher survival rate compared with conventional one.

RADIOTHERAPY FOR PROGRESSIVE SUPRATENTORIAL MALIGNANT GLIOMA: SINGLE INSTITUTION STUDY

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Study objective. Retro-prospective analysis of results of radiosurgery and hypofractionated irradiation for small to medium-size progression of supratentorial malignant glioma in 61 selected patients treated in Burdenko Neurosurgical Institute in 2009-2017.

Materials and methods. 32 men and 29 women was included, mean age was 47,2 years. 39 patients had primary glioblastoma, 5 – secondary glioblastoma, 6 – anaplastic astrocytoma, 7 – anaplastic oligoastrocytoma and 4 had anaplastic oligodendroglioma. 60 patient underwent tumor removal and 1 stereotactic biopsy. 57 patients received postoperative radiotherapy with 58-60 Gy in 29-33 fractions and other 4 had shorter courses (33-45 Gy in 12-18 fractions). Patients with glioblastoma and anaplastic astrocytoma received temozolomide 75 mg/m^2 during radiotherapy. After completion of radiotherapy 54 patients received adjuvant chemotherapy (35 had temozolomide-based regimen and 19 – other regimens). Mean time from completion of radiotherapy to first progression was 8,2 months in glioblastoma group (44 patients) and 16,3 months in anaplastic glioma group (17 patients).

First progression as single growing lesion in primary tumor region (local type of "monofocal" progression) was observed 31 of 44 (70%) glioblastoma and 14 of 17 (82%) anaplastic glioma patients. 6 glioblastoma and non of anaplastic glioma patients had distant type of monofocal progression (single distant new lesion with absence of progression in primary tumor region). Other 12 patients had "multifocal" progression (2 had several local growing foci, 2 had several distant foci and 8 had at least 1 growing local lesion and 1 new distant lesion).

Lesions with volume less than 11 cm^3 was treated with single median dose of 20 Gy, bigger lesions (up to 58 cm^3, median volume – 12,7 cm^3) were irradiated with 3 to 7 fractions up to total dose of 21-39,5 Gy (every day or every other day). Mean follow-up was 13,3 months after salvage irradiation.

Results. Mean time from salvage irradiation to second progression was 8,2 months in glioblastoma group and 17,2 months in anaplastic glioma group; overall survival after salvage irradiation was 16,5 and 31 month respectively. In 6 of 92 irradiated lesions (6,5%) clinically significant adverse radiation effect developed, all were treated successfully with bevacizumab. In primary glioblastoma group (39 patients) addition of more than 3 infusions of 400 mg bevacizumab to treatment was statistically significant associated with better overall survival (p=0.01).

Conclusion. Reirradiation with bevacizumab is an effective option for monofocal and multifocal forms of supratentorial glioblastoma progression.

MICROVASCULAR DECOMPRESSION BY RETROMASTOID KEYHOLE APPROACH FOR NEUROVASCULAR CONFLICT SYNDROMES; PHYSIOLOGICAL APPROACH TO ANATOMICAL PROBLEM

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Pulsatile propulsion of blood through blood vessels is responsible for its circulation. While cardiac cycle related pressure events are clearly defined in arterial flow, the venous flow too has a waveform pattern. Intracranially, the major trunks of the arteries and veins, and the trunks of major cranial nerves course the cerebrospinal fluid filled subarachnoid space. A close contact between a blood vessel (generally an artery) and a cranial nerve (generally the trigeminal and/or the facial nerve), over a period of time may lead to local demyelination, and initiate the phenomenon of ephaptic transmission. Such ephaptic transmission can lead to abnormal volley of impulses to the target musculature or sensory receptors. Subsequently, there can be rekindling phenomenon at the brainstem nuclei of the nerves concerned, leading to constant electric discharge and impulse transmission. In case of trigeminal nerve, the response takes the form of trigeminal neuralgia in the region of distribution of one of the branches, and in case of facial nerve, there is in-

termittent tonic-clonic facial movements of one half of the face, commonly known as hemifacial spasm. Once a space occupying lesion or demyelination has been excluded, the underlying pathology is almost always a vascular compression due to ectatic vessel. Microvascular decompression (MVD) aims to remove the abnormal contact between the vessel and the nerve, and cessation of stimulus for ephaptic transmission, thus restoring the normal physiology. Unlike the non-operative options (which are ablative), end-organ function remains preserved and the relief is permanent in majority of the patients.

Minimally invasive retrosigmoid keyhole procedure for MVD achieves its aim with minimum morbidity, while allowing excellent visualization, wide arachnoid dissection and removal of abnormal contact between the vessel and nerve. The procedure involves making a bony opening of about 2.5 cm at an appropriate level along the sigmoid sinus, cerebellar relaxation and identification of neurovascular conflict. The conflicting arterial segments are generally free from any perforating vessels and assume a redundant loop, that needs to be mobilized under magnification. Once mobilized, the loop can be kept away from the nerve by PTFE graft, arachnoid layer, autologous fat or biological glue. Endoscope can be a useful adjunct. If the veins are respected and CSF leak is avoided, postoperative hospital stay is 48-72 hours, and relief is immediate and permanent with cessation of medical treatment that was being given earlier for the condition.

TRANSCILIARY SUPRAORBITAL KEYHOLE APPROACH IN MANAGEMENT OF ANEURYSMS OF ANTERIOR CIRCULATION: OPERATIVE NUANCES

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Objective. With improvement in neuroimaging, instrumentation and operative microscope optics, and with better understanding of microneuroanatomy, it now possible to approach intracranial aneurysms of anterior circulation through a small eyebrow incision. The objective of the study is to highlight the advantages and limitations of transciliary supraorbital keyhole craniotomy for clipping of these aneurysms.

Methods. We present our experiences with 89 such aneurysms managed in 87 patients operated between 2003 and 2017, in a prospective study. Sixfty five of these patients were in Grade I/II, and the rest were in Grade III-IV. All these aneurysms arising from anterior cerebral and communicating artery, Posterior communicating artery, Internal carotid artery and middle cerebral artery, were clipped by a supraorbital transciliary incision and a craniotomy measuring 2.5x1.5 cm. Two patients required bilateral keyhole craniotomies for bilateral aneurysms.

Results. Clipping could be done in all the patients, and in twelve patients there was intraoperative rupture of the aneurysm. While there was a learning curve, no limitations were apparent, and none of the patients required revision of the procedure or wrapping. None of the patients had suboptimal clip application. Postoperative check angiogram showed obliteration of the aneurysm in all the patients. Patients with preoperative Grade I/II could be discharged from the hospital within seven days, and cosmetic result was excellent in all the cases. Five patients with preoperative grade IV died in the postoperative period due to vasospasm.

Conclusion. The transciliary supraorbital approach offers clipping of intracranial aneurysm with less approach related morbidity as standard approach. The learning curve is short, and does not entail of learning of new skills.

RETROSIGMOID APPROACH FOR NEUROSURGICAL TREATMENT OF TUMOR OF THE POSTERIOR CRANIAL FOSSA

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Aim. To estimate the possibilities of retrosigmoid approach for surgical treatment of tumors of the posterior cranial fossa.

Material and methods. 39 patients, aged from 39 to 72 years, with infratentorial tumors were observed. Woman man correlation – 10:3. Histological diagnosis: vestibular schwannoma – 15 patients; metastatic lesions – 6; meningiomas of the posterior surface of temporal bone pyramid – 5; meningiomas with transverse sinus, sigmoid sinus and the nerve of the cerebellum involvement – 11, epidermal cyst – 1, lymphoma – 1. Clinical diagnosis based on clinical-neurological findings, neurovisualization. Functional activity was assessed according to Karnovsky scale.

Surgical tactics. Rigid fixation in Mayfield frame, side-position, all manipulation under surgical microscope, neuromonitoring, ultrasound destructor. Assessment of tumors` resection: meningiomas – using Simpson scale; vestibular schwannomas – total, subtotal, partial, intracapsular resection.

Results. Period of patients` suffering from vestibular schwannomas and meningiomas from 6 months up to 7 years, epidermal cyst – 10 years; metastatic lesions – from 1 to 2 months. Neurological symptoms were presented in all patients by non-focal, focal and stem. Tumor had irregular round contours, minimal sizes – 2 cm in diameter (1), maximal 4-4.5 cm in 10 cases; in 25 patients – about 3 cm in diameter. Karnovsky scale from 50 to 90.

Surgical resection in 15 patients with vestibular schwannomas. Total removal in 7 patients; 4 – subtotal

with preservation of the capsule sections close to the brain stem and the region of the internal auditory canal; in 4 cases – intracapsular and partial removal because of hemodynamic disorders (asystole, expressed bradycardia). In patients with meningiomas of the posterior surface of temporal bone pyramid – Simpson grade III resection, meningiomas of tentorium with brain sinuses involvement: 2 cases – Simpson grade I, 8 – Simpson grade II, 1 – Simpson grade III. Resection of epidermal cyst close to posterior surface of temporal bone pyramid – Simpson grade II (without bone resection). Resection of lymphomas and metastasis were removed totally in visual control, with elaboration surrounding brain tissue up to 1 cm depth. Blood loss during the operation varieted between 50 to 500 ml. Histological diagnosis: vestibular schwannoma, most part of mixed form meningiomas without anaplasia; metastasis of lung cancer – 3; metastases of breast cancer – 3, primary lymphoma of the brain – 1.

Postoperative period. There was no mortality in our research. Complications: 1 case – postoperation hemorrhage into the tumor bed (metastasis of the breast cancer); reoperation was performed. Complications after resection of vestibular schwannomas: 2 patients had grade 2 according to House-Brackmann scale, 6 cases þ House-Brackmann grade 2; 6 patients – House-Brackmann 4 degree, 1 – House-Brackmann 5 degree. Transitional liquorrhea from the postoperative wound – 3 cases, 2 of them required implantation of lumbar drainage, in the remaining cases.

Conclusion. Retrosigmoid approach considered to minimal invasive approaches and can be used for resection of infratentorial tumor of various histological diagnosis. Rigid fixation in Mayfield frame, patients position on stomach reduces the risks of embolic complications and postoperative pneumocaphales. Using surgical microscope from the moment of opening the dura mater before up to sewn of it, neuromonitoring and ultrasonic destructor make it possible to proceed tumor resection more radically, to reduce postoperative complications.

THE RHINOLOGICAL ASPECTS OF ENDOSCOPIC TRANSSPHENOIDAL SURGERY OF PITUITARY ADENOMAS

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Among all intracranial tumors benign tumors of the pituitary gland are quite uncommon. It affects only 15-20% of patients. There are many surgical approaches for the treatment of the pituitary gland adenoma, especially endoscopic transsphenoidal surgery. In case of the intranasal approach it is necessary to analyze the anatomical variants of structure in development. Postoperative rehabilitation of such patients should include care of the nasal cavity.

Purpose of study. To study the rhinological features of the endonasal transsphenoidal approach in the treatment of pituitary adenoma.

Material and methods. A retrospective analysis was performed on all 12 patients after endoscopic transsphenoidal pituitary gland surgery at the ENT Department together with the neurosurgery department between 2016-2017. Twelve patients with a diagnosis of pituitary gland adenoma with infra- and suprasellar growth were observed.

History, symptoms, endoscopic examination of the nasal cavity and radiological examinations (CT-scan or MRI) were analysed. The removing of the pituitary gland adenoma in all cases was carried out through the endoscopic transnassphenoidal approach under general anesthesia. All removed tumors were sent for histological examination to confirm the diagnosis.

Results. More than 1000 endoscopic transsphenoidal pituitary gland surgery were completed during the period from 2016 to 2017. There are 12 cases of pituitary gland cists, which are combine with some rhinological features. Before the surgery, during the endoscopic examination under local anesthesia it was possible to visualize the natural ostium with the sphenoid sinus in 7 cases. Other 5 patients have moderate edema of the nasal cavity and the anatomical narrowness of the study zone because of nasal septal deviation. All patients have to undergone endoscopic transsphenoidal pituitary gland surgery. In postoperative period they were examined by othorinolaringologyst. On the seventh day all patients received local irrigation therapy in connection with the local inflammatory changes in the nasal cavity. After 2 weeks the inflammation reaction of the nasal cavity survived in 6 cases. Therefore, local antibiotic therapy was added to patient of this group.

Conclusion. Endonasal endoscopic transsphenoidal approach in the surgery of pituitary adenoma is most preferable because of minimizing traumatism of adjacent structures and short rehabilitation period of patients. It is important to analyze magnetic resonance imaging data, computerized tomography data and results of examination of related specialists – otolaryngologists, ophthalmologists in preoperative period to understand technical features during the surgery. Postoperative rehabilitation of patients should include irrigation therapy. In case of prolonged nasal breathing block or secretion from the nasal cavity, some topical antibacterial treatment should be carried out.

SURGERY OF MENINGIOMAS IN THE CHIASM-SELLAR REGION

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Meningiomas of the chiasm-sellar region are the most complicated pathology for neurosurgeons. Their localization close to vessels of the Willis circle, optic nerves, hypothalamus increases a risk of surgical interventions

and postoperative complications.

We operated 257 meningiomas of the chiasm-sellar region during the last 10 years. Their localization was as follows: the saddle tubercle (211 cases – 82,1%), the saddle diaphragm (11 cases – 4,2%), the clinoid process (27 cases – 10,6%) and the saddle dorsum (8 cases – 3,1%). The dominant symptom in all the cases was a visual disorder, which manifested itself to this or that extent. Reduced vision acuity and impaired visual fields were observed in 87% and 90% of patients, respectively. Other symptoms included general cerebral and hormonal disturbances.

A lateral supraorbital approach was performed in the majority of cases. In recent years we have used supraorbital approach through the eyebrow more often. A transsphenoidal approach was used in 33 cases. It should be noted, that a lateral supraorbital approach provides a sufficient angular view and possibility of manipulation in the chiasm-sellar region. Besides, one can almost avoid traction of the frontal lobe due to opening of basal cisterns and liquor evacuation at the first stage of operation. There is practically no necessity of using a bilateral approach or extended basal approaches.

A postoperative period was smooth in the majority of cases. There were 7 cases with seizures watched during the first postoperative day. They were caused by pneumocephalus, which demanded use of anticonvulsants. Two cases developed augmentation of visual disorders with their subsequent regression. Vision improvement and regression of visual disorders were typical of 89% of cases. There were no fatal outcomes in this series. Control MR-examinations were indicative of total and subtotal removal in 93.2% and 6.8% of patients, respectively.

The analysis showed no difference between lateral supraorbital approach and transsphenoidal approach, neither by the number of complications, by the frequency of the removal, or by other parameters.

Conclusion. The choice of approach is the patient's choice.

ENSDOSCOPIC TRANSSPHENOIDAL SURGERY OF SKULL BASE TUMORS (4334 CASES): EXPERIENCE OF 20 YEARS AND VIEWS EVOLUTION

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A transnasosphenoidal approach is characterized by a minimum traumatic effect, which makes it a method of choice in treatment of various basal masses. Beginning with 1996, we started to perform this approach in operations for pituitary adenomas. Further improvement of endoscopic skills led to widening of indications for its use not only in pituitary adenomas but also in basal extracerebral tumors. It became possible to operate adenomas of any size and to perform endoscopic interventions for craniopharyngiomas, choleostomas, chordomas, chondromas and other basal tumors. A transseptal transsphenoidal access, used at the end of the 1990s, was replaced by an endonasal endoscopic approach.

Fluoroscopy, endolumbar administration of oxygen with the purpose of better visualization of a tumor upper pole were popular some time ago. Endoscopic cryodestruction of neoplasms of the sellar-chiastic region was considered to be prospective. However, these methods lost their attractiveness with a passage of time. Their analysis proved, that despite their advantages these methods had certain limitations and gave no strategic superiority.

Nowadays extended endoscopic approaches permit to remove complex giant basal tumor of practically any type. As for our first series of endoscopic interventions, the rate of postoperative recurrences, complications and mortality was 26%, 7.8% and 2.1%, respectively. Then there was a gradual decrease of these indices. Today they are as follows: recurrences – 9-11%, complications – 3-7% and mortality – only 0.17%. Besides, one should mention reduction of an operative period from 2-3 hours, typical of the first endoscopic interventions, up to 15-30 minutes.

The analysis of all errors and complications, dynamics of a learning curve allows to make certain conclusions. Training in the field of transsphenoidal endoscopic surgery is to be carried out in a big specialized center, whose personnel has a great experience of such operations; the first interventions, made by beginners, are to be performed only under supervision of a skillful and experienced neurosurgeon.

TO THE QUESTION OF COMPLETELY ENDOSCOPIC SURGERY MENINGIOM OF THE ANTERIOR CRANIAL FOSSA

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Purpose. In the area of the base of the anterior cranial fossa, develop meningiomas, osteomas and fibrous osteodysplasia, chondromas and chondrosarcomas, chordomas, estesioneuroblastomas, malignant epithelial tumors growing from the paranasal sinuses, etc. Meningiomas account for approximately 13-25% (according to different statistical data) of all primary neoplasms, localized inside the skull. 97% of cases are benign tumors and

only 3% are malignant tumors. Frequency of occurrence in the Republic of Belarus per 100,000 population is 2.4, among men – 1.4, among women – 3.2. Meningiomas of the tubercle of the Turkish saddle account for 7-9% of all meningitis of the brain. Improve the results of treatment of patients with anterior cranial fossa meningiomas by developing and implementing a transcranial endoscopic removal method.

Materials and methods. For the first time in the Republic of Belarus, we developed and implemented a new method of transcranial endoscopic surgery for meningiomas of the anterior cranial fossa, which consists in minimizing access and traumatization of brain structures, using the endoscope for surgical intervention as an alternative to the standard direct microsurgical method of removing tumors of this localization. Subjects of the study were patients with anterior cranial fossa of different age groups operated by transcranial endoscopic and standard surgical methods. In this way, from July 2013 until now, 57 patients with meningiomas of the anterior cranial fossa have undergone surgery on the basis of the RRCC of neurology and neurosurgery. All patients were operated using three main fully endoscopic approaches – supraorbital, transglabellar and antepetiral: cutaneous incisions – about 4-5 cm, cranial trepanation – up to 2.0x2.5 cm.

Surgical manipulations were performed by monoportal access under video monitoring using neuroendoscopic "Karl Storz" racks with straight and oblique optics (30°, 45°, 60°). In the comparison group, we took 58 patients operated on from 2009 to 2012 standard transcranial microsurgical method.

The subject of the study. The study of the nearest results of surgical treatment will be carried out on the basis of an assessment of the neurological status, the reaction of local tissues, the data of control CT and MRI of the head, the length of stay of patients in the hospital.

Results and discussion. Total removal of neoplasms up to 5.5x5.5x4.5 cm was performed for all patients. Improvement of the function of vision occurred in all operated. The function of the sense of smell was partially preserved in 26 (44.8%) patients after the removal of the meningiomas of the anterior cranial fossa. In the control MRI study, all the operated patients had no residual fragments of tumors. All operated patients became active the first day after the operation. The duration of patients' stay in the intensive care unit decreased. Inflammatory complications were not observed. In the main group there were no reoperations and deaths.

Conclusion. Our experience suggests that the use of a rigid endoscope and minimal transcranial surgical access for removal of any size of meningiomas by the meningiomas provided surgical removal of the tumor and separation of brain tissues, cranial nerves and vascular structures without the use of additional dissections and tractions, and also significantly reduces blood loss during surgery, which eliminates the need for transfusion of blood components. Endoscopes with different angles of vision made it possible to panoramic visualize the surgical anatomy and give a full assessment of the degree of intracranial pathology. The use of the new endoscopic method improves the results of surgical treatment of patients with meningiomas of the tuberculum of the Turkish saddle, simplifies and shortens the time of operation, prevents the development of complications in the intraoperative and postoperative periods, allows reducing the length of stay of the patient in the hospital and the intensive care unit. Fully endoscopic transcranial access can be used in place of an expanded access for all lesions of the base of the skull, which traditionally required subfrontal, bilateral subfrontal, transbasal or pteryonal access.

BRAIN BIOMARKERS IN MINIMALLY INVASIVE SPINE SURGERY

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Objective. Minimal invasive surgeries implying therapeutic electrical stimulations (TES), administrations of endogenous peptides (EPT), and stem cells transplantations (SCT) are reviewed in rodents and humans with spinal cord injury (SCI). The efficacy of TES, EPT, SCT, combined use of TES+EPT and TES+SCT, are explored to facilitate and optimize the recovery after SCI. To assess biomarkers potentials in evaluation of neurogenesis, angiogenesis, and gliogenesis glutamate neuroreceptors and glial fibrillary acidic protein (GFAP) were measured.

Methods. Systemic analysis of peer-reviewed publications and proprietary data implying experimental results and prospective clinical applications is conducted. TES are performed by direct deep stimulations of upper and lower extremities. There are data of EPT, SCT (intraventricular or lumbar intrathecal), and advanced radiological (CT, MRI). Immunohistochemical staining of rodent spinal cord is performed. Brain biomarker assays detecting AMPA-kainite receptor peptides/antibodies and GFAP are tested by ELISA.

Results. The TES temporarily improved motor functions and pain reflexes within 72 hours while TES+EPT combinations increased the treatment efficacy up to 3 months. Stem cell transplantations alone show positive dynamics in animals during 1-3 months. These positive effects depicted by histological images showing reduction of neurotoxicity and inflammation with extensive repair of nervous cells. It also correlated with declined MRI-hyperintensities and decreased concentrations of biomarkers in CSF and blood.

Conclusion. Brain biomarkers could be used to select the therapy option, follow up after minimal invasive surgery, and assess treatment efficacy in conjunction with neuroimaging. It is suggested that joint use of TES+SCT would stimulate neurogenesis after SCI where brain biomarkers might be objective tracers of prolonged recovery effects.

DRAINING VEIN SHIELDING IN INTRACRANIAL AVM'S DURING GAMMA-KNIFE: A NEW WAY OF PREVENTING POST GAMMA-KNIFE EDEMA AND HEMORRHAGE

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Introduction. Following gamma knife (GK) therapy for intracranial AVM's, obliteration of the nidus occurs over several years. During this period there is a risk of edema and hemorrhage. We hypothesized that decreasing radiation dose to the draining vein(s) may prevent early draining vein obliteration leading to a decrease in edema and hemorrhage rates in the post GK period.

Materials and methods. This retro-prospective study over 5 years (Jan 2009 to Feb 2014) included patients with intracranial AVM who underwent gamma knife therapy (Leksell Perfexion®, Elekta, Stockholm) at our center. Approval from the institute's ethics committee was taken. All patients who underwent draining vein shielding (DVS) by senior author (DA) were included in the test group and patients who did not undergo DVA were put in the control group. Patients with less than 6 months of follow up were excluded. All patients were followed up 6 monthly clinically as well as radiologically with CT head/MRI brain to see for edema. DSA was done at 2 years for all patients and repeated at 5 years for those with incomplete obliteration of nidus.

Results. 185 patients were included in this study of which 96 were in the control group and 89 in the test group. The mean age, sex distribution, co-morbidities and adjuvant treatment were comparable in both groups. The lobar distribution of the AVM, angio-architecture and radiation dose were comparable between the two groups. Due to shielding, the test group patients received significantly less radiation to the draining vein (0.0001). On follow up, significantly less number of patients in the test group had new neurological deficits (p=0.001).

Importantly, significantly more number of patients in the control group had post-radiosurgery intracranial hemorrhage (p=0.03) and brain edema (p=0.002). Both the group had comparable AVM obliteration rates following radiosurgery.

Conclusion. Shielding of draining vein is a potent new strategy in minimizing edema and hemorrhage as well as clinical deterioration following gamma knife therapy for intracranial AVM's.

CHRONIC SACRAL NEUROMODULATION IN TREATMENT OF THE NEUROGENIC PELVIC DYSFUNCTION IN CHILDREN

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Objective. Spina bifida is a more often reason of the inherit urinary disorders in children. Urinary disorders is a serious clinical problem, conservative treatment is not sufficient in most cases. Neuromodulation of the sacral root is a most perspective method of treatment of the pelvic disorders in children.

Material and method. Seven patients with spina bifida and neurogenic pelvic dysfunction have been operated. Four patients had detrusor-sphincter dissynergy and urinary incontinence, three patients had hypotension of the detrusor and urine retention according to complex urodynamic investigation data. Conservative treatment was failed in all cases. In six cases the quadripolar electrode have been implanted on the S3 root through the Tuohi needle under the X-ray control. In one patient with agenesia of the sacrum we have used microsurgery electrode implantation. Electrical stimulation was started next day after the implantation with rate 4-40 Hz, power wide 200-300 mcs. The duration of the trial period was 1 week. The clinical effect was estimated on the basis of the urinary diary and complex urodynamic investigation data.

Results. The positive clinical effect was observed in 5 cases – four patients with detrusor-sphincter dissynergy and one patient with hypotension of the detrusor. It was observed improvement in urine leakage till 40-50% and increasing of the bladder volume. In patient with urinary retention we have revealed occurrence autonomous urination and decreasing of intermittent catheterization from 4 till 2 times per day. We did not observe any clinical effect in 2 cases.

Conclusion. The preliminary results of the chronic sacral neuromodulation show the possibility in repairing of urination in children with neurogenic pelvic disorders. But until wide clinical application of this method is limited owing to insufficient clinical experience.

LARGE CLIVAL CHORDOMAS TREATED BY COMBINED OPEN AND ENDOSCOPIC ENDONASAL APPROACHES

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Objective. Chordomas are rare locally malignant tumors of the midline, usually involving the clivus. The optimal therapeutic strategy is now thought to consist of "one shot" maximal resection followed or not by charged-particles radiation therapy. Despite aggressive surgical resection and radiation, 20% of chordomas recur within 1 year.

The open transfacial and postero-lateral transcranial approaches still remain the gold standard for chordomas with extensive intradural retrochiasmal and/or deep cervical expansion. In last decades the mini-invasive endoscopic endonasal transclival approach (EETA) has been used as feasible and safe surgical access alone or in combination with the traditional ones, allowing caudal extension to C2 and through the maxillary sinus. We describe our preliminary experience.

Methods. From January 2010 to September 2014, 7 patients (5 males and 2 females, mean age of 41 years) underwent combined maxillofacial-endoscopic approaches for clivus chordomas. In 3 cases, patients underwent to first step with transfacial (Le-Fort and Mid-facial degloving) approach followed by EETA. In other 2 cases, after an initial transfacial approach, the patients underwent a far lateral approach. In 1 further patient we chose a combined endoscopic endonasal and transcranic approach followed by a Kawase one. In the last patient, at the end, we performed a far lateral approach followed by an EETA.

All patients underwent preoperative CT, MRI and three-dimensional imaging in order to evaluate tumors extensions and to plan the optimal surgical approaches. In all cases we used intraoperative neuronavigation.

Results. Gross total removal was achieved in 5 out of 7 patients after the combined approaches. Subtotal resection with decompression was achieved in the other 2 cases. Radiotherapy was administered in these last patients and in one patient with a gross total resection. Two patients showed recurrence within 1 year from the combined approach and were treated by an EETA in a mean follow-up period of 21 months. Histological examination was always consistent with Chordoma. In one case it was necessary to keep the feeding nasogatric tube for two months for a non-healing of the rhinopharingeal mucosa. One patient presented a cerebrospinal fluid leakage, it was resolved with lumbar spinal drainage.

Conclusions. Chordomas may be excised by anterior midline approaches (transoral, transmandibular and transfacial), posterior suboccipital approaches, transpetrous surgery, lateral atlantoaxial approaches, and pterional or middle fossa craniotomies, endoscopic endonasal approach or any combination of these. The standard transoral approach is rarely sufficient for excision of chordomas due to the extensive nature of these tumors and usually a maxillotomy is needed to access the upper clivus. In selected cases of clival chordoma the use of a combined open microsurgical and an endonasal endoscopic approach might increase the radicality of tumor resection while decreasing the operative burden for the patients. Our management relies on close cooperation between the joined specialties of neurosurgery, maxillofacial surgery and otolaryngology. In our experience, combined approach permitted to obtain a gross total tumor resection, with low complications rate.

KEYHOLE SURGERY OF CEREBRAL ANEURYSMS

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Background. For several decades, pterional craniotomy was the main, traditional approach for most anterior circulation aneurysms. However, in a critical analysis it is obvious, that the concomitant surgical trauma is not related to the main purpose of surgery, which in turn can influence the immediate and long-term recovery of patients.

The concept of keyhole surgery has been actively developing in the last two decades. Minimally-invasive approaches allow to reduce iatrogenic trauma and provide a focused surgical route. Important criteria are excellent cosmetic and functional outcome, rapid recovery of patients.

Material and methods. The results of using keyhole approaches are presented from March 2014 to January 2018 in 200 patients: supraorbital keyhole craniotomy (112 patients, 56.6%), mini-pterional craniotomy (50 patients, 25%), mini-orbitozygomatic craniotomy (17 patients, 8.5%), transpalpebral approach (21 patient, 10.5%). Localization of aneurysms was distributed as follows: 110 aneurysms of the anterior communicating artery, 50 paraclinoid aneurysms, 3 aneurysms of the basilar artery and 45 aneurysms of the middle cerebral artery. The patients' condition was assessed on the scale of Hunt-Hess and the volume of SAH on the Fisher scale. The majority of patients had SAH (131 patients, 65.5%), 52 of them were operated in the acute period (39.6%). Unruptured aneurysms were finding in 69 patients (34.5%). Preoperatively all patients with aneurysms performed native and CT-angiography with 3D reconstruction.

Results. All aneurysms were completely clipped, which is confirmed both by intraoperative data and by the

control of 3D CT-angiography in the postoperative period. There were no serious complications or lethal cases. The intraoperative rupture of the aneurysm was in 8 patients (4%). The rupture of the aneurysm occurred during the dissection of the aneurysm and was not associated with retraction of the brain. In all cases, the aneurysms were successfully clipped without neurological consequences. Postoperative complications were assessed at 2 weeks, 6 months and 1 year. In 11 (5.5%) patients with a follow-up assessment of up to 10 months, minimal dysfunction in the temporomandibular joint area and symptoms of temporal muscle atrophy in the area of craniotomy were noted. After supraorbital craniotomy, mini-orbitozygomatic craniotomy and transpalpebral approach periorbital edema was noted in all patients and was not regarded as a complication, as it completely regressed within 3-5 days after operation. Hyperesthesia in the frontal region was noted in 176 (88.2%) patients. Up to 6 months, complete regression was noted in 190 (95.3%) patients. Alopecia in the eyebrow area is not noted. Postoperative cosmetic result was assessed by patients as excellent.

Conclusion. Minimally invasive aneurysm surgery has proven effective and safe. Since the mini-accesses are focused, the correct selection of patients is necessary. Minimizing surgical aggression contributes to a reduction in the number of access-associated complications, rapid activation and social adaptation of patients, reduction in hospital-day and direct financial costs for treatment.

KEYHOLE SURGERY OF TUMORS OF THE ANTERIOR CRANIAL FOSSA

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Background. Minimally-invasive neurosurgery is a modern line of neurosurgery, which is gradually gaining popularity. Widely distributed minimally invasive approaches including with endoscopic assistance in the surgery of intracranial tumors. Obtaining a histological diagnosis, removing the maximum possible volume of tumor tissue is possible both with the choice of traditional extended access, and using concept of keyhole surgery.

Material and methods. From March 2014 to January 2018, 45 patients underwent surgery with supraorbital craniotomy. The majority of patients (28 patients) had meningiomas of the anterior cranial fossa. Gliomas and intracerebral metastases were diagnosed in 17 patients and localized mainly cortico- and subcortical regions of the pole of the frontal lobe and the orbital part of the frontal lobe. The average tumor size varied from 3 to 3.5 cm.

In tumors within the anterior cranial fossa, the method of choice in diagnosis was MRI of the brain with contrast enhancement. In a number of cases, CT and CT-angiography were performed. Critical were the evaluation of bone anatomy and the size of the frontal sinuses.

Results. Mortality, disability or serious permanent approach-associated complications in our group were not noted. Tractional changes in the parenchyma of the brain in the form of edema or hemorrhage in control tomography have not been revealed. Endoscopic assisted to control the removal of the tumor was performed by 28 patients. All meningiomas were removed by Simpson 1. Postoperative cosmetic and functional outcomes were evaluated after 7 days, 1, 3 and 6 months. All patients had periorbital swelling, which completely regressed within 3-5 days after the operation. Weakness of the temporal and frontal muscles was not observed. In the early postoperative period, there was a slight numbness in the supraorbital region, which completely regressed 2 weeks after the operation. Paresis of the branches of the facial nerve is not noted. The overwhelming majority of patients (42 people) were completely satisfied with postoperative scar

Conclusion. Keyhole approaches can be an effective and safe alternative to classical advanced access for tumors of the anterior cranial fossa. It should be noted, that the using of minimally invasive approach requires considerable experience in a limited trepanation window. Therefore, very careful selection of patients and individualization of access is necessary.

TRANSPALPEBRAL KEYHOLE APPROACH IN SURGERY OF CEREBRAL ANEURYSMS AND TUMORS OF THE ANTERIOR CRANIAL FOSSA

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Background. The desire of neurosurgeons to minimize surgical trauma, improve functional and cosmetic outcomes, accelerate the recovery of patients after surgery contributed to the active development of minimally invasive neurosurgery. Modern methods of neuroimaging, microneurosurgical techniques and the improvement of anaesthesiological protocols allowed to operate through small skin incisions and make a small craniotomy with high efficiency and safety.

Material and methods. The authors present the results of using transpalpebral keyhole approach in 42 patients, operated from March 2016 to January 2018. In 30 patients, approach was made to cerebral aneurysms in following localization: 10 aneurysm of the anterior cerebral - anterior communicating artery complex, 20 an-

eurysms of the internal carotid artery in the region of the posterior communicating artery. 20 patients had unruptured aneurysms, 10 patients were operated after SAH in the cold period of hemorrhage. The patients' condition was assessed according to the scale of Hunt-Hess, and according to the CT characteristics of the SAH on the Fisher scale. All patients after SAH were I and II Hunt-Hess scale, Fisher 1-2. All patients underwent before surgery native CT and CT-angiography of the brain with 3D reconstruction, carefully assessed the anatomy of intracranial structures, the configuration of aneurysms, the volume and location of tumors. An important point was the evaluation of the dimensions of the frontal sinuses. The size of the clipped aneurysms did not exceed 15 mm in diameter. In the group of patients with егьщкы of the anterior cranial fossa (12 patients), the pathology is presented as follows: meningiomas of the tuberculum sellae (7 patients), 3 olfactory meningiomas and 2 in the anterior clinoid region. The degree of radical removal of meningiomas was assessed according to the Simpson scale.

Results. All aneurysms were completely clipped, which was confirmed by both intraoperative aneurysm opening and subsequent monitoring with the use of ICG angiography and by performing 3D CT-angiography in the postoperative period. There were no intraoperative ruptures of aneurysms. Removal of meningiomas was carried out according to Simpson 1. There was no serious complications or lethal cases. All patients had periorbital swelling, which completely regressed within 3-5 days after the operation. Weakness of the temporal and frontal muscles was not observed. In the early postoperative period, there was a slight numbness in the supraorbital region, which completely regressed 2 weeks after the operation. Postoperative cosmetic result is rated by patients as excellent. Infectious complications and lethal cases in our group were not noted.

Conclusion. Transpalpebral approach is an innovative, low-traumatic and safe access to anterior aneurysms and tumors of the anterior cranial fossa, which along with other conventional keyhole accesses provides a focused surgical route and an excellent cosmetic effect. The decision to perform transpalpebral access is based on careful selection of patients, taking into account the peculiarities of individual anatomy and the use of modern methods of neuroimaging.

HOW WE CAN EVALUATE INVASIVENESS?

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The basic concept of neurosurgery is to save patients suffering from CNS or PNS disease by means of various surgical procedures. Surgery has, off course, invasive nature. How we can evaluate invasiveness? Many people, not only patients but also surgeons, tend to use scales to evaluate degree of invasiveness, such as length of skin incision, size and location of craniotomy, length of surgical time, amount of intraoperative bleeding, length of hospital stay, etc. Treatment modality can also be considered to evaluate invasiveness. For example, whether to use radiosurgery, endoscopic surgery, or endovascular surgery is usually the issue of invasiveness. However, invasiveness should be evaluated comprehensively with the outcome of surgery. Good postoperative condition of the patients and improved prognosis of the disease should be basic preconditions. The goal of less invasive surgery is to reduce injury and risk of surgery aiming zero-level. Less invasive neurosurgery is a concept both to minimize surgical trauma and to achieve better results by combining best tactics in a neurosurgeon's hand. Some examples of skull base tumor revealing the concept will be demonstrated in the presentation.

REVISITING THE SELECTIVE VESTIBULAR NEUROTOMY FOR INTRACTABLE MÉNIÈRE'S DISEASE IN THE ERA OF ENDOSCOPY AND INTRAOPERATIVE ADVANCED NEUROMONITORING

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Introduction. Vestibular neurectomy is considered a quite effective salvage-procedure to control intractable vertigo associated with Meniere's disease while preserving hearing and facial nerve function. However, it is still a potentially very dangerous procedure in terms of mortality and morbidity for, at the end, a benign disease. Popularized by Dandy, with a short bracket with House and Brackmann, this surgical treatment does not seem to have gained wide popularity in the oto-neurosurgical community for the technical difficulties in selective identification and sectioning of vestibular nerve while sparing the cochlear and facial nerves. This is why the present gold standard for the treatment of severe vertigo associated to Meniere's disease is transtympanic gentamicin injection and, regarding the surgical treatment, the extradural endolymphatic sac decompression surgery. With the present preliminary experience we explored the possibility, thanks to the higher magnification offered by the endoscopic technique and the advanced intraoperative neuromonitoring, to maximize the selective section of the vestibular nerve fibers minimizing, at the same time, surgical complications.

Methods. Seven patients with disabling, intractable vertigo associated to Ménière's disease treated by a combined micro-endoscopic selective vestibular neurotomy were evaluated. All patients come from a failure of a previous extradural surgical decompression of the endolymphatic sac. Demographics, clinical signs and symptoms, quality of life, thresholds of hearing, and adverse events were documented at baseline, 1 week, 1, 3, 6, 9, 12 months after surgery.

Results. At the maximum present follow-up of ~~1 year~~ 18 months vertigo disappeared in 6 of 7 patients and improved in the last one. In all cases, intraoperative neurophysiological monitoring and direct stimulation of nervous fibers allowed the selective identification of the facial and cochlear nerve. Furhtermore, thanks to the better and higher magnification and visualization provided by endoscopic technique, we were able, after the careful inspection of the cranial nerve VIII, to appreciate a slight difference in color between the superior half (the vestibular nerve being relatively grayer) and the inferior half (the cochlear nerve being relatively whiter), which sometimes helped in demarcating the small sulcus between the two components. Moreover, after the initial partial section of the vestibular nerve by-irrigating the field with saline solution, this difference become much more demarcated, hence better guiding the definitive nerve section. In almost all cases, a fine vessel (arteriole) coursing along the demarcation line between the vestibular and cochlear components was identified by endoscopy while was hardly visible even at the highest magnification microscopic view. No major complications occurred, one case presented skin infection.

Conclusion. In our preliminary experience, the modern endoscopic technique and the intraoperative advanced neuromonitoring seem to be able to allow a precise, complete and very selective vestibular neurotomy, preserving at the same time, the cochlear and facial nerve functions. We believe that the surprisingly quite high success rate is due to the completeness of the vestibular nerve deafferentation of almost all its fibers. The main concern is the duration over the time being the follow-up still quite short.

EXTENDED ENDOSCOPIC ENDONASAL TRANSCLIVAL APPROACH FOR TUMORS OF PETROCLIVAL REGION: PRELIMINARY EXPERIENCE

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Introduction. Petroclival tumors remain a surgical challenge. Classically, the retrosigmoid or transpetrosal approaches have long been used to reach such tumors, whereas the anterior petrosectomy has been proposed to avoid crossing cranial nerves. More recently, the endoscopic endonasal approach has been "expanded" (EEA) to the petroclival region, as alternative minimally invasive way for well-selected type of tumors.

Methods. The authors present seven cases of complex petroclival lesions treated via EEA alone or combined with conventional surgical approaches. Two patients presented a large and symptomatic epidermoid cysts located in the ventrolateral brainstem cisterns with cerebello-pontine angle extension. Four patients presented a petroclival meningiomas treated with combined pterional, fronto-orbitozygomatic approaches or anterior petrosectomy and EEA. The last patient was treated with EEA alone for a brainstem cavernoma.

Results. Complete tumor removal was obtained in four patients and subtotal in three patients with meningiomas. In all cases it has been documented a neurological improvement. Two patients presented CSF leakage after surgery treated by seriate office-based endoscopic blood patches and injections of fibrin glue. No others threatening complications occurred after surgery, and the length of hospitalization was less than 10 days.

Conclusions. In comparison to posterolateral skull base approaches, the transclival endoscopic endonasal approach allows direct access to the petroclival region without unnecessary manipulation of neurovascular structures at the cerebellopontine angle. In our preliminary experience, the EEA may represent, in selected cases, an alternative minimally invasive and effective route for dealing with complex petroclival lesions. This approach may offer greater access for resection of midline lesions, especially for lesions that are medial or caudal to the abducens nerve or intradural tumors usually soft and amenable to resection with suction such epidermoyd cysts.

APPLICATION OF ENDOSCOPIC TECHNOLOGIES WITH NEUROSURGERIC TREATMENT OF CHILDREN WITH BRAIN TUMORS

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The aim of the study was to increase the safety and radicality of brain tumor removal in children by improving the technique of endoscopic assisted neurosurgical operations.

Materials and methods. The study includes patients with brain tumors treated at the Burdenko Nation-

al Medical Research Center for Neurosurgery during the period of 2010-2017. The indications for the endoscopic assistance were the tumors with the following localisation: 1. tumors of the chiasmatic-sellar region; 2. posterior cranial fossa; 3. lateral and III ventricles; 4. the base of the skull. Inclusion criteria: 1. children with a confirmed diagnosis of brain tumor; 2. patients with indications for microsurgical removal of the brain tumor; 3. age from 0 to 18 years; 4. patients, who gave informed consent to participate in the study.

Used equipment: operating microscope OPMI Pentero 900 (Carl Zeiss), endoscopes with optics HOPKINS direct vision 0° and 30°, washing system KARL STORZ CLEARVISION® II, microsurgical instruments KARL STORZ, AESCULAP, MEDIN.

For the evaluation of the effectiveness of the use of endoscopic assistance techniques, a comparison of intraoperative video records by microscope and endoscope cameras were used. Neuroimaging methods were used to determine the radicality of tumor removal within 72 hours after surgery.

Results and discussion. 151 children with brain tumors were operated in the Center with parallel use of microscope and endoscope. An assistant endoscope was introduced through the keyhole access under the control of the microscope and inspection of the target area was performed. During surgery different variants of mechanical fixation or free-hand technique were used. To review the hidden areas, endoscopes with angled optics were used. When residual parts of the tumor, initially hidden from the visualization via a microscope, were discovered, the angled microsurgical instruments were used for the removal of the residual part of the tumor, inspection of operation field for blood clots, control of haemostais. On the final steps of surgery, the final examination of the target region was made, and the final result of surgical manipulations was monitored. The entire process of tumor removal was confirmed by intraoperative video recording from a microscope and an endoscope.

The key-hole approaches to the third ventricle via the transcallosal rout, the supraorbital approach to the the chiasmal region and key-hole retrosygmoid approach to the poasterior fossa lesions were elaborated.

Endoscopic assistance was used for the detection of tumor remnants, the residual blood clots, brain arteries hidden over the tumor noduls, parts of the tumor in the sellar during the subfrontal approch, intrasellar CSF fistula, tumor remnants located in the most anterior part of the III ventricle, feeding arteries of the intraventricle tumors (choroid plexus papillomas), evaluation of the radicality of malignant tumors removal in the posterior fossa.

Conclusions. 1. Keyhole approaches for the tumor removal are feasable and safe in children. 2. Endoscopic assistance in microsurgical removal of brain tumors increases the safety of surgical manipulations and radicality of tumor removal.

ANALYSIS OF INTERACTION BETWEEN SURGEON AND OPERATING MICROSCOPE DURING NEUROSURGICAL MANIPULATIONS

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Objectives. At Burdenko neurosurgery center a principally new device "MARI" was developed, which allows the surgeon to move the microscope around the operating field and change its optical parameters without the help of hands.

The purpose of the study was to assess the ergonomics of surgical interventions when using the MARI device.

Materials and methods. We analyzed 10 neurosurgical operations, 5 of which were performed by standard approach with standard craniotomy (group 1) and 5 operations through a burr hole with a diameter of 14 mm (group 2). All operations were performed for the purposes of intracranial tumor removal through following approaches: Subtemporall, pteryonal, transcortical, transcallosal, and retrosigmoid accesses were used. All operations were performed under OPMI® Neuro/NC 4 microscope with a "MARI" device mounted on it.

For detailed study of the interaction between the surgeon and the microscope, all movements of the surgeon were recorded on a video camera. We used: 1. an external camera to record the basic movements of the surgeon; 2. a camera built into the microscope and 3. a camera that recorded the changes in the optical parameters of the microscope – focus and zoom.

The video data was converted and processed in the ELAN program, developed at the Max Planck Institute for Psycholinguistics. Five categories of movements were created, which were manually marked on the layers of time markings.

The main groups of movements were: 1) moving the microscope; 2) changing the angle of the binocular relative to the microscope; changing the optical parameters – 3) zoom; 4) focusing; 5) changing the microsurgical instrument or transferring the tumor tissue to the operating nurse.

Results. In the first study group, the average duration of the operation under the microscope was 65, and in the second – 60 minutes.

The amount of movement in the first group of patients was 238, which took 455.9 seconds (11% of the total duration of the operation under the microscope). The amount of movement of the microscope per unit time was 3.6 in one minute. The instrument changing and/or transfer of the resected pathological tissue took an average of 202 seconds. Zoom and focus during the opera-

tion varied 14 and 16 times, respectively.

The amount of movement in the second group of patients was 290, which took 470 seconds (13%) of the entire duration of the operation under the microscope. The amount of movement of the microscope per unit time was 5 per minute. On the replacement of the instrument / transfer of the tumor tissue, an average of 136 seconds was spent on the operation. Scaling and focus during the operation varied 6 and 15 times, respectively.

In the available literature, we found only one work devoted to this problem (1). It turned out that in our operations the movement of the microscope was performed 9.6 and 7 times more often in the second and the first group, respectively, compared with the operations analyzed in the above work.

Conclusion. Reducing the size of the craniotomy increases the amount of microscope movements during the operation. Operations with application of the MARI device are accompanied by a multiple prevalence of the microscope movement frequency in comparison with the standard procedure.

ENDOSCOPIC TRANSSPHENOIDAL SURGERY OF CUSHING'S DISEASE. RESULTS OF THE TREATMENT

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Objective. General conclusion of 14th years results of neurosurgery treatment of patients with Cushing's disease.

Methods. From 2004 to 2017 period it were operated 783 patients with Cushing's diseases in The National Medical Research Centre for Endocrinology. Primary operated patients were 686, secondary – 97, children – 28.

Results. Patients of children's age usually had underdevelopment of sphenoidal sinus and sella, narrow nasal passages. In these cases we used navigation and high-speed drill. Adult patients also had increased bleeding of the mucosa and hypertrophy of intercavernous sinuses – 40% (280 from 686). Features of corticotropinomas were multifocal and intrahypophysial location – 12% (84 from 686). In these cases we made thorough dissection of adenohypophysis. In 40% cases tumors had invasion into adenohypophysis and surround structures. Usually In these cases we used electrocoagulation of pathological zone. Intraoperation nasal liquorrea were in 30% (205 from 686) and postoperation – 2,7% (19 from 686).

The remission after operation was achieved in 86% cases (590 from 686). The long-term remission was 67% (5 years), 42 from 63. Hypocortisolism was in 86% and eucortisolism was in 14%.

Conclusions. Endoscopic transsphenoidal adenomectomy for patients with Cushing's disease is a highly effective method of treating this pathology with the achievement of remission in 86% during the early postoperative period and 67% in long-term period.

MICROSURGICAL REMOVAL OF TRAUMATIC INTRACEREBRAL HEMATOMAS

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The aim of the study was to study the results of surgical methods for treating traumatic intracerebral hematomas.

Material and methods. The analysis of outcomes of surgical interventions in 25 patients with traumatic intracerebral hematomas (TIH) in the Republican Specialized Scientific and Practical Medical Center of Neurosurgery was carried out. Patients are divided into 2 groups: 11 patients (44.0%) of group I patients (6 men and 5 women aged 30 to 75 years old) were operated according to a standard procedure, and 14 (56.0%) patients in group II – 9 men and 5 women aged 30 to 75 years, carried out the removal of traumatic intracerebral hematomas under microscopic assist. Hemorrhages were lobar, lateral or mixed. The volume of intracerebral hemorrhage was from 70 to 95 ml. The diagnosis was verified using a CT scan. Clinically, all patients were in serious condition with cerebral and focal symptoms of varying severity. On the Glasgow coma scale, the severity of the condition was assessed in 5 (20%) patients in 6 points, 4 (16%) in 7 and 16 (64%) in 8-9 points.

Results and discussion. The operations were performed within 1 to 5 days from the time of injury in the phase of moderate or severe clinical decompensation. In patients of group I, the volume of traditional surgery included the limited or wide craniotomy (more often resection) with the size of the bone window from 5.0 to 7.0 cm in diameter and the subsequent dissection of the cerebral cortex in the "mute zone" for 1.5-2 cm, the development of the edges of the brain wound with spatulas and the removal of traumatic intracerebral hematoma. Hemostasis of the cavity of the hematoma was carried out by waddlers with hydrogen peroxide, bipolar coagulation, and haemostatic sponges. Four (36.4%) patients died. In the control CT scan, a relapse of a traumatic intracerebral hematoma was noted in the 1st-3rd day after surgery, which required repeated surgery, in 3 patients the hematomas were subtotally removed to 80-85% of the original volume. The terms of hospitalization were from 25 to 30 days.

From the operated 14 patients of the II group 1 (7.1%) patient died. At control CT examination on the

1st-3rd day, in some patients, hematomas were subtotal up to 85-95% of the original volume, in others – radically. There were no recurrences of hematoma. The hospitalization period was from 17 to 25 days.

In the postoperative period after the surgery was performed with the use of microscopic assistance, a more rapid improvement of the general condition and a decrease in the neurological deficit were observed than after operations performed according to conventional methods. Thus, in 4 (28.6%) patients with lobar hematomas, at the time of discharge from the hospital, almost complete recovery of the neurologic status was noted, in 6 (42.9%) patients with mixed localization of hematoma, motor deficiency significantly decreased (deep hemiparesis was replaced by a facile one), in 3 (21.4%) patients with lateral traumatic intracerebral hematomas persistent focal symptomatology persisted, although there was a tendency to decrease it.

Thus, the removal of traumatic intracerebral hematomas under microscopic assistance has a number of significant advantages over the traditional method of their removal, namely: a more gentle surgical approach to the hematoma, visual control of the operation, complete hemostasis of the hematoma cavity, and a reduction in the hospitalization of patients. All this in combination with pathogenetic conservative therapy leads to a more complete and early improvement in the general condition of the patient and a reduction in the neurological deficit.

TRENDS IN SURGERY FOR INTRACRANIAL ANEURYSMS

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According to the less invasive nature, endovascular therapy has been widely used and altered the practice of cerebrovascular neurosurgery. And the trend favoring interventional management over surgical treatment is evident and this tendency to choose endovascular aneurysm repair will be continuing from now on. Irrespective of the best strategy for the treatment of patients with aneurysms, the shift towards endovascular procedures will likely continue. Practically, such trend is likely to be insufficient for more complex aneurysms being not suitable for endovascular techniques and may be failing to prepare the next generation of aneurysm. This will inevitably have a significant impact on both the maintenance of competence in those already performing aneurysm surgery on a regular basis as well as an impact upon the education that develops this competence during the formative years of a neurosurgeon's career. Under these circumstances, it is vital to consider the impact of the paradigm shift in aneurysm treatment on resident training.

SURGERY FOR INTRACRANIAL ANEURYSMS IN THE ERA OF ENDOVASCULAR INTERVENTION

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Surgical eradication of the intracranial aneurysms is the most reliable therapy over the long-term follow-up period. However, less invasive nature and introduction of advanced equipment, endovascular treatment has been appealing to patients and also to practitioners. Aneurysms ideal for coiling are also amenable to clipping. Therefore, as coiling is used more widely, aneurysms treated by open surgery would be more complex. Consequently, to achieve the optimal results concomitant to safety with less managing risk in the complex aneurysm surgery, the strategy would not be always simple as neck clipping but also consists of several advanced techniques, and each procedure should be essentially real time monitored by the objective scientific technology as well as surgeons' perception.

In this regards, we have adopted neurophysiological monitoring such as SEP and MEP, endoscope, intra-arterial fluorescent video-angiography, and endoscopic indocyanine green (ICG) video angiography in aneurysm surgery. MEP is very sensitive to motor dysfunction and strongly helps to prevent motor deficits. Endoscope could provide view around corners and observation of areas hidden from the microscope. Intra-arterial fluorescence video angiography using ICG or sodium fluorescein is simple and not time consuming compared to the conventional intraoperative DSA and provides sufficient information about real time blood flow images of perforators and parent artery. However, observation territory of fluorescence videoangiography is limited to the microscopic view while endoscope can provide the surface anatomy of the arteries hidden from microscopic view but not blood flow information. To overcome a drawback of each modality, we also introduced endoscopic ICG video angiography that brings both surface anatomy and blood flow information of the arteries located in the deep and obstructive area from the microscope.

The complex intracranial aneurysms still remain challenges for neurosurgeons in spite of the recent advancement. The complex aneurysms that can not be treated by simple neck clipping have large or irregular shaped, sclerotic or calcified neck, intraluminal thrombosis, dissection, deep anatomical factors and recurrent lesions. In the treatment of these aneurysms, the hemodynamic environment and vascular anatomy including the parent artery, perforators and aneurysmal wall must be completely recognized and the adequate modality should be applied. In this lecture, the experience of complex aneurysms treatment with multi clip technique, clip

on wrapping, ultrasound curetting for thrombus or skull base anatomy, and parent artery occlusion with/without bypass will be reviewed.

EXTENDED ENDOSCOPIC ENDONASAL APPROACH FOR C1-C2 TRAUMATIC AND INFLAMMATORY LESIONS: LESSON LEARNED AND TECHNICAL NUANCES

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Di Somma Lucia Giovanna Maria, Dobran Mauro,
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Introduction. Extended endoscopic endonasal approaches (EEA) are increasingly being used to address different types of anterior cranio-vertebral junction (aCVJ) diseases, including rheumatoid arthritis related bulbo-medullary compression, basilar invagination in complex CVJ malformations and non-healed odontoid type II fractures. EEA, eventually supplemented by a variety of anterior endoscopic C1-C2 screw fixation and how these new techniques may help in extending indications and/or in implementing the conventional approaches to aCVJ lesions which require surgical treatment are illustrated and discussed.

Materials and methods. From 2009 to July 2017, 36 patients affected by aCVJ disorders underwent EEA alone or combined with conventional surgical approaches at our institution. A combined classical anterior transcervical and endoscopic endonasal C1-C2 screw fixation approach for non-union of odontoid fractures was used in 12 cases. A fully endoscopic endonasal decompression and C1-C2 fusion was used in 5 patients affected by complex cranio-vertebral malfomations. EEA was also used in 19 patients with irreducible bulbo-medullary junction compression due to a migrated odontoid process and/or retro-periodontoid inflammatory process. Endoscopic endonasal odontoidectomy was carried out always sparing the anterior C1 arch, in order to preserve spine stability or to be used as pivot point for anterior C1-C2 screw fixation and fusion if needed. All patients were followed-up by diversified imaging modalities (MRI, CT scan and dynamic X-Ray examinations).

Results. An improvement of at least one point in Ranawat or Nurick scales was observed in all cases. Radiologically adequate bulbo-medullary decompression was always achieved. Only two patients developed delayed spine instability, requiring posterior occipito-cervical fixation. Clear bone fusion was always observed when anterior endoscopic C1-C2 screw fixation was used. Two patients had a CSF leaks and two patients suffered from a dehiscence of the mucosal incision with secondary healing confirmed at regular endoscopic outpatient follow-up.

Conclusions. The extended transnasal fully endoscopic technique may represent a valid alternative approach to conventional open transcervical, posterolateral or transoral approaches classically used for aCVJ lesions. The potential advantages over the standard and transoral approaches include less invasiveness, wider and straightforward working angle, enhanced chances of preserving anterior C1 arch, with the possibility for both decompression plus anterior endoscopic C1-C2 fixation/fusion in order to reduce the risk of cranial settling and the need of posterior C1-C2 or occipito-cervical fusion for spine instability.

APPLYING KEY-HOLE CONCEPT IN MICROSURGICAL ENDOSCOPY-ASSISTED APPROACHES FOR POSTERIOR THIRD VENTRICLE AND PINEAL REGION TUMORS

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Introduction. Different surgical approaches have been developed for dealing with third ventricle lesions all aimed at obtaining a safe removal minimizing brain manipulation. The supraorbital subfrontal trans-lamina terminalis route, commonly employed only for the anterior third ventricle, could represent, in selected cases with endoscopic assistance, an alternative approach for posterior third ventricular lesions.

Methods. Seven patients underwent a supra-orbital subfrontal trans-laminar endoscope-assisted approach for posterior third ventricle tumors (two craniopharyngiomas, one papillary tumor of the pineal region, one pineocytoma, two neurocytomas, one glioblastoma). Moreover, a conventional third ventriculostomy was performed via the same translaminar approach in four cases.

Results. Complete tumor removal was accomplished in four cases, subtotal removal in two cases, and a simple biopsy was performed in one case. Adjuvant radiotherapy and/or chemotherapy was administered, if required, on the basis of the histological diagnosis. No major complications occurred after surgery except for an intratumoral haemorrhage in a patient undergoing a biopsy for a glioblastoma, which simply delayed the beginning of adjuvant radio-chemotherapy. No ventriculoperitoneal shunt placement was needed in these patients at the most recent clinical and radiological session (average

39.57 months, range 13 – 85 months).

Conclusions. The supraorbital subfrontal trans-laminar endoscope-assisted approach may provide, in selected cases, an efficient and safe route for dealing with posterior third ventricular tumors.

ENDOSCOPIC ENDONASAL AND SUPRAORBITAL KEYHOLE SURGERY FOR THE MANAGEMENT OF ANTERIOR SKULL BASE MENINGIOMAS: OVERCOMING THE BARRIERS BETWEEN ABOVE AND BELOW APPROACHES AFTER 15 YEARS OF EXPERIENCE

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Introduction. The resection of anterior skull base meningiomas has traditionally been performed via pterional or unilateral/bilateral subfrontal craniotomies. The supraorbital keyhole approach (SKA) and the endoscopic endonasal approach (EEA) were developed to provide alternative and less-invasive approaches to aid the complete resection of these tumors. Supporters of the EEA emphasize the lack of retraction and less manipulation of the brain, early tumor devascularization, and maximal resection of the base of the skull that may be infiltrated by the meningioma. Conversely, defenders of SKA highlight the advantages of the faster surgical route, better vascular control, potential to preserve olfactory function, and lower rates of postoperative CSF leakage. At the beginning of our experience, the two approaches were used alternately based on the characteristics of meningiomas, while in the last few years more often they have been used in combination. The combined EEA-SKA offers 2 complementary surgical corridors to maximize meningioma resection while minimizing complications.

Methods. 41 cases were reviewed and divided according to operative technique into 3 different groups: purely EEA (18 cases); purely SKA (microscopic with endoscopic assistance; 17 cases); and combined EEA with SKA (6 cases). The three surgical techniques were analyzed and compared concerning complications, surgical radicality, endocrinologic, and ophthalmologic outcome and recurrences in patients' follow-up.

Results. Gross-total resection was achieved in 72,22% of the endonasal cases (13 patients out of 18), 76,47% of the SKA cases with endoscopic assistance (13 patients out of 17), and 83,3% of the combined cases (5 patients out of 6). In EEA group 2 patients presented CSF leak that required surgical revision and 11 patients developed complete anosmia. In the SKA group, 2 cases of postoperative frontal lobe contusion / hemorrage were registered which only one required surgical intervention. In the combined group no major surgical complication occurred.

Conclusions. Both approaches provide minimally invasive surgical routes accessing meningiomas of the anterior cranial base. The ideal approach should be tailored to the individual patient considering the tumor anatomy, lateral extension, and vascular encasement. We suggest using the combined approach for larger meningiomas with far lateral extension or broad vascular encasement and concomitant extensive infiltration of the skull base.

NEUROSTIMULATION IN THE TREATMENT OF COMPLEX REGIONAL PAIN SYNDROME

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Objective. The study is aimed to evaluate the results of electrical neurostimulation for the treatment of patients with complex regional pain syndrome (CRPS).

Methods. 16 patients (7 male and 9 female) aged from 32 to 65 (mean age 45,5) were included in this study. Five patients suffered from CRPS type I, nine – from CRPS type II, and two – CRPS III type. In two cases with CRPS I DBS electrodes were implanted in ventrocaudal (VC) thalamus. One patient with CRPS II and another one with CRPS III underwent motor cortex stimulation (MCS) implantation. In all remained cases spinal cord stimulation (SCS) electrodes were implanted. Effectiveness of therapy was evaluated with brief pain inventory (BPI) like pain relief on visual analogue scale (VAS) and medication uptake decreasing.

Results. 75% pain relief was considered as optimal result; 50-75% – as good result, 30-50% – as satisfactory result. Other results were considered as unsatisfactory. Pain relief median was 85%. All patients stopped opioids uptake and decreased doses of other analgesics. Before MCS implantation we use transcranial magnetic stimulation (TMS) as a predictor of MSC result. In both cases TMS resulted in more than 50% pain relief. One year after MCS implantation one patient with CRPS type II complained with increasing dystonic hyperkinesia in her left extremities and neck and increasing pain. Stimulation re-programming, medication therapy and botulism toxin injections were ineffective. MCS system were removed in this patient, and

she underwent cingulotomy with good pain relief during 1,5 years of follow up. SCS system was removed in one patient after 2 months from implantation because of severe progressive local pain in the area of implanted pulse generator. In other patients with CRPS we observed stable pain relief during more than 4 years follow up.

Conclusion. Surgical neurostimulation allows performing good pain relief, decreasing analgesics use and improving quality of live in patients with CRPS. Choice of neurostimulation method need to be employed individually, in consideration of clinical data.

MINIMALLY INVASIVE CEREBROVASCULAR SURGERY USING SUPERCILIARY KEYHOLE APPROACHES TO ACHIEVE SURGICAL GOALS AND MAXIMIZE PATIENT SATISFACTION

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A superciliary keyhole approach using a supraorbital mini-craniotomy, rather than a conventional pterional approach, can allow access to the anterior circulation in the circle of Willis with minimal surgical invasiveness. It provides many advantages, but is invariably limited due to the small cranial opening. Successful keyhole surgery requires an understanding of the limitations and the use of proper surgical techniques. Essentially, this means the effective selection of surgical indications, usage of the appropriate surgical instruments, and refined surgical techniques including straightforward access to the lesion and clean surgical dissection.

A 12-year experience with a superciliary keyhole approach for cerebrovascular diseases included unruptured intracranial aneurysms (n=505), ruptured aneurysms (n=32), and acute ischemic stroke involving intracranial internal carotid artery and middle cerebral artery (n=10). For the patients with aneurysms (n=537), there was no direct mortality from the surgery and only 3 patients (0.56%) developed significant morbidity adversely affecting the Glasgow Outcome Scale (GOS) score. For 10 patients who underwent surgical embolectomy as rescue treatment following failed endovascular recanalization for acute ischemic stroke, a minimally invasive and rapid surgical embolectomy technique was applied and successful for recanalization.

For 21 patients who underwent an ipsilateral superciliary keyhole approach and a contralateral pterional approach for bilateral intracranial aneurysms during a 12-year period, a superciliary keyhole approach provided a much higher level of patient satisfaction with better outcomes as regards the incidence of craniotomy-related pain, cosmetic complaints, and palpable irregularities.

AGE-DEPENDENT ATTITUDES OF ISCHEMIC PATIENTS TOWARDS DISABILITY AFTER DECOMPRESSIVE HEMICRANIECTOMY FOR MALIGNANT MIDDLE CEREBRAL ARTERY INFARCTION

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Objective. While positive results froma decompressive hemicraniectomy for malignant middle cerebral artery (MCA) infarction have already been confirmed for younger patients aged≤60 years, the decision for surgery also presents a disability paradox of an increased number of survivors with severe disability and functional dependency (mRS≥4), especially for elderly patients aged>60 years. Understanding patient attitudes and opinions on disability after a decompressive hemicraniectomy is essential to achieve valid informed consent. Moreover, understanding the effect of age on patient attitudes is critical in the case of malignant MCA infarction. Therefore, this study investigated the acceptable level of disability for ischemic patients according to age.

Methods. Patients who had experienced a recent minor stroke were asked to complete a questionnaire comprised of 2 parts: 1. demographic information, including patient age, gender, years of education, working status, religion, and economic status and 2. acceptable level of disability based on a modified Rankin Scale (mRS) with corresponding illustrations to explain the mRS levels. The inclusion criteria for this study were as follows: 1) age>20 years; 2) diagnosis of acute ischemic stroke within 1 year; 3) minor or moderately severe ischemic stroke with ischemic volume<100 ml; 4) no surgical decompression; 5) current functional outcome based on modified Rankin Scale (mRS) score between 0 and 2, and 6; ability to understand and complete the patient questionnaire without language impairment.

Results. Patient age was identified as an independent determinant of the worst acceptable mRS with a negative correlation. For non-dominant hemispheric malignant infarction, the worst acceptable mRS was significantly lower (mean±SD: 2.0±1.3) for the oldest patients aged>70 years when compared with the patients aged<60 years (mean±SD: 3.0±0.6) and aged 60-70 years (mean±SD: 3.0±0.8). Meanwhile, for dominant hemispheric malignant infarction with language impairment, all age groups showed a significantly lower value for the worst acceptable mRS (mean±SD: 1.8±1.1 for patients aged<60 years, 1.8±1.2 for patients aged 60-70 years, and 1.0±1.4 for patients aged>70 years).

Conclusions. Patients exhibit a considerable heterogeneity of opinions regarding the worst acceptable disability level following surgical treatment of malignant infarction. However, the patients in the current study showed

different attitude to disability according to their age. The most common worst acceptable mRS was mRS 3 for the groups aged≤60 years and 60-70 years. Patients aged>70 years showed the lowest worst acceptable mRS. In addition, Language impairment with dominant hemispheric infarction further decreased the worst acceptable mRS.

SURGICAL INTERVENTION OF BRAINSTEM CAVERNOUS MALFORMATIONS IN HEMORRHAGIC ACUTE PHASE

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Background. Catastrophic neurological deterioration will be caused within a short period by acute spontaneous hemorrhage of brainstem cavernous malformation. Medical and conservative treatment have so long been the mainstay for the management of symptomatic patients since the risk of surgery against clinical outcome is still hard to balance. Herein, we summarized our experience about radical resection of brainstem cavernous malformations (BCMs) in hemorrhagic acute phase and discuss the potentially optimal medical choice to deal with such kind of disease.

Cases Illustration. Clinical data from 6 patients with BCM in hemorrhagic acute phase (0-3 weeks) were retrieved in this study. The mean patient age was 31.2±9.33, and the most common location was the pons. Multiple bleeding before surgery were observed in all cases. The average diameter of hemorrhagic lesions at hospital admission detected by CT scan is 28.7±6.35 mm. The clinical presentation and surgery approach varied a lot depending on location. Notably, almost all the patients were suffered from spontaneous respiratory disturbance with 3 of whom were performed intubation and assisted by mechanical ventilation. Gross total removal was achieved in 4 cases, while the other 2 cases were resected sub-totally. The mean duration of clinical follow-up was 9.8±5.05 months. Neurological improvement was found in 5 cases at the point of discharge and latest clinical follow-up. 1 patient underwent subtotal resection experienced rehemorrhage at 9 months after surgery.

Discussion. To the best of our knowledge, radical resection of BCMs in hemorrhagic acute phase has not been commonly reported. For the consideration of progressively neurological deterioration, surgery may serve as the only option for these cases. In our small series of patients, we recommended that surgery should be performed in hemorrhagic acute phase especially for those multiple bleeding events occurred. Remarkably, disturbance of spontaneous respiratory should be raised as another important predictor for surgical intervention. In general, we reported favorable outcomes after surgery in hemorrhagic acute phase for BCMs. However, risk of rehemorrhage result from lesion residual by subtotal resection can not be completely avoided.

SPHENOID WING MENINGIOMAS: ANTERIOR CLINOIDAL

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The definition of sphenoid wing meningiomas and their classification in anterior clinoidal and pterional is presented.

The anatomical aspects, clinical presentation, and imagiological features (with details to take into account when planning surgery) of anterior clinoidal meningiomas are then shown.

Surgical technique is described in detail, with tips to avoid complications.

Some cases are presented to demonstrate the points previously discussed.

Review of the literature is shown, namely regarding surgical outcomes.

MEDICAL RESIDENCY IN PORTUGAL

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The portuguese model of residency programs in general and specifically for neurosurgery is presented:

- General internship
- Access of residents
- Creditation of residency centers
- Evaluation of residents
- Programs
  - Neurosurgery residency program and evaluation grid
- Final Examination

Research programs and oportunities for residents are also described.

Finally, model for fellowships (post residency programs) is discussed.

BACKGROUND OF USING IMPLANTABLE PORTS IN NEUROONCOLOGY

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Aim. To assess the prospects of using implantable ports for complex treatment of patients with primary or secondary CNS neoplasms.

Material and methods. We`ve observed 7 patients, aged from 20 to 67 years: women – 3, men – 4. All patients had CNS tumors. Histological diagnoses: neuroleukemia – 1 patient; multiple myeloma – 4, diffuse B-cell lymphoma – 1, anaplastic choroid papilloma – 1. Neuroimaging (rCT, MRI of head and spinal cord) with complex diagnostics of hematological diseases were performed. Karnovsky scale between 40-80 points. Numbers of implanted vertebral ports – 1, lumbar – 6. Further patient surveillance consisted of cytostatic, hormonal and anesthetic drugs administration.

Discussion. Drug medication was performed in small doses, volumes from 1 to 2 ml. Total manipulations varied from 6 up to 15 and more. Patient suffering from acute lymphoblastic leukemia had complications of neuroleukemia and neoplasm in the anterior part of right lateral ventricle (clusters of lymphoid cells). Ventricular port was implanted in the projection of the ventricular triangle with directing catheter to the tumor. Five injections of Cytosar^{R} and Methotrexate^{R} were performed in 12 days. Neurovisualization – control didn`t detect radiologic signs of tumor in right ventricle and cerebrospinal fluid was sanitated from blast cells. In 4 patients with multiple myeloma, lumbar ports were established for Cytosar^{R} and Dexamethasone^{R} medication. For treating B-cell lymphoma, also were chosen Cytosar^{R} and Dexamethasone^{R}. Patient, 25 years old, suffering from anaplastic choroid papilloma in spite of occasional surgical resections of brain tumor, had dissemination of the process through the liquor pathways to spinal cord and had complication of severe pain syndrome. As a palliative care lumbar port was implanted for analgesic therapy.

Implantation of ventricular ports for drug medication is the prospective addition to multiagent chemotherapy for treating patients with hematological, neuromuscular disease extending "therapeutic window", increase survival rate and improve the quality of life.

Conclusions. Surgical implantation of ventricular and lumbar ports is minimally invasive and low traumatic procedure. For patients with cancer – usage of systems for «local» drug administration is a promising and prospective technique as combination for complex therapy. Port-system allows to easy control of the composition of cerebrospinal fluid and drug medication directly to the affected part of the brain or spinal cord. That helps to reach high enhance efficacy with low doses of chemotherapy land reduce toxicity. Injection drugs through the port promotes a uniform distribution of the drug in liquor system, creating high concentration of medicine around the pathological locus. "Port treatment" is easily tolerated for patient, can be implanted in different position of the body and «levels of liquor system», does not depend on the severity of patient`s condition. It is possible to administer cytotoxic hormonal, analgesics drugs. The procedure can be performed outpatiently.

KEYHOLE STRATEGY FOR CEREBRAL ANEURYSMS AND TUMORS

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Purpose. The concept of keyhole neurosurgery is not to reduce the size of the craniotomy as small as a real keyhole, rather to make minimum craniotomy required to access deep pathologies at the end of the route. Clipping and frontal base tumors via keyhole is one option for treating.

Materials and methods. We operated 277 cases of unruptured anterior circulation aneurysms using supraorbital keyhole via eyebrow skin incision for internal carotid artery aneurysms and anterior communicating artery aneurysms (117 cases), pterional keyhole via outer canthal zigzag skin incision for middle cerebral artery aneurysms (160 cases). We operated 40 cases of the relatively small frontal base tumors (26 pituitary adenomas, 9 parasellar meningioma, 5 craniopharyngiomas). The pituitary tumors were operated using combined TSS and keyhole approach. We developed a tailor-made method based on surgical simulation using 3D imaging of individual patients to allow safe performance of aneurysm clipping and tumor removal via keyhole mini-craniotomy.

Results and discussion. The mean maximal diameters of supraorbital keyhole and pterional keyhole for aneurysmal clipping were 29±3 mm and 25±2 mm. The surgical morbidity was 0.8% without mortality. The mean maximal diameters of supraorbital keyhole for tumor removal was 27±3 mm. The gross total removal was achieved in 95% of the cases.

Conclusion. The keyhole approach is less invasive surgery if it based on careful preoperative simulation. We will show the preoperative planning and operative techniques.

THE ROBOTIC MANIPULATOR ON THE BASIS OF RUSSIAN STEREOTACTIC SYSTEM POANIC AND THE PROSPECTS FOR ITS USE IN STEREOTACTIC NEUROSURGERY

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Currently, the development of stereotactic equipment is on the way of automation. Stereotaxis is the most suitable for the introduction of robotics from all the neu-

rosurgical areas, which is largely due to the fundamental features of the stereotactic method based on mathematical calculations and translational movements of the operating instrument. The experience gained at the present time in the use of stereotactic robots shows their high efficiency, determined by a reduction in the time spent on the operation, as well as a decrease in the labor consumption of the operating procedure. The latter is of essential practical importance, as currently used non-automated frame stereotactic systems require a neurosurgeon certain labor costs, both in the preparation of equipment for surgery, and when changing the target points during neurosurgical intervention. Undoubtedly, the use of robotics reduces the possibility of accidental errors associated with the human factor when performing stereotactic operations. The available publications demonstrate high accuracy of the guidance at the target points of the brain, achieved with the help of stereotactic robots, at least not inferior to the accuracy of modern frame stereotactic systems (Lefranc M. et al., 2014; González-Martínez J. et al., 2016; Cardinale F. et al., 2017). At the same time, commercially available at the present time, stereotactic robots have very high and not always recouping the sale price.

In previous years, concern "CSRI "Elektropribor" in cooperation with the stereotactic department of the Institute of Human Brain of the Russian Academy of Sciences (St. Petersburg) had developed a frame-based stereotactic system "POANIC", widely spread in some clinics of Russia and CIS countries. This manipulator has been adapted to modern methods of neurovisualization and can be used in both functional and non-functional stereotaxis. From 2017 both organizations are working together to develop an automated stereotactic complex for neurosurgical interventions on a brain on the basis of the manipulator "Oreol-P" (part of the stereotactic system "POANIC"), as well as equipment for controlled destruction of intracerebral tumors and foci of pathological activity in the target points of a brain.

To date, the general concept of the device is developed and the working prototype is created. We plan to serially manufacture the robotic stereotactic system within the next few years. A special feature of the new robotic system is the compatibility with the widespread in neurosurgical clinics neuronavigation equipment (Medtronic, BrainLab, etc.), which made it possible to reduce the cost of the system and simplify its integration into a modern neurosurgical operating room. The robotic arm spatial reference module allows to use both skin markers and rigidly fixed fiducials connected with skull bones or dental impression of patient for intraoperative registration of the patient's head. Registration based on the patient's head surface shape is also available. Micro-motors of kinematic units of the manipulator are equipped with position sensors and friction brake mechanisms.

The main characteristics of our robotic stereotactic manipulator are:

- absolute error of guidance of the stereotactic cannula on the intracerebral target is not worse than ± 1 mm in useful volume of space not less than 0.4 m^3;
- angle of access of the instrument to the burr hole in two perpendicular axes perpendicular to the plane of the tangential ideal sphere with a burr hole of at least ± 160°;
- the presence of a software and hardware for instrument moving on isocentric arc of ¼ of the circumference for the possibility of rapid correction of the trajectory of insertion of the stereotactic cannula;
- micro-drive of instruments to a length of 160 mm with a discreteness of 0.1 mm.

Thus, the new stereotactic robotic system has the characteristics that ensure its suitability for work in modern neurosurgical operating rooms to execute the tasks of frame and frameless stereotaxis.

STEREOTACTIC ABLATION OF CEREBRAL GLIOMAS: EXPERIENCE OF THE CRYOSURGERY AND THERMAL DESTRUCTION

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In recent years, due to the wide adoption of imaging (MRI and CT), diagnosis of brain tumors has significantly improved, and the number of cases detected at early stages has increased. It is well known that the effectiveness of treatment of such patients strongly depends on possibility end extent of tumor resection. However, gliomas localized in difficult-to-access and eloquent areas (region of central gyrus, basal ganglia, thalamus, insula, etc.) are mostly inoperable. But they may be safely destroyed with a pinpoint inserted stereotactic probe which executes the minimal invasive ablation of such tumors through a burr-hole on the patient's head. It significantly reduces the risk of postoperative complications compared to traditional open operations.

Nowadays, the method of stereotactic laser thermal destruction of deep gliomas under MRI control is developing (Mohammadi A.M., et al., 2014; 2016). In recent years, there have been reports about the possibility of using transcranial focused ultrasound for the safe aiming ablation of tumors (Coluccia D., Fandino J., Schwyzer L. et al., 2014). However, these methods require the expensive specialized equipment and are not available in most neurosurgical clinics.

In the second half of last century, cryodestruction was used by Kandel, for the stereotactic ablation of brain tumors. Later, however, cryoablation had been pushed

out of stereotactic neurosurgery by other methods because of the disadvantages of the devices working with liquid nitrogen. At the neurosurgical clinics of the Russian Military Medical Academy and the Institute of Human Brain, since 1999, we perform multi-positional stereotactic cryoablation of gliomas using a specially designed cryosurgical device working with the temperature of solid carbon dioxide. This equipment has some advantages over devices, using liquid nitrogen. To date 172 patients with the deep tumors located in thalamus, insula, basal ganglia, temporal mediobasal structures, corpus callosum, region of Central gyri and other deep and eloquent areas are operated on. All interventions are carried out under local anesthesia, so we have the opportunity to perform the trial (reversible) cooling in target points. In this connection, an intraoperative neurological and neurophysiological monitoring allows promptly to identify possible adverse effects during the trial impacts and thus to prevent serious complications.

Stereotactic intratumoral targeting is based on results of preoperative MRI fused with 11C-methionine PET of brain which provides the possibility to use areas of the radiotracer accumulation on tomograms (regarded as zones of maximum tumor cells proliferation) as targets for selective ablation. Stereotactic guidance is executed using stereotactic frame or frameless neuronavigation Medtronic StealthStation S7.

Our technique allows to precisely destroy tumors or their proliferative active zones with total volume to 30 cm^3. The important advantage is that the cryodestruction of biological tissue, destroying the cell structure, does not cause denaturation of tumor antigens. This fact lies at the base of the known phenomenon of the immunostimulatory effect of cryodestruction which is used in general cryooncology: there is stimulation of cellular immune response after cryodestruction of the tumor (Fukagai T., Tazawa K., Higaki Y. et al., 1990). Analysis of operated cases shows good results for increasing survival, and relatively low risk of neurological worsening in the postoperative period. The survival rate in the operated cases was reliably higher than in patients treated only with radio- or chemotherapy in every group of patients with grades II, III and IV tumors. Postoperative mortality was about 1%. The majority of cases had no worsening of life quality: permanent impairment of a neurologic state was watched only in 8.7% of patients. At the zones of cryoablation, on post-operation MRI in dynamics, we observed the gradual formation of the liquor cysts.

However, there was an increased risk of postoperative intracerebral hemorrhages after cryoablation in patients previously treated with radiation therapy. In this regard, in this group of patients, we use stereotactic radiofrequency thermoablation instead of cryoablation. Using the Cosman G4 generator for stereotactic radiofrequency thermoablation and enlarged electrode we have operated on 6 patients with recurrent gliomas who have had post-operation radiation therapy. Postoperative hemorrhages in our cases don't happened. It was also possible to perform the trial impact by means of electrical stimulation and reversible heating of tissue. In contrast to cryodestruction, where there is colliquation necrosis with the consequent formation of liquor cysts, the thermoablation is followed by the coagulation necrosis. Compared with cryosurgery, the total duration of operation decreases due to the fact that there is no necessity to wait for the thawing of frozen intratumoral foci. However, we observed malignant transformation of grade II gliomas in two patients in the late postoperative period.

Thus, the stereotactic cryosurgery and thermoablation may be safe and useful options of surgical treatment of tumors localized in deep and eloquent areas of brain contraindicated to an open surgery.

USING TITANIUM CAGE IMPLANTS AND ANTERIOR PLATING IN CERVICAL RECONSTRUCTION

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Study design. A preliminary outcome assessment study of titanium cage implants with anterior cervical plating in anterior cervical reconstruction.

Objectives. To evaluate the efficacy and safety of using titanium cage implants and anterior plating in cervical reconstruction.

Summary of background data. Anterior decompression and interbody fusion is a widely accepted surgical treatment for patients with cervical spondylosis. Tricortical iliac crest autograft has been the gold standard but is associated with morbidity at the bone graft donor site, whereas allograft fibula is associated with pseudarthrosis. Problems such as pseudarthrosis, graft collapse, and extrusion still persist with the accepted method of harvesting and implanting bone autografts.

Materials and methods. Thirty-four patients were treated by channel corpectomy followed by placement of a titanium cage packed with autogenous bone graft from the vertebral bodies to reconstruct the anterior column. An anterior cervical plate was added in 30 of 34 cases that involved decompression of two or more levels. The follow-up period ranged from 24 to 56 months, with an average follow-up period of 32 months, and included examination and radiography.

Results. Six months after surgery, there was radiographic evidence of fusion in 97% of the patients. Eighty-eight percent of the patients (30 of 34) did not experience any complications (neither cage dislodgment nor hardware failure). Four patients had complications that included pseudarthrosis (1), extruded cage (1), cage in kyphosis (1), and radiculopathy (1).

Conclusions. Titanium cages provide immediate strong anterior column support with minimum hardware complications and avoid bone graft-site morbidity. Titanium cages, with concomitant use of anterior plating, offer an effective and safe alternative to bone autografts.

LONG-TERM CLINICAL AND ANGIOGRAPHIC OUTCOMES OF WRAP-CLIPPING FOR RUPTURED BLOOD BLISTER-LIKE ANEURYSMS OF THE INTERNAL CAROTID ARTERY UNDER THE ADVANCED MONITORING

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Purpose. Wrap-clipping is one of the recommended treatments for ruptured blood blister-like aneurysms (BBAs) of the internal carotid artery (ICA), and has an advantage in preserving the anterograde blood flow of the ICA. However, long-term outcome of this procedure has not been elucidated. In this study, we examined the efficacy of wrap-clipping using polytetrafluoroethylene (PTFE) membrane for ruptured BBAs.

Material and Methods. We analyzed the clinical and radiological data of 9 patients with ruptured BBAs treated between 2007 and 2016. Wrap-clipping using PTFE membrane was performed under advanced monitoring techniques including fluorescence video angiography, intraoperative DSA and endoscope. Postoperative DSA was routinely carried out during hospitalization, and angiographic follow-up by 3DCTA or DSA to confirm the durability of the treatment and the stenotic condition of the ICA. Clinical outcomes were assessed by the modified Rankin scale (mRS).

Results and Discussion. Wrap-clipping with PTFE membrane was performed without any permanent morbidity in all patients with BBAs. Endoscope could show the position of the medial blade of the clip and the surrounding perforators in the dead angle of the microscope. The effectiveness of fluorescence video angiography for the visualization of the blood flow of the ICA and the surrounding arteries was reinforced by intraoperative DSA, which revealed the blood flow in the wrapped lesion. There was a regrowth of the aneurysm 1 month after the treatment which was repaired surgically, and thereafter the recurrence of the BBAs or progression of ICA stenosis was not observed in the following angiography with a mean follow-up period of 37 months. There were neither rerupture nor ischemic complications and the mRS of all the patients were 0 with the mean follow-up period of 61 months.

Conclusions. Wrap-clipping using PTFE membrane for ruptured BBAs is a useful and acceptable procedure promising long-term effectiveness. The durability of this method can be strengthened by the aid of modern technologies.

HISTORY: WHO WAS AXEL PERNECZKY?

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The essentials of the scientific life of Axel Perneczky is presented regarding major events and with reference to the literature. A scientific portrait of A. Perneczky is created based on a ten – year experience within his team (8 years at university of Mainz). This portrait contains the major scientific structures he started up with and also his visions, innovations, inventions but also his teaching and activities in hands on events. His work as author and editor, his promotorship and his preference for art are illustrated. Finally this portrait is completed by his unique characteristics professionally as well as personally.

EVOLUTION OF THE KEY-HOLE CONCEPT: THE MIN-KEY CONCEPT

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The recent roots of the keyhole concept are highlighted in short. The most historical features are shown. The concept of Yasargils and the changes in the concept of Perneczky are analyzed. After discussing the weak points the recent evolution oft he concept is described. The focus is changed from the key-hole in MIN to the keys for MIN. The question is raised: „what are the keys of MIN in present and the near future. Finally education and training techniques are discussed.

INTRACEREBRAL HAEMORRHAGE (ICH) EVACUATION BY MIN TECHNIQUES

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Introduction. STICH I and II trials did not take notice of minimal invasive neurosurgery (MIN) strategies and techniques. EndoSTICH trial and MISTIE trial are studying two minimally invasive techniques (endoscopic evacuation and katheter-lysis) which however do not compete the needs of the majority of hemorrhages. What clinical trials fail to detect is clearly known by pathophysiology: Hemorrhages need to be evacuated. The major issue seems to be the surgical trauma. To study the status quo by clinical trials will not be helpful We elaborated a MIN technique with high effectiveness and applied it up to now in over 250 cases. We present a retrospectively analysis of the 50 recent cases.

Material and Method. This MIN concept combined several techniques to assist microsurgery: Highend neurosonography with small probes („burr-hole-probe/ALOKA/ Hitachi) and mouth tracking of the microscope, both mandatory. Additionally we added endoscopy (Wolf, Aesculap, Storz) and LASER (Th-YAG Revolix). More than 250 patients under went this application within 12 years by the presenting author. A series of the 43 recent cases, 18 female and 24 male, 69.1 y (40-83) (4 children excl.), was analyzed. The approaches varied from burr-hole to 1€ or 2€ in size depending from the imaging findings and expected difficulties.

Results. Compared with STICH I the favorable outcome was pushed from 26.1% to 82,7%. In nearly all cases it was possible to evacuate the hematoma within 1 hour and the hematoma evacuation decreased the ICP to normal levels. Clinical results were excellent in lobar bleedings with isochoric before surgery. Large and deep-seated hemorrhages needed longer recovery time but in all cases postop CT showed fast reduction of perifocal edema and ICP. This technique can be applied also under so called "inoperable condition" like very high age, bad blood coagulation conditions (Quick as low as 50 and PTT high until 40).

Conclusion. Combination of ultrasound, mouth tracking, endoscopy and LASER enabledevacuation of all type of hematoma minimal invasively and very effectively inless than one hour. Ultrasound real-time control detected all types and locations of bleeding causes (aneurysms, angiomas, cavernomas, tumors). The evacuation amount and the reaction of the brain were under visual control. Mouth tracking enables free hands for fast acting if needed and safe operative control.

COMBINED TREATMENT OF CRANIOPHARYNGIOMAS. THE ROLE OF MINIMALLY INVASIVE SURGICAL TECHNOLOGIES

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Introduction. Craniopharyngiomas (CF) – benign epithelial tumors that develop from the remnants of Rathke's pouch cells. Most often, CF manifest themselves in two age groups: in children 5-14 years old making 5,6-13% of intracranial tumors and in adults 50-74 years old making 2-5%.

Materials and methods. In the last decade, the Institute annually for the surgical treatment received 100-120 patients with CF. The total number of cases (given and repeated) exceeds 2500.

For transcranial removal of CF we use different combinations of basal and transcallosal approaches. In pediatric patients this type of surgery reaches 60%, and in adult patients only 20% Starting in 1987 we use transsphenoidal approaches (first microsurgically, from 2005 pure endoscopicaly). Extended endoscopic approach makes possible radical tumor removal. Now transsphenoidal operations for CF in pediatric group takes only 20%, instead 60% in adults. For cystic craniopharyngiomas in some cases, we use Ommaya systems. It takes 20% of both pediatric and adults group.

Results. In recent years, lethality in adult transcranial operations in adults has not exceeded 2%, and for transnasal and Ommaya systems, in both age groups, remains zero. The frequency of recurrence of CF does not exceed 22% with total removal and reaches 53% with partial. The recurrence rate of papillomatous craniopharyngiomas does not exceed 8%. In recent decades, we have been actively using the method of irradiation with craniopharyngioma in the mode of radiosurgery or stereotaxically oriented radiotherapy (Gamma Knife, Cyber-Knife, Novalis). In cystic CF after the end of irradiation, there was a sharp reduction in the production of cystic fluid. The results of irradiation of patients with craniopharyngiomas illustrate the possibility of performing operations with preservation of the pituitary stalk with subsequent irradiation of the tumor residue. This approach certainly provides the best endocrine status.

Conclusions. In many respects the result of treatment is determined firstly by the level and adequacy of intensive care techniques in the early postoperative period, and secondly by the correctness of selecting hormone replacement therapy from the first hours after surgery and throughout the entire subsequent life of the patient. The results of application of modern minimally invasive techniques (radical and palliative transnasal surgeries, installations of Ommaya systems with subsequent stereotactic irradiation) show that a positive trend has emerged in the treatment of craniopharyngiomas. Now, with an adequate choice of treatment tactics, patients with craniopharyngiomas have a chance for a long-term relapse-free life with high quality of life.

MINIMALLY INVASIVE APPROACH FOR SURGICAL TREATMENT OF CRANIOVERTEBRAL JUNCTION MENINGIOMAS

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Objective. To demonstrated the advantages of using a minimally invasive approach for surgical treatment of craniovertebral junction meningiomas.

Methods. In Burdenko Neurosurgical Center between 2010 and 2018, 54 patients (12 males, 42 females) underwent surgical removal of craniovertebral junction meningiomas. Mean patient age was 57.8 years (30-82 years). Mean follow-up was 52.2 months (6-300 months). Patients were divided into 2 groups: Group I consisted of 38 patients operated with classic open surgical approach; Group II consisted of 16 patients who were operated with a minimally invasive surgical approach. Frankel, Karnofsky, VAS scales and MRI were used to evaluate patient outcomes. In both groups resection of the internal layer of the dural sheath was mandatory.

Results. Group II patient presented with a lower postoperative VAS score (mean difference between groups was 4 points), lower postoperative analgesic consumption, shorter hospital stay (mean hospital stay for group I – 6 days, for group II – 3 days) and with the same percentage of total resection and Frankel score.

Conclusions. Minimally invasive surgical approach for treatment of craniovertebral meningiomas permits total tumor resection with lower intraoperative soft tissue and muscle trauma based on postoperative MRI findings, lower postoperative pain, lower analgesic consumption and shorter hospital stay in comparison with the classic open surgical approach.

MICROVASCULAR DECOMPRESSION (MVD) OF THE COCHLEOVESTIBULAR NERVE FOR TREATMENT OF TINNITUS

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Objective. Neurovascular conflict of cranial nerves is well known and often treated as underlying cause of trigeminal neuralgia, glossopharyngeal neuralgia and hemifacial spasm.

It is also known as possible underlying cause of tinnitus, but in this pathology it is significantly less frequently diagnosed and treated.

The reason is first due to the vast variety of possible causes of tinnitus, making this entity highly heterogenous, with neurovascular conflict as only one of less frequent etiologies.

Other reason for rare qualification to treat neurovascular conflict in tinnitus is lack of strong objective criteria to support consistency of causative relationship between tinnitus and vascular compression of vestibulocochlear nerve (changes of amplitude of peak II and the interpeak latency I-III in Auditory Brainstem Response (ABR) are among the very few of them)

Another reason for rare surgical treatment in this entity is usually clinically mild, not disabling course of tinnitus - thus not justifying intracranial surgery (with its catalogue of possible serious complications) as a treatment option.

And last but not the least reason is lower success rate (28-60% as reported in literature) of microvascular decompression of eight cranial nerve for tinnitus – as compared with results of MVD for conflicts of other cranial nerves.

Material. Within the period 2009-2017 840 patients were referred for neurosurgical assesement as having both tinnitus and MRI documented neurovascular ipsilateral conflict of eight cranial nerve in the zone of its entry to the brainstem.

Among them 92 patients were identified as highly suspected of suffering from tinnitus secondary to neurovascular conflict (while any other possible abnormalities of the auditory pathways or any other possible causes of objective tinnitus (i.e. vascular bruits) were excluded.

In only 17 patients of this group the intensity of tinnitus had a debilitating influence on their daily activities to the extent justifying the proposal of intracranial surgery and balancing the weight of possible complications.

Methods. Finally 5 patients (out of 17 qualified by the neurosurgeon) decided to be operated (2 of them with history of suicide attempt because of devastating intensity of tinnitus and secondary depression in the past).

Microvascular decompression (MVD) was performed in these 5 patients.

Results. In all 5 patients the intensity of tinnitus was successfully reduced to the level not affecting their daily activities postoperatively (with 2 cases of full disappareance of tinnitus).

In one case permanent ipsilateral hearing loss occurred postoperatively, and in one case facial nerve palsy occurred on fifth postoperative day (due to vascular mechanism) which was successfully treated with facial hypoglossal anastomosis one year postoperatively. Remission of depressive symptoms and no reattempt of suicide was observed in 2 patients with previous history of depression on the median 3 year follow up.

Conclusion. MVD may be considered as an accepted and successful treatment option in very rare, highly selected, cases of tinnitus, with well documented underlying neurovascular conflict of the eight cranial nerve, and only in patients with exceptionally debilitating course of this, usually mild, disease.

RADIOSURGERY VS MICROSURGERY IN BENIGN CENTRAL NERVOUS SYSTEM TUMORS. IN PURSUIT OF ALGORITHM

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Objective. Common parallel history of microsurgery and various forms of radiosurgery in the treatment of benign CNS tumors lasts since half of a century. Over

this period a big volume of data characterizing risk – benefit ratio of each method, has been accumulated, which should have provided medical community with convincing arguments to propose strict algorithms for patients qualification to each treatment modality. But still there is a lot of controversies concerning the best treatment option, and what even more important – there are still big differences in qualification criteria between various centers.

Method. Author presents his own unique experience in this field, coming from heading at the same time – both the academic department of neurosurgery and regional radiosurgery centre (CyberKnife) in Warsaw, Poland – with reference to results of treatment in these centers and the best series from the literature.

In author's experience there are several important obstacles for unification of selection criteria.

Results. Controversies over the aim of the treatment.

It should be first well defined what is the aim of treatment in individual case. Should it be to eradicate the tumor (make it completely disappear) or if it is enough only to stabilize it, prevent it from further growing (which may be the case in elderly patients or in hypo symptomatic lesions). Lack of well defined aim of the treatment is often a reason of misunderstanding.

Conflict of Interest. The fact that very often microsurgery and radiosurgery are not available at the same the same place, and can not be offered alternatively by the same neurosurgeon, creates a situation of conflict of interest. Usually people tend to qualify patients to the methods which are locally available, and the treatment which may be provided personally by them.

Lack of profound knowledge in each field. Need for Multidisciplinary Team.

Usually physicians have profound knowledge concerning only one of those fields (radiosurgery vs microsurgery), but extremely seldom concerning both of them simultaneously. This creates a need for obligatory multidisciplinary team work.

Specific experience of individual doctors.

Usually (it concerns mainly neurosurgeons) people who have better than average results and experience in specific procedures tend to propose them to patients more eagerly than it may come from generally accepted rules.

Differences of learning curves.

It should be taken into account that, shape of the learning curve in microneurosurgery is different than in radiosurgery and usually it is more difficult and time consuming to become a specialist in micro neurosurgery than to become a specialist in radiosurgery. One of the implications is, that patient with deeply located "surgically demanding" tumor may be safely and successfully treated in almost all radiosurgery centers, while he may be optimally treated microsurgically only in certain highly selected neurosurgical centers.

Patient's driven decision about treatment method.

There are numerous patients, who express their will to be treated with the method which is suboptimal from the point of view of a doctor, but the only acceptable one, from their point of view.

This phenomenon is especially responsible for overuse of radiosurgery in certain centres.

Conclusion. The awareness of the existing obstacles may help to create best treatment option algorithm to chose between microneurosurgery and radiosurgery in benign CNS tumors.

MIDLINE LUMBAR INTERBODY FUSION USING INDIVIDUAL 3D NAVIGATION TEMPLATES

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Introduction. Cortical bone trajectory technique is a novel minimally invasive approach to perform lumbar interbody fusion. The main advantages are better biomechanical properties and smaller muscle dissection. The key point of the technique is achieving a close contact between screw and cortical bone. Application of 3D printed individual navigation templates can be used for more precise screw implantation as well as for decreasing time of surgery and radiation exposure.

Purpose. To evaluate feasibility, accuracy and safety of cortical bone trajectory screw implantation in lumbar spine using individualized 3D navigation templates.

Materials and methods. 12 patients who underwent midline lumbar interbody fusion with cortical bone screws trajectory were included. All the cases were presented by degenerative disorders (degenerative spinal stenosis with or without spondylolisthesis). One-level surgery was performed in 8 cases, two-level in 3 cases, three level in 1 case. A total number of screws was 58. Individualized 3D printed spine models and navigation templates were produced based on preoperative CT data. The templates were sterilized and used during the surgery. After getting a close contact between template and lamina, drilling and tapping of the screw trajectory were performed through the templates followed by screw implantation. Accuracy and safety of the screw insertion were assessed by postoperative CT and classified with Screw Guide Template System (SGT) by calculation of screw deviation from the preplanned trajectory and evaluation of screw breach of pedicle wall.

Results. There were not neurovascular and other complications caused by screw implantation. All the screws except one were inserted correctly, the mean

deviation from planned trajectory was 1,2±0.74 mm. The grade of deviation was estimated as class 1 (SGT system, <2mm) for 46 screws (88.4%), as class 2 (2-4 mm) for 5 screws (9.6%), as class 3 for 1 screw (2%). Safety of screws implantation was estimated as Grade 0 (all the screws were completely surrounded by bone structures) for all the screws. There were not cases of reimplantation caused by failed trajectory during the surgery as well as afterwards.

Conclusions. 3D printed individualized navigation templates is a safe and effective method for cortical bone trajectory technique. As we know from literature review, this is a first report of using 3D printed templates for cortical bone trajectory implantation in lumbar spine.

APPLICATION OF 3D NAVIGATION TEMPLATES FOR SUBAXIAL CERVICAL PEDICLE SCREW IMPLANTATION – RESULTS OF A PILOT STUDY

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Object. Pedicle screws demonstrate the best biomechanical properties over other posterior fixation techniques. Nevertheless, the procedure is still challenging despite on many attempts to improve an accuracy of screw insertion. Application of a novel 3D navigation based on individualized templates is able to make it easier and safer.

Purpose. To evaluate accuracy and safety of cervical pedicle screw placement below C2 using individualized 3D navigation templates.

Materials and methods. 7 patients who underwent C3-C7 pedicle screw implantations with 3D-printed templates were included. Summary 28 screws were placed. Preop CT-angio was performed for vertebral artery visualization. The individualized 3D printed model of vertebrae and navigation templates were produced by using 3D printing technology. The templates were sterilized and used during the surgery. The placement of the screws was examined by postoperative CT. The accuracy and safety of the screw insertion were assessed and classified with Screw Guide Template System (SGT).

Results. Among 7 patients there were 2 trauma cases, 1 tumor and 4 degenerative deformities. There were not neurovascular or other complications caused by screw insertion. The mean deviation from planned trajectory was 1.4±0.65 mm. The grade of deviation was estimated as class 1 (SGT system, <2mm) for 25 screws (89.3%), as class 2 (2-4 mm) for 3 screws (10.7). Safety of screws implantation was estimated as Grade 0 (all the screws were completely surrounded by bone structures) in 26 cases (93.2%), as grade 2 (<50% of screw diameter perforates bone) in 2 cases (7.8%).

Conclusions. Application of 3D printed individualized navigation templates is a feasible, safe and effective technique for pedicle screw placement in subaxial cervical spine. Results of this pilot study demonstrate an actuality of this technique for further investigation in larger cohort.

ACCURACY AND SAFETY OF C2 SCREW PLACEMENT USING 3D NAVIGATION TEMPLATES – RESULTS OF A BICENTRAL PILOT STUDY

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Object. C2 screw placement is a common procedure associated with some tremendous complications such as vertebral artery injury. Recent studies have demonstrated good clinical results of screws implantation in spine navigated by individualized 3D printed templates.

Purpose. To evaluate accuracy and safety of C2 pedicle screw placement using individualized 3D navigation templates.

Materials and methods. 11 patients who underwent C2 pedicle screw implantations with 3D-printed templates were included. A total number of screws was 22. Preop CT-angio were performed for vertebral artery visualization. The individualized 3D printed model of vertebrae and navigation templates were produced by using 3D printing technology. The templates were sterilized and used during the surgery. The placement of the screws was examined by postoperative CT. The accuracy and safety of the screw insertion were assessed and classified with Screw Guide Template System (SGT).

Results. Among 11 patients there were 9 trauma cases, 1 CVJ development abnormality and 1 CVJ tumor. 20 pedicle screws and 2 laminar screws were implanted. There were not neurovascular, infectious or other complications. The mean deviation from planned trajectory was 2.1±1.08 mm. The grade of deviation was estimated as class 1 (SGT system, <2mm) for 17 screws (77.3%), as class 2 (2-4 mm) for 4 screws (18.1%) as class 3 (>4 mm) for 1 screw (4.5%). Safety of screws implantation was estimated as Grade 0 (all the screws were completely surrounded by bone structures) for 19 screws (86.4%), as grade 2 (<50% of screw diameter perforates bone) for 2 screws (9%), as grade 3 (>50% of screw diameter perforates bone) for 1 screw (4.5%). Deviations were as-

sociated with some features of templates design which couldn't prevent some grade of templates shifting to posterior vertebral structures during instrumented manipulations.

Conclusions. Application of 3D printed individualized navigation templates is a safe and effective technique for C2 pedicle screw placement. There are some features of templates construction which can influence accuracy of implantation.

THE EFFECTIVENESS OF FULL-ENDOSCOPIC SURGERY FOR GUNSHOT WOUND OF THE LUMBAR SPINE

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Goal. To assess the possibility of full-endoscopic surgery in the case of a bullet wound in the lumbar spine.

Materials and methods. Clinical observation of the victim, a male of 24 years, hospitalized in the clinic of neurosurgery of the Military Medical Academy on the second day after receiving a gunshot blind wound lumbar region. At admission: complaints of weakness in the feet, numbness on the back surface of both legs and perineum, impaired feeling of filling the bladder. Complaints arose immediately after the injury. During the first 24 hours, weakness in the right foot was noted. Objective examination revealed the entrance hole of the gunshot wound in the lumbar region to the left; lower paraparesis was observed up to 3 points, bilateral absence of achilles reflexes, hypoesthesia in dermatomes S1-S5 on both sides, delay of urination.

Computed tomography revealed a wound channel having an oblique trajectory from the inlet through the median line of the body between the base of the spinous processes of the LV-SI vertebrae, terminating blindly in the vertebral canal near the right intervertebral joint LV-SI, where was the metal bullet. There were no bone injuries of the spine, damage to large vessels, abdominal organs, retroperitoneum and small pelvis.

Under general anesthesia, full-endoscopic intervention was performed. A puncture access to the LV arc was made, a working port with a diameter of 8 mm was installed, into which the endoscope «SpineTip» (Karl Storz) was inserted. Further manipulations were carried out under the supervision of endoscopy through a special endoscope channel 3.5 mm in diameter, under conditions of continuous irrigation with physiological sodium chloride solution.

After a partial resection of the arc and dissection of the yellow ligament, the bullet was grasped by forceps and extracted through the working port. The diameter of the bullet was 5 mm, length 23 mm. When revision of the epidural space, a rounded defect of the dura mater, up to 2 mm, was found in the cuff region of the right S1 spine. Endoscopically established signs of anatomic integrity of the nerve. Through the canal of the endoscope, the plastic of the defect of the dura mater has been performed with fragments of «Tachocomb®». The endoscope and the working port are extracted. One nodal suture is applied to the skin.

Results and discussion. The duration of the operation was about 40 minutes. The blood loss did not exceed 10 ml. There were no intraoperative complications. Postoperative and gunshot wounds was healed within 10 days against the background of antibiotic therapy. There were no liquorrhea. Computed tomography and magnetic resonance imaging, revealed signs of absence of a foreign body in the spinal canal. Within three months the patient has increased strength in his feet, recovered the function of urination, defecation and erection. Partly regressed sensitivity disorders. Pain in the back and legs does not currently bother. The patient continues rehabilitation.

Gunshot wounds of the spine and spinal cord in civil and military time, constitute 10-21% of all spinal cord injuries.

Indications for surgical treatment with gunshot wounds of the spine are: an increasing neurological deficit; compression of neural structures with bone fragment, intervertebral disc or foreign body; cerebrospinal fluid; gunshot penetrating blind damage to the cone of the spinal cord and horse tail; instability of the spine; formation of an abscess and pain syndromes in the late period.

The purpose of the operation with penetrating blind wounds is the decompression of the neurovascular formations of the spinal canal, restoration of the integrity of the dura mater and the patency of the subdural space. Surgical access should be chosen logically, guided by the position of the bullet in the vertebral canal.

To the best of our knowledge, this is the first experience of performing full-endoscopic surgery in the world literature, with a gunshot of a blind penetrating wound of the spine.

Conclusions. The method demonstrated the possibility of a quick and safe approach to a wounded projectile located in the lumbar spinal canal through the LV-SI interlaminar window, made it possible to extract the bullet without difficulty and to audit the epidural space, to effectively seal a small defect in the dura mater. Absence of postoperative infectious complications and liquorrhea, timely healing of postoperative and gunshot wounds, distinct improvement in the neurological status of the victim allows us to recommend the use of the full-endoscopy method for similar gunshot wounds of the lumbar spine at the stage of specialized medical care.

NEW APPROACHES IN DIAGNOSTICS, NAVIGATION AND ROBOTICS FOR BETTER LOCAL TUMOR CONTROL IN GBM PATIENTS

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Glioblastoma (GBM) is a devastating disease. Despite different approaches, we are still far away from finding a cure. Most patients diagnosed with GBM die within 12-15 months. 96%of recurrences occur within the former resection margin. In patients with residual tumor on early postoperative MRI, the follow-up images display enlargement of remnants in 92% of these cases. Therefore, the purpose of the present study was to offer the new approaches to intraoperative molecular navigation, robotic brachytherapy and postoperative MRI assessment for better tumor control at the site of surgery.

Material and methods. Feasibility of GBM surgery guided by high resolution intraoperative positron emission tomography (PET) Imaging was evaluated in phantom Study. New generation of portable, high-resolution, dedicated brain PET devices with ^{18}F-fluorodihydroxyphenylalanine (^{18}F-DOPA) was used. In the first series of experiments, 1200cc gelatin "brain" phantom was mixed with ^{18}F-DOPA to background activity concentration of 0.23 uCi/cc. Gelatin lesions ("tumors") with volumes of 2ml, 1ml, 0.5 and 0.2 ml were mixed with ^{18}F-DOPA to activity concentration of 0.61 uCi/cc and 1.22 uCi/cc to achieve the lesion/background ratio of 2.5:1 and 5:1 respectively. The "tumors" were implanted into the "brain" phantom before scanning. Whole-brain PET datasets were acquired for 10 minutes and reconstructed using Maximum Likelihood Estimation Method (MLEM). In the second series the phantom colored gelatin lesions with volumes of 2ml, 1ml, 0.5 and 0.2 ml were inserted into the gelatin brain phantom to achieve lesion/background ratio of 5:1. The phantom was installed in the field of view of PET scanner and lesions were removed gradually under PET guidance to imitate partial and gross total tumor removal.

New robotic device (Xsoft) for intraoperative balloon electronic brachytherapy (iBEB) was exploited in 8 patients with recurrent GBM (rGBM) who underwent 5-ALA neuronavigation guided resection. Post resection cavity volume was measured by filling it with normal saline to select the balloon volume. iBEB of 20 Gy was carried out. Gadolinium enhancement brain MRI plus MRI-perfusion was obtained within 24 hrs. after surgery. Patients were followed up every 2 months using the same imaging modalities.

New software to determine the Residual contrast-Enhanced Tumor Volume (RETV) in postoperative MR images was created. In single center retrospective study of 50 consecutive GBM patients underwent 5-ALA surgery. All of them had 24 hour postoperative MRI evaluated with the new software.

Results. In the first experimental series with PET all 5:1 and 2.5:1 lesions can be clearly visualized on PET scans, however at 2.5:1 lesion/background ratio 0.2 mL lesions are likely close to the limit of detection.

In the second experiment, gradual extraction of gelatin "tumors" under PET guidance was successful and no colored "tumor" residues were found on subsequent visual inspection of the phantom by an independent observer.

In robotic iBEB gross total tumor resection was achieved in 5 patients (group I) and subtotal in 3 patient (group II) with no additional neurological deficit. In group I all patients have no evidence of tumor progression so far (follow-up period from 0,5 to 17,0 months). In group II mean progression free survival after second surgery was 5,7 months only.

Single center retrospective study all patient divided in two groups: group I (n=29) RETV was <2.5cm^3, in group II (n=21) RETV turned out to be >2.5 cm^3. No significant difference was found between groups in terms of age, gender, preoperative tumor volume and adjuvant therapy. Followed up was>3 years. Overall survival in group I was 16.5+/- 2.5, whereas in group II only 3.2+/-0.9 (p<0.01).

Conclusion. High-resolution brain PET imaging is feasible in the intraoperative environment and can be successfully used for molecular navigation at GBM surgery.

Gross total rGBM resection followed by robotic iBEB seems to be promising technology to extend the life expectancy in GBM patients. No serious complications have been observed so far

The new software for postoperative MRI assessment of the extent of GBM resection is accurate and easy to use for both daily neurosurgical practice and research.

The RETV is a significant predictor for the early postoperative progression and death.

Further cooperative study is warranted.

BURR HOLE SUBTEMPORAL SELECTIVE AMYGDALOHYPPOCAMPECTOMY

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The aim of the study. Assessment of surgical treatment and outcome in patients with epilepsy and hippocampal sclerosis through subtemporal 14 mm burr hole approach.

Materials and methods. During two-year period (2016-2017) 24 selective amigdalohippocampectomy were performed through subtemporal burr hole approach.

All surgeries were performed using microscope and microsurgical technique with no endoscopy involved. To improve surgical field visualization we used MARI device (Tolikety Co Ltd) for hands-free microscope navigation.

Patients' age varied from 16 to 46 years (median 30 years). There were 13 women and 11 men. All patients presented with drug-resistant epilepsy. The diagnosis was confirmed by clinical data and video EEG-monitoring. All patients were assessed by epileptologist, neuropsychologist and neuroophtalmologist before and after (at least 6 months) the surgery. Results were assessed by Engel scale.

Results. In all cases subtemporal selective amygdalohyppocampectomy was performed.

We resected corpus amygdaloideum, head, truncus and cauda of the hippocampus alongside with gyrus parahippocampalis up to the quadrigeminal plate level.

Time of surgery from skin to skin varied from 60 to 115 min. (median – 80 min). The extubation time varied from 5 to 120 min. (median – 40 min). In 12 cases patients began walking on the same day of the surgery, the rest of the patients -next day of the surgery.

Contralateral homonymous upper quadrantanopia was observed in 10 cases (42%). In the rest of the cases we did not observe any visual field disturbances, also no other types complications was documented. The follow-up data were collected from all patients. The minimum follow-up period was 6 months. In 19 cases outcome was evaluated as Engel I a (79%). In 2 cases Engel II b (8%), in one case – Engel III (8%), and in 2 cases Engel IV (8%)

Conclusions. Selective amygdalohyppocampectomy through burr hole approach can be considered as an effective method of treatment in patients with hippocampal sclerosis suffering with refractory epilepsy.

OUR EXPERIENCE OF USAGE DIFFERENT TYPE OF TISSUES WITH PRESERVED TROPHY FOR SCULL BASE RECONSTRUCTION IN TRANSSPHENOIDAL ENDOSCOPIC SURGERY

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Objective. Now we have an experience of more than 5000 pure endoscopic tumor removal of sellar-region, hiasmal-sellar-region and clival-region.

High risk of post-op CSF-leakage is a main feature of cranial base reconstruction. Multilayer technique known as a standard. We prefer autologic tissues for closure. In some cases we try to use tissues with preserved trophy.

Materials and Methods. We use turned back middle turbinate (MT) in 30 cases and mucoperiosteal flap (MPF) in 220. For MT mobilization we cut the anterior 2\3 of it pedicle. In all cases we use fat and different type of glue.

For MPF we use Haddat methodic in one or both nostril. We used MT and MPF either for direct defect closure or for the last layer of "sandwich". We prefer a different strategy in different surgical situation.

Results. We had only one smooth CSF-leakage in case with direct closure by MT 3 weeks after the operation. Our differentiated strategy for scull-base closure decreased CSF-leakage to 3% in cases with low risk and 10% in cases with high-risk of SCFleakage. Wide bone defects on clivus and direct connection of suprasellar cistern with III-ventricle is two variant with maximal risk of recurrent CSF-leakage.

Conclusion. On our opinion MT is a good material for small sellar defect closure but it's better to use for mechanical fixation for other material (fat in sphenoid sinus). MPF is a good material for using alone or like a different layer in a "sandwich." MPF is non-alternative material for CSF-closure in cases with meningitis. In all cases we must use as smaller bone defect as possible. Fat-tissue is good hermetic for small arachnoidal or dural defect but I most of the cases it better to use like an intermediate layer of sandwich. The best type of glue is a thrombin glue, but it's only a short-term hermetic for the layers of sandwich. We see the future development of scull-base reconstruction in creation of new type high adhesion materials and in usage of mechanical methodic of MPF fixation – suturing or clipping to the dura.

A DIFFERENTIATED APPROACH TO THE TREATMENT OF GIANT PITUITARY ADENOMAS. CHANGE OF INDICATIONS FOR SURGERY, CHOICE OF SURGICAL METHODIC, FEATURES OF SKULL-BASE RECONSTRUCTION. THE ROLE OF MINIMALLY INVASIVE SURGICAL TECHNOLOGIES

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Objective. Pituitary adenoma surgery today in the world is considered routine technology.

From 2000 to 2016 we underwent 4614 adenomas of the pituitary gland, 4098 – transnasal access. Tumors > 60 mm 377 (transnasal 240) Tumors > 40 mm 1057 (transnasal 830).

Methods. We have now abandoned attempts to remove prolactin. We have significantly changed the methods of transnasal tumor removal and methods of closing skull-base. In extreme cases, we use a two-stage removal (transcranial + transnasal).

Results. Lethality decreased from 5% (90th years) to <1%. The frequency of postoperative nasal liquorrhea in recent years does not exceed 3%. We propose a differentiated approach to both methods of tumor removal and closure of the skull base defect (from multilayer and multilevel plastics to complete rejection of it).

Conclusion. Changing the approach to choosing methods of tumor removal, the active application of modern ICP management techniques has made it possible to provide safe and radical removal of the tumor in cases previously considered hopeless.

EFFICACY AND SAFETY OF TRANSCRANIAL DECOMPRESSION OF THE OPTIC NERVE CANAL IN SURGERY OF TUMORS OF THE CHIASMATIC-SELLAR REGION

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Objective. During the period from 2001 to 2017 we performed 170 transcranial decompressions of optic nerve canal (ONC) – 21 lateral ONC wall during extradural approach and 149 ONC-roof during intradural. Meningioma – 139 (105 – tuberculum sella – area). Pituitary adenoma – 18. Craniopharyngioma – 7. Other – 6.

Methods. In 5 cases we use Kerrison Rongeur In 165 – diamond burr. In all cases we cut falciform ligament. In 28 cases we found evident and in 116 moderate constriction mark on the optic nerve (ON) due to ligament compression. In 108 cases we open fight ONC, in 31 left, in 31 – both.

Results. In most of the cases, visual function was unchanged or improve. Rare cases of blindness we ascribe by technical mistakes or terminal stage of ON-atrophy.

Conclusion. Transcranial decompression is a safe and effective method of mobilizing the optic nerve to reduce the risk of its traction damage in surgery of chiasmatic-sellar region tumors. The data presented by us can be used as a comparative group for studies of the efficacy of transnasal decompression of ONC in tumor surgery of chiasmatic-sellar region.

3D-CT reconstruction of pre. and post.op CT imaging is an effective and mandatory methodic to avoid intraoperative mistakes and visualize small defects of sphenoid wall.

MINIMALLY INVASIVE NEUROSURGERY: DEVELOPMENT, APPLICATIONS AND ADVANTAGES

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Purpose. Minimally invasive neurosurgery (MIN) refers to technical and technological advances that have enabled neurosurgeons to reduce the morbidity and improve accuracy and quality of neurosurgical procedures. The purpose of this paper is to analyze on the basis of personal experience how the development of MIN changed the practice of neurosurgery over the last decades.

Materials and methods. A synthesis of the literature on this topic is presented. Selected cases taken from the author's personal experience are shown and the changes that the development of MIN has determined on the management of these pathologies are analyzed and discussed.

Results and discussion. When compared with previously used procedures the neurosurgical managements accomplished according to minimally invasive technique showed several advantages including more accuracy, less morbidity, short hospital staying and speed recovery.

Interactive computer imaging with frame-based and frameless stereotaxy as well as endoscopic techniques used alone or in combination in order to perform minimally invasive approaches allowed to navigate a safe path within the cranium. Furthermore the possibility to perform a preplanning of surgery by linking the imaging data with the living pathology cannot be underestimated. Safety and precision have been further enhanced by the use of the intraoperative physiological monitoring. Interventional neuroradiology and stereotactic radiosurgery add further dimensions to the minimally invasive approach.

Conclusion. The development and practice of MIN have redefined the practice of neurosurgery. It was a real privilege to have seen and experienced the development of techniques and technologies that led to a continuous improvement in the quality and results of surgical performances.

MONITORING METHODS IN NONINVASIVE NEUROSURGERY: METHODOLOGICAL CHALLENGES

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Goals. Analysis of some methodological challenges of physiologic monitoring in noninvasive neurosurgery

and assessment of alternatives to cope with them.

Methods. Some relevant indices of signals as the electroencephalogram, the electrocardiogram, the beat-to-beat blood pressure, and others, are calculated in the frequency domain using methods as the Fourier transform. However, this method should only be applied assuming that the biological processes under study show a linear, stochastic, and stationary behavior. Neurosurgical procedures impose a non-stationary condition, and cannot be ruled out the presence of nonlinearity of the processes associated with these signals in those conditions. Therefore, calculation of spectral indices requires the use of alternative methods. Recently, novel methods have been proposed for the calculation of reliable indices from nonlinear and non-stationary signals. They include the empirical mode decomposition (EMD) followed by the Hilbert transform, generally known as the Hilbert-Huang method (HHT).

Results. We have implemented and tested four algorithms for the calculation of the EMD method and developed the particular procedures allowing the calculation of instantaneous values of the main parameters in the frequency domain of the EEG and the ECG, and also in the assessment of the fluctuations of the functional state of the autonomic nervous system using heart rate, and heart rate variability analysis. Using the HHT method it was possible to obtain continuous time-frequency-phase diagrams that have shown to be useful for physiologic monitoring, avoiding the above mentioned methodological limitations.

Conclusion. The HHT method can be successfully used in the calculation of spectral indices of biological signals used for physiologic monitoring in noninvasive neurosurgery.

MINIMALLY INVASIVE APPROACH IN NEUROSURGERY – SOROKA MEDICAL CENTER EXPERIENCE IN KEYHOLE SURGERY

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Purpose. Demonstrate the advantage of minimally invasive neurosurgical technique in treatment of different brain and spine pathologies.

Materials and methods. Based on our experience, we present the results of utilization of minimally invasive keyhole approaches in treatment of more than 400 patients with variety lesions located in the cranial space and spinal canal.

Results and Discussion. We have been using the minimally invasive technique based on the "Keyhole" concept since 1998. The lesions treated by this technique included: malignant and benign tumors, cysts, vascular malformations, infections and other miscellaneous diseases.

In most of cases was achieved complete resection of lesions, proved on postoperative imaging studies. There were no complications associated with surgery. Two patients need additional surgery for CSF leak and hydrocephalus. In presented series was no mortality.

Conclusion. Utilizing Keyhole Concept and microneurosurgical and/or endoscopically assisted access, allowed us to gain excellent optimal and safe exposure to a number of different pathologies of the cranial space and spinal canal. The lesions were resected under complete control and with full preservation of surrounding neurovascular structures.

FACIAL NERVE PRESERVATION IN SURGERY FOR LARGE VESTIBULAR SCHWANNOMAS

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Purpose. Surgery for large vestibular schwannomas is very difficult to obtain good surgical results, and it requires tips and devices to achieve both high resection rate and high preservation ratio of facial and/or hearing function.

Materials and methods. My personal surgical experience of large vestibular schwannomas (Koos 4) is 852 out of all 1187 patients (Koos 1-4). I have been using intraoperative continuous facial nerve monitoring with direct electrical stimulation on the root exit zone since 1997 in vestibular schwannoma surgery, which is a method for checking facial EMGs during tumor excision in real time. We performed three types of intraoperative facial nerve monitoring: free-running spontaneous EMG, evoked facial nerve EMG with occasional and continuous electrical stimulation, as well as two types of moritoring for hearing function (ABR and CNAP: cochlear nerve action potentials).

Results and discussion. Overall functional preservation rate of the facial nerve (House and Brackmann grade 1 or 2 at 1 year after surgery) was 97.1% and hearing preservation ratio was 36.5% with a 96.5% mean resection rate for the tumor in Koos 4 group.

Conclusion. Using a intraoperative continuous facial nerve monitoring with direct electrical stimulation is useful to increase the tumor excision rate while avoiding severe postoperative facial nerve palsy in vestibular schwannoma surgery.

TRANSPETROSAL APPROACHES FOR SKULL BASE TUMORS AND VASCULAR LESIONS

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Purpose. Transpetrosal approaches (TPA), including anterior TPA, posterior TPA, and combined TPA, are very

useful in skull base surgery and surgery for deep seated vascular lesions.

Materials and methods. The author performed more than 200 mastoidectomy procedures and 200 anterior TPA/middle fossa approaches (including 100 combined transpetrosal approach) for 1600 skull base tumors and vascular lesions.

Results and discussion. By using transpetrosal approaches, difficult skull base surgeries were succesfully performed and obtain satisfactory results in most cases.

Conclusion. Younger neurosurgeons who want to be a well-sophisticated open surgeon should master these skull base approaches.

DELAYED EPISTAXIS AFTER ENDOSCOPIC TRANSSPHENOIDAL REMOVAL OF PITUITARY ADENOMAS

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Objective. To develop optimal methods for the prevention and treatment of epistaxis after transnasal endoscopic removal of pituitary adenomas.

Material and methods. We analyzed the medical history of 3730 patients who underwent endoscopic endonasal surgery for the pituitary adenoma in N.N. Burdenko Scientific Research Neurosurgery Institute since 2005. The study included patients who re-admitted to the N.N. Burdenko Scientific Research Neurosurgery Institute due to epistaxis in the first 30 days after surgery.

Results and discussion. Were identified 12 (0,3%) patients who required re-hospitalization due to epistaxis. For hemostasis in 10 patients were carried out endoscopic inspection of the nasal cavity and coagulation of bleeders. In two cases, epistaxis was stopped by tamponade of the nasal cavity.

Epistaxis is a serious complication after transsphenoidal removal of pituitary adenomas. In most cases (64%), sphenopalatina artery was the source of bleeding. In four patients the development of bleeding was accompanied by high blood pressure. K. M. De Los Reyes et al. consider the need for strict blood pressure control, especially in the early postoperative period.

Conclusions. The most effective way to treat such a formidable complication after transsphenoidal removal of pituitary adenomas, as epistaxis, is endoscopic inspection of the nasal cavity and coagulation of bleeders. Tamponade of the nasal cavity should be considered only as a temporary procedure to allow transportation of the patient in a specialized hospital. To reduce the risk of postoperative nasal bleeding, the surgeon should avoid damage of the sphenopalatina artery.

SURGICAL TREATMENT OF PARA-INTRAVENTRICULAR CYSTS IN CHILDREN

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The purpose of the research: to analyze the effectiveness of surgical treatment of para-intraventricular cysts of different etiology in children.

Material and methods. The research is based on an analysis of the results of the surgical treatment of 166 patients with para-intraventricular cysts who were operated at the State Institution "Romodanov Neurosurgery Institute" NAMSc of Ukraine in 2006-2016 years. The age of patients was from 1 month up to 17 years (the average age was 4.5±1.2 years). 91 (54.8%) patients were males, 75 (45.2%) – females. According to etio-pathogenesis, all patients were divided into two groups: Group I – children with post-inflammatory cerebrospinal cysts – 86 (51.8%); Group II – with dysontogenetic cysts – 80 (48.2%) children. Post-inflammatory cysts were predominantly of intraventricular localization, dysontogenetic cysts were particularly paraventricular. In all patients, liquor cysts had clinical manifestation (syndrome of high intracranial pressure, "mass effect"). Extracranial drainage of cysts with the implantation of shunt systems was performed in 104 cases. Cystostomy was performed in 166 children, endoscopic fenestration of cysts walls was performed in 134 patients, microsurgical – in 32. Catamnesis from 2 to 7 years was followed up in 137 (82.5%) patients.

Results and discussion. The main method of treatment for para- and intraventricular liquor cysts with the syndrome of intracranial liquor hypertension are operations aimed at communicating the pathological cavity of the liquor cyst with normal liquor spaces – the operations of cystostomy (cysto-ventriculostomy, cysto-ventriculo-cisternostomy). Despite the same effectiveness of microsurgical and endoscopic operations, endoscopic operations are accompanied by less blood loss, shorter duration of operation and a shorter period of hospitalization ($p<0.05$). Endoscopic interventions should be considered as the method of choice. In a cases of cysts of dysontogenetic origin, the probability of compensating of liquor circulation without the use of shunt systems exceeds 70%. The post-inflammatory nature of the pathology indicates the need for extracranial drainage of the cerebrospinal fluid.

Conclusion. A differentiated approach to the planning of surgical interventions, taking into account the etiology and a well-grounded combination of intracranial and extracranial drainage of liqour in para- and intraventricular cysts, should reduces the number of shunt-dependent patients and also reduces the risk of dysfunction of the shunt system in patients requiring extracranial drainage of the liquor.

QUALITY OF LIFE AFTER MICROVASCULAR DECOMPRESSION IN TRIGEMINAL NEURALGIA

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Trigeminal neuralgia (TGN) is more likely to affect middle-aged and elderly patients, accounting to 70% of the observations, with women predominating among the patients (73%). The clinical picture of the TGN is determined by the symptom-complex of affection of the branches and the most specific symptom is presence of the trigger zones of pain development, which is noted in 97% of patients.

According to modern data, the etiological factor of TGN is the compression of the root of the trigeminal nerve by cerebellar arteries and other vessels in the posterior cranial fossa in 94% of cases. Chronic recurrent course of the TGN affects seriously quality of life (QOL) of the patients.

The aim of the investigation was to study the QOL of patients with TGN after microvascular decompression surgery.

We have analyzed the results of observations of 392 patients with TGN after microvascular decompression surgery for the period 2008-2017. Female patients prevail over men in 1/3. The age of patients is from 25 to 79 years with the predominating 43% of patients from 60-79 years. The quality of life was assessed on the basis of the subjective feelings of patients with the help of a common health questionnaire – MOS SF-36, the European Quality of Life Questionnaire – EuroQol-5D and the short questionnaire of pain – McGill Pain Questionnaire, which passed the standard validation procedure. Evaluation of the statistical significance of the differences in these questionnaires was determined traditionally – taking into account the Student's t-test at a value of $p<0.05$.

The parameters before the microvascular decompression of the spine of the triple nerve according to the MOS SF-36 questionnaire were as follows: FF-70, RFF-65, B-20, OZ-50, SF-70, REF-60, PZ-50; EuroQol-5D: M-1, C-3, BA-2, B/D-3, T/D-3; and on the questionnaire of pain - McGill Pain Questionnaire in all the observations on the pain parameters studied reached up to 4, 5 in total to 40, 50 points. The parameters after conducting the microvascular decompression of the trigeminal nerve root from the MOS SF-36 questionnaire were as follows: FF-95, RFF-98, B-80, OZ-84, SF-88, REF-85, PZ-87; EuroQol-5D: M-1, S-1, BA-1, B/D-1, T/D-1; and according to the questionnaire of pain – McGill Pain Questionnaire in all observations on the studied pain parameters reached up to 0, 1 in total to 4, 5 points.

The quality of life of patients after the microvascular decompression of the trigeminal nerve root was approximated to good indices for patients, and the duration of the disease-free period was more than 15 years.

Thus, the most effective method of surgery in TGN is to perform microvascular decompression, which allowed to achieve a stable process of pain relief in 97% of observations. The quality of life corresponded to the lower values before the operation, and after carrying out the microvascular decompression of the trigeminal nerve root, the results were good and different for the patient in all the questionnaires.

THE EFFICACY OF ETV IN MANAGEMENT OF HYDROCEPHALUS SECONDARY TO POSTERIOR FOSSA LESION: A LOCAL EXPERIENCE IN UPPER EGYPT

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Introduction. The advent of endoscopic third ventriculostomy (ETV) has gained popularity due to the high complication and failure rates of ventriculoperitonel shunt

Objective. To assess the efficacy of endoscopic third ventriculostomy in management of hydrocephalus secondary to posterior fossa Lesion.

Methods. It's a clinical prospective observational study that was conducted on 24 patients of both genders with different ages who presented with manifestations of posterior fossa lesions and increased intracranial pressure at the Neurosurgery departments, Sohage University hospital, Sohage and Qena University hospital, South Valley University, in the period from March 2015 to March 2017. A complete clinical assessment was done, a final diagnosis was made and ETV was done for all patients. Patients were followed up within one month post-operatively. Data was analyzed using the SPSS (version 16.0).

Results. The study included 24 patients with obstructive hydrocephalus due to a posterior fossa lesions. There were 12 males and 12 females with male to female ratio of 1:1, the age ranged from one year up to 50 years old, two (8.3%) patients were below two years, and 22 patients was above two years. manifestations suggesting increased intracranial pressure were found in all patients where papilledema was the presenting sign in all patients, followed by 6th. Nerve palsy in 14 (58.3%) patients.

Clinical improvement occurred in 20 (83.3%) patients, in spite that not all of them showed radiological improvement, the ventricular size was decreased of its preoperative measures in six (25%) patients and the other patients showed no significant changes of the ventricular size.

Postoperative histopathological results were as follow; the most common type was Ependymoma (n=8, 33.3%), followed by medulloblastoma (n=6, 25%), Cer-

ebellar astrocytoma (n=5, 20.83%), Pineal region tumor (n=3, 12.5%), and arachnoid cyst (n=2, 8.33%).

Conclusion. ETV is safe and effective modality of treatment of hydrocephalus secondary to posterior fossa lesions, with high success rate and few complications and can replace shunt operation for those patients.

EVALUATION OF THE QUALITY FUNCTIONING OF BRAIN AT ALL AFTER MICROSURGERY

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Goal of investigations. Microsurgery interventions, in depend on their localization and state of patient, could evoke problems predicted consequents eliciting of which on initial study of appearance is critically important for their the most effective treatment. However methods for such purpose are limited mainly on EEG indices informational possibility, of which is acceptably not for all cases. One of the possibility to make clear the prediction of after microsurgery complication may be based on instrumental observation of functioning of circuli-matabolic mechanism responsible for brain functioning, this mechanism is high sensitive to changes of functioning of brain at all and its separate hemispheres. Reason of high sensitivity which is based on the complexity of mechanism responsible for brain circulatory-metabolic support, representing the integrative interaction of cerebral blood circulation, CSF mobility and scull, as united mechanism change its activity due to consequence of microsurgery, it may reflect to the quality of total brain circulatory-metabolic supply. This express firstly of changes, of some fictional structure. Under normal conditions this interaction is strongly balanced, but in cases, if any element of this complex indices itself, taking part in integrative interaction of the different component, doesn't not change quality of brain activity and it is functionally invisible. However, after some time and brain circulatory insufficient or decrease brain circulatory tolerance is appeared. Therefore it is the most important, to find definite simply and evaluated induces, which could help to predict of brain circulatory insufficiently as consequence microsurgery. Aim of this investigations is to evaluate indices, definitely indicate the initial chances in functioning of mechanism, which is responsible for brain circulatory-metabolic supply on the base of instrumental observation of components which are already destroying, but this is not yet reflect on quality of brain functioning, but also may point out to optimal way of their anticipate approach problem.

Method and materials. Evaluation functioning of brain and its separate hemispheres after microsurgery was provided by instrumental complex included as input signals recordings composed by rheoencephalographic, using simultaneously two (216 and 200 rHz) frequences (REG «Mitstar»Russia) and transcranial dopplerography(TCDG-«DWL» Germany) and their consequent analysis was provided by specially adapted «Chart-5» software of analog-digital transformer (PowrLab-8 «ADInstrument» Australia), connected REG and TCDG with PC «Windous-10. Instrumental complex make possibly measure CBF, CSF pulse mobility, cranial compliance, cerebrovascular reactivity (CVR), quantitative evaluation of slow volume intracranial fluctuations of REG and TCDG in limits 0 – 0,3Hz. It was investigated 46 patients mainly middle age. Investigations provide nonstop records duration 10-12 min during which functional tests -respiratory arrest, hyperventilation and Stookey tests are used for evaluation of cerebrovascular reaclitvity(CVR).

Results and their discussion. Investigations provided with patients after neurosurgery indicated change activity of cerebrovascular control mechanisms. The most of recorded indices are chanced hemispheric asymmetry and spectral diagram of slow intracranial volume fluctuations, but most of them after one-two days are normalized, however there are some indices, which could to predict the developing of cerebra-vascular disturbances as result of local microsurgical intervention. The most generally sensitive index is CVR. The decrease of its indexes clearly indicate the possibility of general circulatory insufficiently in next 10-16 hours and after lateral intervention changes of CVR in intact hemisphere it happens later for 6-8 hours. CSF mobility decrease and cranial compliance is definite indicator of the possibility of the beginning tissue hydration, especially if hemispheric asymmetry of these indices is increased. The increase of hemispheric difference of ratio between REG measured at two frequencies also alerting index. Changes of pattern of slow frequency of intracranial volume fluctuation may be indicator of control processes in cerebrovascular systems.

Conclusion. Received date indicate, that there is a real possibility to predict at same cases negative consequents of microsurgery intervention by observation of indices, indicating of functioning mechanism, responsible for quality of brain functioning. Of course it is necessary to evaluate the most informative indices for every particular situation.

COMPUTER-TOMOGRAPHY DIAGNOSIS IN ACUTE SPINAL INJURY

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Purpose. To assess the information content computed tomography (CT) of spinal injury.

Material and method. Results 82 patients with spinal injury over the period 2014-2017. All the patients had

a CT examination of the spine and spinal cord injury. Antiquity injury sways 1:0 up to 8 days. Patient's age ranged from 18 to 68 years. Depending on the level of the spine patients was as follows: cervical department – 21 (25.6%), thoracic – 34 (41.5%), lumbar – 27 (32.9%).

Results. With 3-dimensional reconstruction and analysis of the results we have identified: fracture of the body in combination with a fractured cervical vertebra and turning-point ear vertebra in 14 (66.7%), and in patients with dislocation and fracture of the articular processes was observed (100%). Analysis of CT examination of the level of injury has exposed not only the vertebral body fracture, but in 26 (76.5%) comminuted fracture was observed in body and in 21 (61.8%) observations of fracture of shackle and costal articulation. Analysis of CT examination of lumbar level injuries revealed a fracture of the vertebral body and shackle in 22 (81.5%) observations and in 16 (56.3 %) cases of fracture of articular processes.

Thus, the data suggest that the research conducted by the information value of CT in vertebral injury reaches 100%. This, in turn, characterized the selection tactics of patients with spinal-brain trauma and surgical prejudice volume of surgical intervention.

NOT INVASIVE ANGIOGRAPHY IN DIAGNOSIS OF VASCULAR LESIONS OF THE BRAIN

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Selection of the optimal method of surgical intervention, when cerebral aneurysms and arteriovenous malformation one remains to be fully resolved. The main task of the surgeon is to perform full shutdown vascular pathology, to ensure minimal risk of neurological complications, selecting the safest kind of transaction, not expanding the amount of intervention and reducing timing restrictions physical activity and improve the quality of life in this category of patients.

As a rule, the main method of diagnosis of vascular brain pathology is angiographic study: Endovascular radio intervention, computed tomography (CT) and magnetic resonance (MRI) angiography. However, each of the methods has as contraindications and its availability to carry them out. It is associated with clinical period of vascular lesions in the brain. So, in cold asymptomatic period, research possible in full. In the so-called hot period not possible hemorrhagic invasive neuroimaging methods: either the CT or MRI angiography.

Objective. To examine the information value of computer tomographic angiography in the diagnosis of vascular diseases of the brain.

Material and methods. We analyzed the results of computer tomography (MSCT) angiography from 32 patients with acute hemorrhagic cerebrovascular pathology character for the period 2013-2017 y. Age of the disaster ranged from 1:00 up to 8 days. Age of patients ranged from 38 to 68 years. Depending on the localization of cerebral hemorrhage according to the MSCT supratentorial hemorrhage have revealed 18 (56.2%) patients; subtentorial indicated in 9 (28.1%) and mixed-supra-, subtentorial hemorrhage at 5 (15.7%).

Results and discussion. Angiographic with MSCT three-dimensional reconstruction and analysis of the results obtained by us vessels in the aneurysm was found 9 (28.1%) observations and arteriovenous malformation (AVM) 12 (37.5%) cases. In 11 (34.4%) our observations revealed the gap cilliar arteries against the background of hypertensive disease with malignant arterial hypertension. Characteristic of cerebral aneurysms was the availability of expansion plot distal branches of middle cerebral and anterior communicating arteries causing intracerebral hemorrhage stroke-development. In patients with subarachnoid hemorrhage, arteriovenous malformations were identified by us as vessels of the middle and posterior cerebral arteries.

The data obtained showed that a distinctive feature of the aneurysm was the cause, the so-called deep well arranged intracerebral not traumatic hemorrhage stroke. Whereas lateral mixed stroke hematoma and bleeding subarachnoid evolved when cerebral AVM rupture. This in turn has characterized the choice of tactics, the type and volume of surgical intervention.

Conclusion. Thus spent us study showed that the informative value of MSCT angiography in patients with acute cerebral hemorrhagic disaster nature reaches a high level and identifies the main pathogenetic hemorrhage mechanism as in the parenchyma of the brain tissue, and subarachnoid space. Integral parts of MSCT study were the reconstruction of the vascular bed of the brain in real time, which in turn directly prejudice the tactics of treatment of patients with this pathology.

ADVANTAGES OF MODERN NEUROIMAGING IN THE PLANNING OF SURGICAL REMOVAL OF TUMORS OF THE CEREBRAL HEMISPHERES

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One of the main tendencies in the development of modern neurosurgery is highlighted, which consists in applying the data of modern neuroimaging and electrophysiological technologies with the aim of minimizing operational trauma. Preservation and improvement of

patients' quality of life is currently a priority in the surgery of brain tumors.

The purpose of the work. Estimation of the results of surgical treatment of brain tumors of supratentorial localization using the data of DT-tractography.

Materials and methods. We studied patients with tumors of supratentorial brain localization, who were on inpatient treatment at RSSPMCN of the Ministry of Health of the Republic of Uzbekistan, and operated under the same conditions in the period 2015-2016. As the object of the clinical analysis, 72 patients, operated under the same conditions, were taken, 42 of them using new technologies. This group of patients was made MPT with the regime of DT-tractography and intraoperative neuromonitoring of motor tracts of white matter of the brain.

Results and discussion. In describing the degree of radical operative intervention, we followed the classification with the terms of total, subtotal removals and open biopsy. Data DT-tractography found that more than half (51.4%) of primary surgical procedures resulted in subtotal removal of the tumor, total removal of the tumor was possible in 40.2%, open biopsy – in 8.5% of cases. In all cases of resection, histological verification of the tumor was performed.

Histological signs of supratentorial brain tumors in 30,4% of patients revealed a meningioma, 25.0% had an oligodendroglioma, in 14.1% anaplastic astrocytoma, in 13.1% a fibrillar-protoplasmic astrocytoma, glioblastoma in 12.1%, and meningosarcoma in 5.2%. Comparing the available data of DT-tractography, we carried out the planning of operative intervention, taking into account the minimal traumatization of the conducting paths and the cortex of the brain.

However, in the real conditions of growth of the tumor, all the usual anatomical landmarks and details usually either disappear or are displaced. Knowledge of the relationship between the pathways and the boundaries of the tumor is already an integral part of the preoperative planning of the resection volume in many clinics. Our research allows us to determine the diagnostic algorithm, to understand in which cases it is necessary to perform DT-tractography for patients with brain tumors.

With the correct choice of the method of surgical treatment of neoplasms of supratentorial brain localization with the use of modern neuroimaging data (DT tractography) against the background of intraoperative neuromonitoring, it is possible to achieve the greatest possible improvements in treatment results, reduce disability, shorten the period of rehabilitation, mortality and relapse. But the most important point is a gradual improvement in the quality of life of patients and further social and labor adaptation without aggravating signs of the disease.

Conclusions. Thus, optimization of the volume of removal of tumor tissue is directly related to the possibilities of preoperative planning of surgical intervention, specification of tumor topography, obtaining the most complete information on the ratio of the tumor to the functionally important cortical areas of the cerebral cortex and the conductive fibers of the white matter.

OCCULT ISOLATED ARTICULAR BRANCH CYST OF THE LATERAL PLANTAR NERVE

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Introduction. Intraneural ganglion cysts (IGCs) are mucinous cysts found within peripheral nerves. The most common site of occurrence is the peroneal nerve. IGCs can cause neuropathic pain and motor and sensory deficits. IGCs have obvious macroscopic features on imaging (magnetic resonance imaging [MRI] or ultrasonography) and during surgery; however, it is not uncommon, owing to limitations in imaging facilities, or radiologist or surgeon experience with this rare condition, for IGCs to be confused with extraneural ganglion cysts. Failure to identify the joint-ganglion connection can be associated with a high rate of recurrence.

Report. During the course of a recent routine tarsal tunnel decompression in a 46-year-old female patient with fluctuating plantar foot symptoms, we made the incidental discovery of a tiny amount of cyst fluid in an articular branch to the subtalar joint; no cystic expansion of any parent nerves in the ankle was present. Retrospectively, we could confirm the cyst and its joint connection from the MRI studies. We present this case as the first example of an IGC localized to an articular branch.

Conclusion. We have presented a novel example of cyst fluid localized to the articular branch of the lateral plantar nerve. It is unknown whether the occult cyst represented an ultra-early phase of a cyst that had not yet formed or the remnant of one that had been larger and involved the parent nerve before being nearly completely resorbed. In either case, this isolated articular branch involvement is the conduit for IGC progression and can easily be overlooked.

INTEGRATED APPROACHES TO PREVENTIVE TREATMENT OF RELAPSE OF PAIN SYNDROME IN VIDEO ENDOSCOPIC SURGICAL INTERVENTIONS ON LUMBAR INTERVERTEBRAL DISCS

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The process of optimizing surgical approaches in the treatment of lumbar degenerative disc disease forc-

es us to continue searching for optimal solutions in the treatment of recurrent pain syndrome. This pathology is noted at various times after the operation and can reach more than 25%. A detailed retrospective analysis of 63 patients operated on for lumbar osteochondrosis showed that 18 patients (28.6%) had recurrent pain syndrome of different intensity. At the same time, 2 patients (11.1%), a relapse of herniation of the operated intervertebral disc was revealed. In 11 patients (61.1%) found the scar-adhesive process at the level of the operated motor segment of the spine. In 27.8% (5 patients) a combination of scar-adhesive process with recurrent herniation of the operated intervertebral disc was revealed.

Taking into account the obtained data, the aim of our study is to develop a method of "Integrated approaches to preventive treatment of relapse of pain syndrome in video endoscopic surgical interventions on lumbar intervertebral discs".

Materials and methods. The method is based on intraoperative measures that can prevent, in the postoperative period, the development of pathological processes, different in their pathogenesis, leading to a relapse of pain. The most significant of these processes we refer scar-adhesions, hernia recurrence of the operated intervertebral disc and/or their combination.

After carried out minimally invasive video-endoscopic discectomy with the aim of preventing the development of recurrence of hernia of the operated invertebral disc is used chemonucleolysis cavity of the operated disk by sprinkling it chondroitine enzyme.

In order to prevent the development of scar-adhesive process, short-term plastic surgery of the defect of the intervertebral space (formed after the removal of the yellow ligament and/or the elements of the vertebrae), performed as surgical access to the spinal canal by the barrier-reducing tissue, is carried out. As a barrier-reducing tissue, we use a collagen sponge impregnated with sodium dexamethasone phosphate, which is placed on the defect of the intervertebral space and then fixed (pressed) by the long back muscle.

Results. The proposed method is used in the treatment of 10 patients. Follow-up study conducted in up to 8 months. At the same time, neurovisualization signs of recurrent herniation of the operated disc and the formation of scar-adhesive process at the level of surgical exposure were not noted.

Conclusions. The obtained data indicate that in the focus of osteochondrosis, after surgery, in 28.6% pathological processes develop in the form of scar-adhesive process, recurrent herniation of the operated intervertebral disc or their combinations that can cause a recurrence of the disease. The use of the method developed by us "Integrated approaches to preventive treatment of relapse of pain syndrome in video endoscopic surgical interventions on lumbar intervertebral discs" is able in the postoperative period to prevent the development of pathological processes that call for relapse of pain syndrome, which will significantly improve the results of treatment of this pathology of the spine.

PROSPECTIVE POSSIBILITIES OF THE MINIMALLY INVASIVE STEREOTACTIC LASER THERMOABLATION OF ASTROCYTIC TUMORS OF SUPRATENTORIAL LOCALIZATION

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The purpose of the study. Based on the experimental studies carried out, the method of minimally invasive stereotaxic laser thermoablation of astrocytic tumors should be improved.

Materials and methods. We used applied the experience of using a laser radiation of 970 nm during open operations in neurooncological patients, as well as conducted experimental studies on rabbits brains. The characteristics of safe radiation of a diode laser have been worked out and the surgical technique for performing the thermal ablation of cerebral astrocytic tumors was improved (Patent of the Russian Federation No. 313.20132 of 31.07.2013 No. 2533032 "A method for treating glial brain tumors of supratentorial localization").

Results and discussion. The histological studies in the experimental work on the brains of 20 rabbits resulted a clear boundary between the ablation zone of the tissue and the normal preserved surrounding brain. The selected mode of the laser radiation of 970 nm and the peculiarities of the radiation supply to the tissue made it possible to show thermal ablation safely and predictably. The laser was used in 31 open operations to remove tumors of different histostructure. Stereotactically, 8 patients with glial Gd II-IV tumors were operated. The first clinical experience of stereotactic thermoablation demonstrates the best effect in the treatment of astrocytic tumors Gd II-III.

Conclusions. Currently, interstitial laser thermodestruction of tumors in the world practice has received a new impetus in its application. Laser neurosurgical stereotaxic techniques and equipment "NeuroBlate system" and "Visualase Thermal Therapy System" are actively used. The development of a minimally invasive neurosurgical technique is an actual and modern direction in the surgical treatment of astrocytic tumors. There is a possibility of combining a stereotaxic operation with a so-called "Keyholl" surgery, allowing puncture aspirate cysts or necrotic part of a tumor. This technique has its advantages over the already used technologies, such as cryosurgery, radiosurgery, open surgery.

ENDOSCOPIC ELECTRODE IMPLANTATION ON THE PERIPHERAL NERVE FOR TREATMENT OF CHRONIC PAIN

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Objective. Standard procedure of electrode implantation on the peripheral nerve requires wide approach that may be reason of postoperative scar. It can conduct to increasing of the chronic pain and unsatisfactory clinical result. Endoscopic electrode implantation makes possible the minimal invasive approach and improves the result of treatment.

Material and method. The patient with neurogenic sural nerve pain syndrome have been operated. He suffered from severe pain syndrome till 8-10 points (VAS scale) and painful hypoesthesia in calcaneal region after the sural nerve trauma. Conservative treatment was failed.

The small skin incision was performed behind the lateral ankle. Revision of the sural nerve was performed under the endoscopic control. Quadripolar electrode was implanted on the sural nerve under visual control trough the endoscope working port. The electrode was fixed by the epineural seam.

Results. The chronic electrostimulation was performed on the second day after the operation. The pain syndrome was regressed till 1-2 points (VAS scale). The stable clinical effect was kept during six month.

Conclusion. Endoscopic technics provides the minimal invasive electrode implantation and precise arrangement the electrode on the nerve trunk under the visual control. Further investigations are required to compare long-term results of the endoscopic and opened electrode implantation.

SURGICAL TREATMENT OF RUPTURED AND UNRUPTURED ANTERIOR CIRCULATION ANEURYSMS: COMPARATIVE CASE-CONTROL STUDY OF PTERIONAL AND SUPRAORBITAL KEYHOLE APPROACHES

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Objectives. To determine efficiency and safety of supraorbital eyebrow approach (SEA) in clipping of ruptured and unruptured aneurysms in comparison with pterional approach (PA) and finding advantages and disadvantages of SEA in clipping of aneurysms.

Methods. 166 patients, aged 18-70 years, with aneurysms of anterior circulation were included in the present study. All of them underwent treatment in the department of neurosurgery of the Interregional Clinical Diagnostic Center (Kazan) from 2013 to 2016. On the first stage of the study we compared the factors influencing outcomes in groups of patients operated by SEA (n=49) and PA (n=117). On the second stage the efficiency and safety of approaches were compared using case-control methodology. In selected SEA (n=37) and PA (n=37) groups we compared the following factors: sex, age, Hunt-Hess and Fisher scale grades, size and location of the aneurysms, duration of the surgery, presence of intraoperative rupture of aneurysm, blood loss volume, frontal sinus opening, intraoperative and postoperative complications, hemorrhagic and ischemic complications on postoperative CT, patients' satisfaction with cosmetic result of the surgery and outcomes by GOS. For the efficiency parameters, we used the outcome of treatment by GOS and the degree of patients' satisfaction with cosmetic result. For the safety parameters we used blood loss volume, frontal sinus opening, postoperative CSF-leak, intraoperative and postoperative (hemorrhagic and ischemic) complications.

Results. On the first stage of the study we found that patients who underwent SEA had statistically significantly lesser intraoperative blood loss than in the PA group (p=0.0000002). On the postoperative period neurological deficit (p=0.003) was less frequent in patients operated using SEA, with less developed epileptic seizures (p=0.035), lower incidence of hemorrhagic complications (p=0.003) and better outcomes by GOS (p=0.01). On the second «case-control» stage of the study we confirmed the fact of statistically significant lower blood loss in SEA group (p=0.0000002). In the PA group we observed more often, but without statistically significant differences, intraoperative rupture of aneurysms (p=1), postoperative neurological deficit (p=0.115), appearance of newly emerged epileptic seizures (p=0.493) and hemorrhagic complications (p=0.0557). There were no mortality cases in both groups. In the SEA group the outcomes by GOS were 4 and 5 points (favorable outcome), in PA group 2 (5.4%) patient matched 3 points by GOS, 35 (94.6%) patients – 4 to 5 points (p=0.063). The mean subjective satisfaction of cosmetic result by visual analogue scale was statistically significantly higher (9.4±1 point) in SEA group than in the PA group (8.8±1 point, p=0.01).

Conclusion. SEA is an adequate access for clipping of anterior circulation aneurysms, in particular aneurysm of ACA-AcomA and MCA, with efficacy and safety parameters that are not inferior than pterional approach.

BURR HOLE MICROSURGERY FOR VENTRICULAR TUMOR TREATMENT

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Purpose. Recently, in modern neurosurgery, there has been a clear tendency towards minimally invasive surgical approaches. We implemented 14 mm burr hole approach for ventricular system tumor treatment.

Materials and methods. During one and a half year period (February 2016 to November 2017) was performed 67 surgical removals of ventricular and pineal region tumors via 14-mm burr-hole in 61 patients. Four patients underwent repeated surgical treatment. All surgeries were performed under operating microscope, without any endoscopic assistance. To improve surgical field visualization we used the MARI device (MARI (Tolikety Co Ltd) for hands-free microscope movements.

Median age was 36 years (16-79 years). There were 36 women and 25 men in this group. All 61 patients underwent tumor removal. Repeated surgeries were performed in cases of postoperative hemorrhages or persistent hydrocephalus.

Thirty-four patients presented with pineal region and/or third ventricle tumors, 22 patients presented with tumors of the third and lateral ventricles, three patients had tumor located in the fourth ventricle and in one patient tumor located in the lateral, third and fourth ventricles. Tumor volume varied from 0,4 ml to 260 ml (median 6,95 ml).

We used transcortical approach in 39 patients, infratentorial supracerebellar approach in 16 patients, anterior transcallosal approach in 4 patients and telovelar approach in two cases.

There were 10 neurocytomas, 7 meningiomas, 8 germinomas, 5 pilocytic asrocytomas, 5 ependimomas and a few other histological types.

Extant of tumor removal in all cases was evaluated by MRI in early and late postoperative period.

Results. In 9 cases (5%) open biopsy was anticipated and performed. In 47 patients (91%) gross-total or near-total resection was performed (more than 90% of tumor volume was removed).

In 5 patients (8%) tumor removal was subtotal (75-90% of the tumor volume). More than 90% of patients were ambulant on the next day, two patients on the second day and two patients on 20th and 30th days, respectively.

Four patients had postoperative complications (6%). In three cases postoperative hemorrhages were revealed and those patients were re-operated. In two cases development of hydrocephalus was detected. The condition of 41 patients (67%) improved after surgery, no changes were observed in 8 (13%) patients and two of them worsened (3% cases).

Conclusion. Surgical treatment of ventricular system tumors via burr hole are quite promising. Radical removal may be achieved with minimal complication rate.

BURR HOLE MICROSURGICAL APPROACH FOR INTRACRANIAL NON VASCULAR LESIONS. RESULTS OF 200 CONSECUTIVE CASES

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Purpose. Recently, in modern neurosurgery, there has been a clear tendency towards minimally invasive surgical approaches. For this purposes "keyhole" surgery and endoscopic surgery are increasingly being used. The main advantage of these approaches, in comparison with traditional microneurosurgery, is the minimization of the impact on neuro-vascular structures along the surgical corridor. To provide a minimal degree of retraction injury of the brain tissue, we offered approaches through a burr hole with a diameter of 14 mm.

Materials and methods. During one and a half year (February 2016 to November 2017) 200 microsurgical interventions through a single burr hole with a diameter of 14 mm was performed by the first author for various intracranial pathologies. All operations were performed microsurgicaly under the operating microscope without endoscopic assistance. To provide the optimal view of the surgical field through the narrow operating corridor we used the Mari device for hands free reposition of the operating microscope (MARI (Tolikety Co Ltd)).

The age of the patients varied from 16 to 79 years (median – 38 years). Female to male ratio – 1.2 /1. Tumor resection was performed in 161 (80%) patients and in 24 (12%) cases, hippocampal sclerosis was revealed. In the remaining 16 cases, patients required reoperation because of the postoperative hemorrhage or epidural hematoma – 5 cases, separation of adhesions within the ventricular system or microsurgical third ventriculostomy – 10 cases. In one case, the biopsy was not informative.

Lesions were divided depending on their location as follows: third ventricle and the pineal region – 41 cases, mesial temporal lobe tumors – 8, hippocampal sclerosis – 24, other hemispheric tumors – 17, cerebellopontine angle tumors – 33, lateral ventricles – 30, thalamic and the basal nuclei – 10, brain stem and fourth ventricle – 17,

the cerebellum – 9, falcotentorial and the anterior cranial fossa – 6, others – 2.

The tumor volume varied from 0,4 ml to 260 ml (median 9,5 ml).

Various surgical approaches were used: transcortical – 83 (41%), subtemporal – 31 (15%), retrosigmoid – 36 (18%), infratentorial supracerebellar – 25 (13%), interhemispheric – 18 (9%), telovelar – 5 (3%) and eyebrow – 2 (1%). The extent of resection was assessed on the basis of CT scans – in 47 and MRI in 153 cases.

Results. In 17 cases, microsurgical tumor biopsy was anticipated and performed. In those cases where the goal was the maximum possible removal of mass lesions or amygdalohippocampectomy, extant of resection was assessed in 165 cases. Among them total or near total removal was achieved in 142 (86%) patients, subtotal 16 (10%) and partial 7 (4%) operations. Time of operation ("from skin to skin") varied from 35 to 300 minutes. Median 80 min. Time of extubation after the operation varied from 10 min up to 9 hours (median 1 hour). All patients who could ambulate before surgery, were verticalized after first or second postoperative day. Postoperative complications were observed in 16 (6%) cases: hemorrhage in – 5 cases (4 revisions), CSF leak – 4 cases and one case of aseptic meningitis. In 6 cases focal neurologic deficits were documented. The condition of patients after surgery improved in 63%, no changes was observed in 31% and worsened in 6% of cases. Mortality was observed in one case in patients after removal of the metastasis from the frontal lobe. The cause of death was a dissemination of the tumor through the organs.

Conclusion. Preliminary results of the neurosurgical operations through the burr hole for various intracranial pathologies are quite promising.

ENDOSCOPIC REMOVAL OF NONTRAUMATIC INTRACEREBRAL HEMORRHAGE

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Goal. Determination of the effectiveness of endoscopic removal of the non-traumatic hypertensive intracerebral hematomas (HIH).

Materials and methods. It were treated 245 patients with parenchymal intracerebral non-traumatic hemorrhages in our clinic from the 1st of january, 2015 to the 31st of december, 2017. 64 patients were operated with hematomas in all, and we used endoscopic technique in 36 cases (54.7%). Endoscopic removal of HIH was carried out in term of 1st to 10th day from the time of hemorrhage (the optimal – from the 3rd to 7th day). Localization of the HIH: in 19 cases – it were subcortical hemorrhages, in 17 cases – putominal.

It was performed cerebral CT-angiography to everyone, to exclude the pathological vascular formations. The level of consciousness of the patients was from 11 to 14 points (Glasgow coma scale), lateral dislocation varied from 0 mm to 8 mm. The volume of HIH was from 30 ml till 80 ml. All surgical interventions were carried out under neuronavigation control through bure-hole with a diameter of 10 mm We had to perform craniotomy after bure-hole removing of the HIH in 2 cases.

In the first case it was intraoperative bleeding due to the removal of a poorly organized clot, witch localized in the projection of the lenticulo-strial arteries. In another case, the conversion of the endoscopic operation to the craniotomy occurred when the cavernous angioma was suspected during the removal of the HIH.

Results. Postoperative CT was performed immediately after the operation for all the patients, and later - in 24 hours. We removed from 80 to 98% of the HIH volume in 64 cases.

The lethal outcome was in one case (2.7%). The cause of the patient's death was a severe concomitant pathology. In 55% cases (36 patients, endoscopic removing cases) in according to the Outcomes Glasgow Scale, the following results were obtained: 3 points – 24 patients, 4 points – 11, 5 points – 1. The best outcomes were achieved in terms of 3-7 days from the debut disease.

Conclusions. Endoscopic removal of HIH is a perspective, minimally invasive technique with low percentage of postoperative complications and mortality. This technique contributes to early and good functional recovery of patients with intracerebral hemorrhage.

RADIOSURGICAL TREATMENT OF MESIOTEMPORAL LOBE EPILEPSY

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Objective. Mesiotemporal lobe epilepsy is a form of symptomatic epilepsy related to hippocampal sclerosis with a high rate of pharmacoresistance. In most cases optimal treatment modality is open surgery. Despite high efficacy of mesiotemporal lobe resection, 4-18% patients have residual epileptic seizures worsening quality of life. Seizure-free rates after re-operation were described from 20–60%. For patients with incomplete resection stereotactic radiosurgery (SRS) is the method of choice. The aim of the study is to assess early results of treatment of mesiotemporal lobe epilepsy in cases of insufficient efficacy of ablative neurosurgery.

Methods. Six patients with hippocampal sclerosis (focal cortical dysplasia IIIa according to Blumcke classification) with verified epileptogenic zone suffering from intractable epilepsy, who underwent anterior one-third lobectomy combined with amygdalohippocampectomy, have seizures in 12 months after surgery. Three patients were Engel class IIIA, two patients – IIC and one – IIB.

Standard pre- and post-operative evaluations, including 3 Tesla MRI and video electroencephalography monitoring, were performed in all patients. Residual mesial structures were identified in all patients. After placement of stereotactical frame amygdala, anterior 2/3 of hippocampus and adjacent parahippocampal gyrus were irradiated with Gamma Knife Perfexion (Elekta AB, Stockolm) administering a 20-22 Gy margin dose at 50-55% isodose.

Results. A significant reduction of seizures frequency was observed in 6 months after SRS in 4 patients, the last 2 patients were seizure-free without discontinuation of anticonvulsants. In 2 cases there was a transient increase in partial seizures (auras). One patient showed radiation-induced temporal lobe edema without neurological deterioration; MRI spectroscopy data provides an evidence of radionecrosis – high lipid-lactate peak.

Conclusion. SRS is an effective at reducing seizures after surgery failure in mesiotemporal lobe epilepsy. Prescribed peripheral doses in the range between 20-22 Gy are safe for patients who had temporal lobe resection in the early post-SRS period. However, possible late radiation toxicity can be diminished due to existing postoperative cavity and therefore lower volume of irradiated normal tissue. Moreover, none of our patients in this study had any permanent neurological deterioration or mortality after SRS. Further investigations are needed to prove a new possibility for treatment for epilepsy resistant to both anticonvulsants and surgery.

SURGICAL MANAGEMENT AND LONG TIME FOLLOW UP IN PEDIATRIC PATIENTS WITH CRANIOPHARYNGIOMA

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Optimal treatment of craniopharyngioma in chidren with supraseller extension remains controversial. However, the report form NYU group showed favorable outcome of radial resection. We report our recent experience with radical resection and long time follow up of both 29 primary and 13 recurrent craniopharyngiomas in children.

Methods. Analysis was performed in 42 children who underwent trans-cranial operations mainly via fronto-basal interhemispheric route between 1998 and 2013. The aim of surgery was resection with curative intent except such cases with hard fibrous adhesion and massive calcified part. Intended subtotal resection was performed in young children with normal pituitary function in order to expect future physical development. The mean follow-up was 10.0 years.

Results. There were no significant differences in the neurological, endocrinological or functional outcomes between patients with primary and those with recurrent tumors. Two of the patients died during long time follow-up due to heart attack and rupture of ACA dissecting aneurysm.

Conclusions. We believe that radical resection offers the best disease control and potential cure with acceptable morbidity. Radical resection is still possible in patients with recurrent craniopharyngiomas with morbidity similar to that of primary tumors.

CAVERNOMAS IN CHILDREN

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Cavernoma was thought to be a benign vascular hamartoma caused by developmental malformations of the vascular bed, it is recognized that lesions may increase in size. In children, subacute worsening of neurological symptoms is commonly observed. Such lesions should be removed totally. In this paper, we discuss surgical strategy and present videos of deep-seated large cavernoma in children.

Cases. Seven pediatric cases will be presented. Cavernoms were located in the thalamus, thalamus to midbrain, cerebellum to medulla and basal ganglia. The most commonly presenting symptom was progressive motor weakness (6 cases) and epilepsy was observed in one. Radiological signs of acute hemorrhage were observed in 6 cases. Trans cortical approaches through a small cortical window were applied to supra-tentolial cavernomas. Staged surgery was performed in three cases. Among them, two cases showed re-bleeding during observation period.Postoperatively, there was no additional neurological deficit, and all patients showed marked improvement of neurological symptom.

Conclusion. Trans cortical approach is a valid choice for the removal of deeply seated cavernomas in children. Via this approach, tumors can be removed without significant sequelae related to the surgery. Total resection is necessary to with patients' clinical improvement in deep-seated large cavernomas.

PAIN MANAGEMENT BY RADIOFREQUENCY NEUROTOMY PROCEDURE OF THE «FACET JOINTS SYNDROME»

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Introduction. Pain is a common symptom of the degenerative disease of the spine. The facet syndrome is responsible for pain development in the majority of such

patients. The radiofrequency neurotomy (RFN) is a minimally invasive procedure to treat the pain caused by the "facet joints" syndrome. The aim of this study is to analyze the results of treatment of degenerative spondylarthrosis with minimally invasive treatment (RFN)

Materials and Methods. During the study period from January 2011 to January 2017 we performed 483 RFN of the dorsal ramus of the spinal nerves innervating the facet joints. Somatic and neurological status was assessed and CT and/or MRI, flexion and extension radiographs were performed in all patients. The procedure was performed under local anesthesia with fluoroscopy control. The port needles were used for the procedure. Before the manipulation, sensory and motor stimulation were performed in order to control the position of the electrode. In all cases, during imaging the signs of degenerative changes of the spine (osteochondrosis, spondylosis, spondylarthrosis) were revealed. The severity of pain was graded by using the visual analog scale (VAS).

Results. Two hundred eighty men (58%) and 203 women (42%) were enrolled into the study. The age was between 22 and 89 years. All patients had low physical activity in daily life, decreased performance, sleep disturbance and impaired quality of life due to pain syndrome. All patients suffered from the pain syndrome upon initial examination, and the average pre-operative median VAS was 7 (6-8) points. Four hundred thirteen patients (85,5%) underwent RNF in lumbar spine (85 patients of those – after microdiscectomy, and 11 – after nucleoplasty), 43 patients (8,9%) – in thoracic spine, and 27 (5,6%) – in cervical spine (7 of those – after anterior fusion).

All patients tolerated the procedure well. There were no complications. During the 2 post-operative days, the intensity of pain syndrome was gradually decreased in 282 cases (58,4%) of patients (post-operative VAS score was 3 (2-4) points in average). In post-operative day 10, 453 patients (93,8%) reported a significant reduction of pain syndrome, the average VAS score was 2 (1-2) points out of ten. Seventy-five (15,5%) patients noted a recurrence of pain symptom in 1 year.

Conclusion. RFN is a safe and effective method of treatment of the facet syndrome. It is minimally invasive, relatively simple, and fast method, highly effective in spondylarthrosis, in early postoperative period and follow-up. It results in a significant reduction of pain syndrome (from 7 to 2 points according to VAS). We consider this method should be spread out in clinical practice.

ESSENTIAL TECHNIQUE FOR SUCCESSFUL MICROVASCULAR ANASTOMOSIS

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Microvascular anastomosis is very basic, but quite important technique for successful surgery in patients with extra- and intracranial arterial occlusive diseases, moyamoya disease, and complex cerebral aneurysms. In this lecture, the author reviews essential technique for successful microvascular anastomosis. All patients should receive intravenous drip (500 to 1,000 mL) overnight before surgery to avoid ischemic complications during and after surgery. The dissection of the donor arteries such as superficial temporal artery (STA) is the first step of surgery, but is a very important procedure. The donor arteries should be "naked" by dissecting the surrounding connective tissue as much as possible, which would make it easier to handle the donor arteries during anastomosis. It is quite important to repair the galeal tissue after the dissection of donor arteries to keep the scalp blood flow and avoid the delayed wound healing. Thorough hemostasis is essential to perform microvascular anastomosis under the "calm and quiet" operative field. The end of donor arteries should be designed like a "fish mouth" to make anastomosis procedures easier and acquire larger bypass flow. It would be better to prepare the longer recipient for the same purpose. The blue dye is put onto the surface of cut ends of the donor and recipient to visualize them clearly. The author prefers a 8-0, 10-0, or 11-0 nylon thread for radial artery grafting, STA-MCA/ACA anastomosis, or pediatric moyamoya disease, respectively. Generally speaking, it is quite natural to leave the same margin for stitching the donor and recipient, but the margin of the recipients should be left more slim in moyamoya disease, because they have a very small caliber and a very thin wall. Before starting the anastomosis in the first side, the opposite end of the donor should be put into the lumen of recipient to avoid stitching the opposite side of recipients during the anastomosis in the first side. A "marking pin" technique is useful for perfect completion of the final stitches. ICG videoangiography is quite useful to confirm the patency of microvascular anastomosis especially in moyamoya disease.

HISTORY AND PERSPECTIVE OF BYPASS SURGERY FOR MOYAMOYA DISEASE

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Moyamoya disease is an uncommon cerebrovascular disease that is characterized by progressive occlusion of terminal portion of the internal carotid artery and its main branches within the circle of Willis. This occlusion results in the formation of a fine vascular network (moyamoya vessels) at the base of the brain. Clinical features of moyamoya disease substantially differ between children and adults. Most pediatric patients with moyamoya disease develop transient ischemic attack (TIA) or cere-

bral infarction, whereas about half of adult patients develop intracranial bleeding and another half develop TIA or cerebral infarction. It is well known that cerebral hemodynamics in moyamoya disease is markedly impaired in the territory of internal carotid artery, especially in the frontal lobe. Collateral circulations aggressively develop via the moyamoya vessels, external carotid artery, and vertebrobasilar system. Nuclear imaging techniques such as SPECT and PET are quite valuable to evaluate cerebral hemodynamics and to determine surgical strategies in moyamoya disease. Surgical revascularization is known to improve cerebral hemodynamics and significantly reduce the recurrence of TIA, ischemic and hemorrhagic stroke. Surgical procedures include direct and indirect bypass. Superficial temporal artery to middle cerebral artery (STA-MCA) anastomosis is the main procedure of direct bypass for moyamoya disease. The diameter of donor arteries ranges from 0.5 to 1.0 mm in both pediatric and adult patients. Furthermore, the wall of donor arteries is pathologically thin, which is one of the biggest reasons for challenging surgical procedure. Direct bypass is usually performed with 10 to 14 sutures, using a 10- or 11-0 nylon threads. Clamping time ranges from 20 to 35 min. Intraoperative indocyanine green (ICG) videoangiography is quite useful to confirm the patency of bypass graft during surgery. There are many reports about short-term (<5 years), but not long-term (>10 years) outcome after bypass surgery for moyamoya disease. However, recent reports have shown that a certain subgroup of patients may be at risk for subsequent stroke even after 10 years post-surgery. Therefore, the author evaluated a long-term (5-20 years) outcome after STA-MCA anastomosis and ultimate indirect bypass (encephalo-duro-myo-arterio-pericranial synangiosis; EDMAPS) for moyamoya disease (n=80). There were 30 pediatric (<18 years) and 50 adult patients. There were 22 males and 58 females. Their mean age was 30.4±19.8 years, ranging from 1 to 70 years. Clinical diagnosis included TIA or ischemic stroke in 67 patients, hemorrhagic stroke in 10, and asymptomatic in 3. STA-MCA single or double anastomosis was performed followed by ultimate indirect bypass (EDMAPS) through large front-temporal craniotomy onto 128 hemispheres of 80 patients. Donor tissues for EDMAPS included the dura mater, temporal muscle, STA, and frontal pericaranial flap and enabled to supply surgical collaterals to the entire carotid territory. All patients were prospectively followed up at outpatient clinic for a mean of 10.8±4.2 years, ranging from 5.1 to 20 years. MRI and MRA were performed once or twice per year. As the results, one of 80 patients recurred hemorrhagic stroke during follow-up perids (0.12% per patient-year). Radiological examinations demonstrated that the disease progression occurred in the carotid system of non-surgical side in one side and in the PCA in 7 sides (1.1% per side-year). In conclusion, STA-MCA anastomosis and ultimate indirect bypass (EDMAPS) is the best choice to prevent further cerebrovascular events for longer than 10 years by widely providing surgical collaterals. However, long-term regular follow-up is essential to identify disease progression especially in the PCA.

THE USE OF STEREOTACTIC RADIATION FOR INCREASING THE EFFECTIVENESS OF COMBINED TREATMENT OF CRANIOPHARYNGIOMA IN PEDIATRIC PATIENTS

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Craniopharyngiomas (CP) are relatively rare benign tumors. Localization, character of growth and tendency to recur causes difficulties in treatment, especially in childhood. The goal of this study is to compare the effectiveness and safety of surgical (GTR and incomplete) and combined treatment of craniopharyngiomas.

Material. We have analyzed 135 children primary operated in Burdenko Neurosurgery Institut in 2005-2012 and 75 irradiated patients with CP. Median follow up was 89,9 months (16,9 - 134,1). Neurologic, endocrine, visual functions, growth, weight, BMI, quality of life and neuroimaging data before and after treatment were assessed. Surgical treatment included tumor removal (total in 35%, subtotal in 25%, and partial in 25% cases), transnasal cyst evacuation – in 11%, Ommaya implantation – in 4% patients. Fractionated RT was performed in 30 (Novalis, median dose 54 Gy), hypofractionated – in 30 (CyberKnife, 5fr x 5-5,5 Gy, 3 fr x 7 Gy) and radiosurgery – in 15 patients (GammaKnife, average PD=13,5 Gy (8 - 16 Gy), average PI=49,3% (33,3 - 60%).

Results. 5-year PFS after total resection was 79%, it was significantly (log-rank test, p<0.01) higher then after non-total resection – 18%. There was no significant difference in PFS between subtotal and partial tumor resection, transnasal cyst evacuation and Ommaya implantation. 5-year PFS after partial tumor resection followed by stereotactic RT/RS was 86%. 5-year PFS after adjuvant irradiation (median in 2.8 months after incomplete removal, n=50) was 100%, while after salvage RT/RS (at relapse, median in 24.9 months after surgery, n=25) 79%. There is no significant difference between PFS after adjuvant and salvage irradiation (p=0.5).

80% children after tumor removal had panhypopituitarism and DI. Only in 1/15 cases irradiation induced new hormone deficit – adrenal insufficiency.

11,4% patients had transient cyst enlargement after RT/RS.

Vision increased after surgery in 22%, decreased in 14%, and stay the same in 64% cases. Visual impairment more frequently occurred in patients with severe vision impairment before operation (p=0.01). After RT/RS visual functions remained unchanged in 78%, improved in 16%, worsened in 6% patients. Vision didn't deteriorate after irradiation in any child with severe vision impairment.

Median SDS BMI didn't differ before and after removal of endosuprasellar CP (p=0.1). Diencephalic disturbances appeared after total removal of stalk and intraventricular CP (in 11/25 patients). Obesity didn't appear in any patient after partial removal of tumor followed by adjuvant RT (p=0.02).

Quality of life was significantly higher after combined treatment of stalk and intraventricular CP then after total removal (p=0.01).

Conclusion. Endosuprasellar craniopharyngiomas without spreading to third ventricle should be removed totally. Combined treatment (partial removal and stereotactic irradiation) provides the same PFS as total removal. Stereotactic irradiation is more safe then radical surgery of craniopharyngiomas spreading to third ventricle. Combined treatment of stalk and intraventricular craniopharyngiomas is preferred, as it provides high PFS and don't impairs quality of life.

A CASE REPORT: COMBINED TREATMENT OF THE INTERNAL CAROTID ARTERY'S SYMPTOMATIC OCCLUSION AND THE EXTERNAL CAROTID ARTERY'S STENOSIS IN A HYBRID OPERATING ROOM

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The figures for the ischemic stroke (IS) in the Russian Federation account for 350 per 100 thousand per year. In half of the reviewed cases IS resulted from atherosclerotic lesions in precerebral and large cerebral arteries. Endovascular and open surgical interventions have proved viable for hemodynamically significant stenosis of large arteries.

Aggravated cases with one-off or repeated transient ischemic attacks (TIA) leading to occlusion of the main vessel require reconstruction of the vascular bed with extra-intracranial microanastomosis. Patients filed for surgery are chosen depending on the neuroimaging data that confirm damages to brain perfusion. One of the contraindications to this modality is a major stenosis of the external carotid artery (ECA). This requires a staged approach, with the stenosis of ECA being treated before the imposition of microanastomosis is scheduled.

This article features a successful combined operation on a patient with a symptomatic occlusion of the internal carotid artery (ICA) and a major stenosis of the ECA conducted at a hybrid facility. The patient underwent an endarterectomy from the ECA and simultaneous imposition of microanastomosis, as well as an intraoperative CT perfusion study and angiography confirming the potency of the anastomosis.

Case report. A 67-year-old right-handed man suffered repeated TISs and ISs in the pool of the right middle cerebral artery. CT-angiography revealed the occlusion of the right ICA and a major stenosis of the right ECA. PET-CT revealed distorted perfusion in the field that supplying by occluded artery. Surgery was performed in a hybrid operating room by both neurosurgeons and vascular surgeons. As a result, atherosclerotic plaque was removed from the ECA alongside microanastomosis of the right superficial temporal artery with M4 segment of the right middle cerebral artery. The robotic C-arm (Artis zeego, Siemens Healthineers, Forchheim, Germany), an integrated rengenegative operating table allowed for intraoperative cerebral angiography visualizing the viability of the bypass and CT perfusion (NeuroPBV), which confirmed the improvement in blood supply to the brain. On the 5th day following the surgery, the patient was discharged without further neurological symptoms.

Results. Combined approach to treating occluded main vessels of the neck in the hybrid operating room is highly effective as it allowed for joint efforts of different specialist surgeons, as well as reduced time of operation and the patient's stay in hospital. Angiographic control and CT perfusion make it possible to assess the quality of the bypass, to confirm the improvement to brain perfusion during the surgery, which facilitates the patient's examination in the early postoperative period.

DAMAGE TO THE ICA DURING ENDOSCOPIC ENDONASAL TRANSSPHENOIDAL SURGERY

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Objectives. the internal carotid artery (ICA) injury is considered one of the most serious complications of transsphenoidal surgery.

Material and methods. Five thousand tumors were operated by an endoscopic transsphenoidal approach at Burdenko neurosurgery institute for the period from 2005 to January 2018. In 7 cases (0,14%) occurred the ICA injury.

Results. All patients with the ICA injury underwent angiography which revealed false aneurysm formation in 5 cases (71,4%) and ICA occlusion in 1 case (14,3%). We put muscle plug in 1 case because of post-op angiogram in this case was normal. A stent-graft was installed in 1 (14,3%) patient who later was discharged without any neurological symptoms. Balloon-occlusion for a false aneurysm was performed in 2 cases (28,6%): one patient died from ischemia and brain oedema caused by collateral circulation insufficiency; the second patient was discharged without neurological complications. the patient underwent staged surgery that included the creation of a high-flow extra-intracranial anastomosis, subsequent endovascular ICA occlusion at the pseudoaneurysm level using balloon-assisted coiling. One patient (14,3%) developed an instant postoperative ICA occlusion died from ischemia and brain oedema.

Conclusion. Damage to the ICA during transsphenoidal operations is a rare but potentially fatal complication. Thorough preoperative examinations (MRI and CT of the brain), use of different methods of intraoperative neuroimaging (navigation systems, intraoperative Doppler) will reduce the risk of this complication.

LATERAL EXTENDED TRANSSPHENOIDAL ENDOSCOPIC APPROACH. ANATOMIC STUDY

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Objective. Today extended transsphenoidal endoscopic approaches are widely used in neurosurgery for removal tumors of the parasellar region. We performed an anatomic study of the lateral extended transsphenoidal endoscopic approach.

Material and methods. We studied anatomy of the lateral extended transsphenoidal endoscopic approach in five adult cadaveric heads in which the arteries and veins were injected with latex. Endoscopic transethmoidal transsphenoidal approach and lateral extended transsphenoidal endoscopic approach through pterygopalatine fossa were also performed.

Results and discussion. Lateral extended transsphenoidal endoscopic approach is minimally invasive and can be used to remove tumors located in the paramedian plane. Endoscopic endonasal transethmoidal transsphenoidal approach is a kind of lateral expanded approach, after which the ICA is located at the center of the operating field, and allows to work laterally to the ICA more safely. The lateral extended transsphenoidal endoscopic approach through the pterygoid fossa allows to access to the CS and the Meckel's cave, the medial part of the middle cranial fossa.

Conclusion. The lateral extended transsphenoidal endoscopic approach allows to resect tumors from the most lateral and anterior cavernous sinus parts, and also makes it possible to remove the tumors are located in the Meckel's cave, the infratemporal fossa, the medio-basal part of the middle cranial fossa.

TRANSSPHENOIDAL ENDOSCOPIC SURGERY OF TRIGEMINAL SCHWANNOMAS

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Objectives. Trigeminal schwannomas account for 0,8-8% of all intracranial schwannomas. Dumbbell-shaped tumors are a big challenge to remove. We've investigated efficacy of a lateral extended transsphenoidal endoscopic approach (LETEA) to remove trigeminal schwannomas.

Methods. Eight patients with trigeminal schwannomas were operated on using the lateral extended transsphenoidal endoscopic approach (LETEA) in the N.N. Burdenko neurosurgical institute for the period 2011-2014: there were dumbbell-shaped tumors in 5 cases, tumors were located in the middle fossa in 4 cases.

Results. In 4 cases (50,0%) a tumor was removed via LETEA. In 4 cases (50,0%) we performed a two-stage surgery (a combination with LETEA and retrosigmoid app.). At first, the tumor was removed using the posterior cranial fossa via the retrosigmoid approach, if there were cerebellar ataxia and occlusion symptoms.

In 1 case (12,5%) we tried to perform LETEA and it caused an ICA injury in the cavernous sinus. Then we performed an endovascular imbolisation. There were no vascular complications. Total or near total removal occurred in 7 cases (87,5%). Postoperative complications included transient deterioration of V and VI cranial nerves occurred in 5 cases (62,5%). There wasn't CSF leak. There was 1 death (12,5%) because of bacterial meningitis.

Conclusions. The lateral extended transsphenoidal endoscopic approach should be considered as good access to the parasellar region. The principal problem of this approach is a high risk of an ICA injury, which can be reduced using different methods of intraoperative neuroimaging (navigation systems, intraoperative Doppler).

KEY HOLE APPROACH FOR NON-RUPTURED ACOM AN

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The surgery for non-ruptured aneurysms needs less invasive techniques for the purpose of early come back to normal life of patients. We perform over 100 unruptured aneurysm surgeries in a year. We often use key hole techniques for Acom aneurysms.

We select approach from shape of Acom complex and aneurysm direction. For anterior and inferior dome projection type we use the supra orbital approach. In case Acom complex located high position or upper and posterior dome projection we use key hole unilateral interhemispheric approach. We introduce these two approaches with operative videos and examine about the operative techniques for key hole Acom aneurysm surgery.

For the key hole aneurysm surgery, microsurgical techniques to make enough operative fields around the aneurysm from small entrance are very important. Operative instruments are also important. We often use thin

blade slightly curved micro scissors and small head angled clip applier, especially upper 10 degree type. In case of interhemispheric approach we use navigation system to locate craniotomy for good access entrance and preserving bridging vein.

Good operative results and high satisfaction of the patient were obtained by this operation method. The early come back to normal life is required with increasing patients from the brain checking center. We considered our less invasive operative method for unruptured aneurysms was very useful in such cases.

SUPRAORBITAL KEYHOLE APPROACH IN ANTERIOR CRANIAL FOSSA MENINGIOMAS

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Background. The priority in modern neurosurgery is the principle of minimal invasiveness. This principle urges search for more effective ways of removing brain tumors with minimal surgical trauma. Transciliary supraorbital approach is a modification of the traditional subfrontal approach and is characterized by smaller skin incision and craniotomy. The key difference of this modification is the need to use special surgical and optical instruments, as well as manual skills.

Purpose. To evaluate possibilities of transciliary supraorbital approach for anterior cranial fossa meningiomas.

Material and Methods. During 2010-2016 years 48 patients were operated on in our neurosurgical clinic (13 men, 35 women, 35-68 years old, mean age 47 years) with meningiomas of the anterior cranial fossa (15 olfactory meningiomas, 24 planum sphenoidale meningiomas, 9 meningiomas of the tuberculum sellae). The tumor diameter varied from 15 to 40 mm. The tumor diameter is divided into small (<2.5 cm), medium (2.5-4.5 cm) and large (>4.5 cm). Tumors were removed by transciliary approach both microsurgically and with endoscopic assistance.

Results. Gross total resection was achieved in 46 (95.8%) patients, subtotal in 2 (4.2%). Out of 13 patients with visual impairment, 9 patients improved, one remained stable, and three deteriorated. Three patients had tumor recurrence, CSF leak in one, 2 patients had palsy of frontal branch of the facial nerve. Cosmetic result in all patients was satisfactory.

Conclusion. Transciliary supraorbital approach is a modern minimally invasive modification of subfrontal approach, which allows to remove anterior cranial fossa meningiomas up to a large size radically and with good functional results. Endoscopic assisting gives an additional visualization with more radical tumor removal and more effective hemostasis.

MICROVASCULAR DECOMPRESSION VIA KEYHOLE RETROSIGMOID APPROACH IN TRIGEMINAL NEURALGIA

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Introduction. Microvascular decompression (MVD) is a standard procedure for the treatment of trigeminal neuralgia (TN). It was established and divided by P.J.Jannetta. Different surgical variation of MVD were described in literature.

Objective. To evaluate the efficacy of keyhole retrosigmoid approach for focused microvascular microsurgery.

Material. Between 1998 and 2017, 484 operations of MVD were performed in City Hospital #2, Saint Petersburg. MRI for detection of offending vessels was performed in all patients. We discriminated rostral and caudal zones of trigeminal nerve compression.

For rostral compression keyhole infratentorial lateral suboccipital variation of approach was done and for caudal compression – keyhole supralateral suboccipital variation of approach. BNI scale was utilized for pain assessment before and after surgery. Intraoperative data, questionnaires and self-assessment questionnaires were analyzed.

Results. Keyhole microscopic variation of retrosigmoid approach was used in 208 cases (43% form all MVD patients), only in patients with exactly identified zone of compression by MRI. Rostral compression was found in 156 cases (75%), caudal compression in 52 patients (25%). Complete and partial symptoms relief (BNI I-III) was obtained in 195 (93%) cases. There was no CSF leakage in our group. There was no serious complication such as deaths or infarction in the cerebellum or the brainstem in our series.

Conclusion. MVD via keyhole variation of retrosigmoid approach is a feasible option for differential use with prominent advances (less operation time, less surgical trauma, no brain traction, no dissection of non involved cranial nerves).

DIFFERENT MICROSURGICAL NON-FUSION TECHNIQUES FOR CERVICAL RADICULOPATHY

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Introduction. Cervical radiculopathy is typically caused by unilateral disc herniation or uncovertebral osteophytes that compress the ventral aspect of the nerve. Direct removal of a cervical lesion causing radicular symp-

toms without concomitant fusion seems to be an ideal treatment in selected patients.

Objective. To evaluate the efficacy of anterior cervical foraminotomy without fusion for cervical radiculopathy.

Material. The clinical study included 358 patients undergoing anterior cervical foraminotomy without fusion in City Hospital #2, Saint Petersburg between 1998 and 2017 (247 men (69%) and 111 women (31%); mean age 49.09±1.03 (24-75) years). All presenting with unilateral radicular symptoms (radicular pain 358 (100%), sensory loss 207 (59%), motor weakness 169 (47%)), which were associated with various degrees of neck pain (235 (66%)). Disc herniations and/or uncovertebral osteophytes were confirmed on magnetic resonance imaging and high-resolution computerized tomography scanning. We examined clinical data, pre- and postoperative neurological status.

Results. All patients in the immediate post-operative period showed relief of their pain, and there were no major complications. There was a significant improvement in NDI and VAS scores for arm and neck pain postoperatively. According to Odom's criteria excellent result was in 288 cases (80.5%), good in 67 cases (67%) and fair in 3 cases (0.8%). 3 patients (0.8%) complained about the Horners syndrome and 2 (0.6%) hoarseness in the immediate postoperative period which resolved within 6 months. The long-term results were favourable and there were no cases of reoperation and major complications.

Conclusion. Various surgical procedures have been used for the surgical treatment of cervical radiculopathy secondary to degenerative changes of the cervical spine. Among these procedures, anterior cervical foraminotomy without fusion allows for direct access to the pathology and is less invasive. It was associated with excellent clinical outcome and a less painful postoperative course, allowing patients an almost immediate return to unrestricted full activity.

RESULTS OF MINIMALLY INVASIVE ASPIRATION FOR TREATMENT OF SPONTANEOUS PUTAMINAL HEMORRHAGE

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Objective. Assessment of clinical effectiveness using of minimally invasive aspiration for spontaneous intracerebral hematomas of putamenal localization.

Materials and methods. A retrospective analysis of 49 cases for surgical aspiration intracerebral hematomas of putamenal localization. The age of the patients was 35-77 years (mean 55). Male – 32, female – 17. Before surgery the GCS was from 9 to 15 points (mean – 13), paresis grade from 0 to 2, observed aphasia was in 27 patients. Volume hematoma – from 25 to 110 cm^3 (mean 47), midline shift of the brain – from 0 to 12 mm (mean 7.2). The intervention was performed in the first 3 days after cerebrovascular accident – 35 patients, 4-7 days – 9, for 8-14 days – 4, one operation is performed on a patient 16 days after hemorrhage. The 3D CT reconstruction and a neuronavigation system performed using for calculation of the puncture trajectory. Aspiration of the hematoma was during the operation and left before the removal of the catheter in the cavity of the ICH. Immediately after the operation was performed CT control and every day until the drainage was removed from the ICH cavity. The dynamics of intracranial pressure (ICP) evaluated on the background of aspiration of ICH, a parenchymal ICP sensor were implanted to 8 patients.

Results and discussion. Intraoperatively was possible to aspirated 35 to 95% of ICH volume (mean 50.32%), with the best results observed in the subacute and chronic phases and the two drainages in the ICH cavity. The midline shift of the brain decrease in the CT scan after surgery mean was 42.65%. The aspirations conducted in the postoperative period and depended on CT dynamics. During the aspiration of the ICH, we tried to achieve a reduction in the volume of ICH by more than 50%. In our study, the mean volume at the end of the aspiration sessions was 66, 45%, which required the presence of a catheter in the ICH cavity from 1 to 7 days (mean 3).

The ICP indicators before surgery averaged 25 mm Hg. When removed 5 ml volume of ICP decreased to 15-16 mm Hg. and next to a 3-7 mm Hg. (mean 5 mm Hg).

By the end of hospitalization, a decrease in paresis grade was noted in 16 patients, partial regression of aphasia in 3 patients. Rebleeding putamenal hematoma was noted in 5 cases, 2 of which required an open removal of ICH. Mortality was 32.6%. In one case, the cause of death was a rebleeding ICH, which led to a progressive edema and shift of the brain. The extracerebral complications was the causes in all other cases of death.

Thus, the minimally invasive removal of ICH by aspiration allowed to achieve a reduction of volume hematoma even in the acute phase of hemorrhage by more than 50%. The partial lysis of ICH explained the best results of aspiration in the subacute phase hemorrhage. The method minimally invasive aspiration also allows to reduce the level of ICP, which is one of the pathological components of the pathogenesis of intracerebral hemorrhage. Improvement in the functional outcome was in 18 patients.

Conclusions. The use of minimally invasive aspiration of ICH is one of the effective methods of treatment of patients with putamenal intracerebral hemorrhage.

INTRADISCAL INJECTION OF CHONDROPROTECTOR IN TREATMENT OF DORSOPATHY

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Purpose of the study. To improve the results of treatment of dorsopathy with the application of the developed method of puncture for diagnosis and treatment of intradiscal hypertension.

Materials and Methods. Since 2014 we have observed 159 patients with osteochondrosis of the lumbar spine complicated by radicular and discogenic pain syndrome. In MRI studies patients with protrusions or hernias with subglottic fragments, have been identified. These patients were suitable for minimally invasive surgical treatment without open discectomy. All patients were treated with percutaneous nucleoplasty under the control of internal disc pressure (patent No. 2527909 "Method for measuring of intradiscal pressure in spine diseases and injuries" from 14.07.2014) followed by alflutope (patent No. 2576447 "Method of treatment of intradiscal hypertension in degenerative-dystrophic changes of the spine" from 05.02.2016), as well as 10 patients with intradiscal injection of aflutope with hydrodiscectomy.

We used three-phase structure consisting of collagen fibers, aggregates of proteoglycans and water for modelling of the pulpy nucleus of the intervertebral disc. We suggest this structure is organized as follows: collagen fibers and aggregates of proteoglycans form an elastic porous medium in which water can be stored and transported. Such a medium is characterized by porosity and permeability.

The change in proteoglycan aggregates leads to a decrease in the elasticity of the pulpy nucleus of the intravertebral disc and is accompanied by a transition of water from the bound to the free state. Increasing the amount of free water in intravertebral disc is the cause of intradiscal hypertension, which is an indicator and one of the causes of pain in dorsopathy.

To stabilize degenerative and dystrophic processes we used the chondroprotective drug alflutope.

The injection of alflutop directly into the focus of the dystrophically altered intravertebral disc increases the effectiveness and reliability of its action, prolongs the full-fledged production of proteoglycans.

The parameters used to evaluate the severity of degenerative processes in the disc: height of the intravertebral disc; discometry data (measurement of intradiscal pressure 1 in the fibrous ring, intradiscal pressure 2 in the center of the nucleus pulposus before disc decompression; and in the fibroid ring (intradiscal pressure 3) after decompression of the disc in order to detect the difference in pressure change); assessment of the pain syndrome with VAS scale; Lasegue Test, MRI data: hernias, protrusions, endplates and vertebral bodies (sclerosis, Modic I, Modic II).

Results. Three groups of patients were identified depending on discometry, porosity, permeability. The models for a specific disc of the existing three-phase model were created: collagen, proteoglycans and water.

The first group of patients were those with intradiscal pressure values of 50 cm H_2O. The condition of the disc was estimated as "elastic", the beginning of the droplet formation was observed at 40 cm H_2O, the removed part of the disc had a fibrous structure, dense and elastic. After the operation intradiscal pressure was 20 cm o H_2O. This type of disc retained the ability to restore proteoglycans.

The second group of patients were those with an intradiscal pressure of 35 cm H_2O. This disc is described as "loose", the beginning of droplet formation was observed at 15-20 cm H_2O. The removed part of the disk looked "mucous" and contained a lot of liquid. After the operation the value was 15 cm H_2O. The ability for recovering was significantly reduced.

The third group of patients consisted of patients with intradiscal pressure of 20-25 cm H_2O. The condition of the disk was described as "empty", the removed part of the disk looked "watery". After the operation was the intradiscal pressure was 5-10 cm H_2O, the beginning of droplet formation was observed at 5-10 cm H_2O.

For all the patients of three groups, the pain syndrome was controlled on the operating table. Intradiscal injection of alflutope in the end of hydrodiscectomy prevented the development of postoperative discogenic hypertension syndrome.

In the early postoperative period, the patient underwent 5 paravertebral blockades with alflutop with 2 days intervals. One-year catamnesis: good results were achieved in 92% of patients, satisfactory results in 8%.

Conclusions. Intradiscal injection of alflutope is safe and does not cause complications.

The application of the three-phase model can be used both for models of natural degeneration, and for diagnosis and treatment of chronic pain syndrome in dorsopathy and predicting treatment outcomes.

The administration of alflutop in patients after hydrodiscectomy prevented the development of postoperative intradiscal hypertension.

The developed minimally invasive method of treatment of intradiscal hypertension can be performed at all degrees of disc changes. This allows prognosticating in patients in the postoperative course. Additional intradiscal injection of alflutop is pathogenetically justified because of its stimulating effect on regenerative processes in any type of intervertebral discs and restoration of

chondrocyte homeostasis in the cartilage, the formation of full matrix aggregates, the restoration of the hydration of the pulpy nucleus.

EXTENDED TRANSNASAL ENDOSCOPIC APPROACHES IN SURGERY OF CHIASMO-SELLAR AND TUBERCULUM SELLAR TUMORS

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Objectives. To assess efficiency and results after tumor removal through extended transnasal approaches.

Material and methods. In department of neurooncology of Federal Centre of Neurosurgery 352 patients with pituitary adenomas were operated using endoscopic transnasal approach (98% of the total number of operated patients with this pathology). All patients underwent brain MRI 1,5 T – 3 T, CT Somatom Emotion 16, hormonal work-up on automatic immunoassay analyzer Immulite 1000.

Average age is 46.5±12.5 y.o. Sex differentiation: Female – 64%, Male – 36%.

There were 630 pituitary adenomas, 22 craniopharyngiomas, 14 meningiomas, 12 chordomas, 4 other tumors. Correlation b/w primary tumors and tumors with continued growth is 535:147. After intraoperative CT with IV contrast in 35 cases we had to continue excision of residual part, which was not visualized during the surgery. Radical tumor excision was confirmed by intraoperative CT and planned MRI (post/perioperative and in catamnesis in 3,6,12 months).

Extended transnasal approaches with removal of nasal concha, tuberculum sellae, cribriform plate, formation of bone window into cavernous sinus were performed in 75 cases. Among them 22 extended to floor of anterior cranial fossa, 34 intruded into cavernous sinus or clivus on 1 or 2 sides and/or extended into 3rd ventricle.

Results. Total removal – 55%, subtotal – 42%, biopsy and partial removal – 3%. Intraoperative mortality – 0. Perioperative mortality – 0,82% (in 2015-2017 – 0%). We managed to verify and preserve visually intact residual pituitary tissue in 31% of cases.

Postoperative liquorrhea appeared in 38 of cases (5,6%); spontaneous healing in 32 cases; in 6 cases patients needed surgical repair of CSF pathway; 12 patients suffered from meningitis and patients had neuroendocrine deficits.

Conclusion. Extended endoscopic transnasal approaches provide surgeons with sufficient surgical window to perform more radical and relatively safe surgical intervention.

METHOD OF ENDOSCOPIC ASPIRATION OF INTRACEREBRAL HEMATOMAS

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The open removal of subcortical and cerebellar hematomas is accompanied by a minor brain trauma. When removing deep hypertensive hematomas, minimizing brain trauma during surgery is the main aim, the solution of this problem will allow improve outcomes in the surgical treatment of hemorrhagic stroke. Intracerebral putamenal hematomas are observed about 55% of all hemorrhagic stroke incidence, and accompanied by lethal outcomes and deep disability. The surgical strategy selection concerning hypertensive hematomas remains controversial and unclear till nowadays.

One of the priority scientific development is minimally invasive methods surgery of hemorrhagic stroke. In the neurosurgery department of the Sklifosovsky Scientific Research Institute method of endoscopy is used for the evacuation of hypertensive hematomas has been used since 2004. Over the past time, three methods of aspiration of intracerebral hematomas have been worked out – through the trocar, through the trocar with the use of a silicone microcatheter and through a transparent port.

Objective. To develop optimal method of hematoma endoscopic aspiration for surgical treatment of hemorrhagic stroke.

In the department of neurosurgery, the Sklifosovsky Scientific Research Institute from 01.01.2005. to 31.12.2017. 336 patients with hemorrhagic stroke were surgically treated. The study included 98 patients. The main group consisted of 68 patients (63 with putamenal and 5 with cerebellar haematoma), operated by endoscopic aspiration, control group – 30 patients operated openly. The control group is formed by the method of simple randomization according to the main criterion of selection for operative intervention – the level of wakefulness. There was not significant difference between two analyzed groups for such parameters as sex, age, wakefulness before the operation, the volume and localization of the hematoma, the presence of ventricular hemorrhage, the displacement of the median structures, the concomitant pathology ($p<0.05$).

Fifty-eight patients were operated through a trocar for ventriculoscope. Diameter of this trocar is 6.5 mm, under control of frameless navigation. Five patients were operated through a similar trocar under navigation control, but a silicone catheter was used for aspiration. Five patients were operated with transparent ports of different diameter in the air under the control of the endoscope.

Results. The following results were achieved in the study group: successful – in 2 (3%), moderate disability – in 16 (25%) cases, severe disability – in 35 (55,5%), vegetative state – in 4 (6,5%). Postoperative mortality – 6 (11% patient died). Patients in the control group had the following outcomes: successful

– in 1 (4%), moderate disability – in 4 (17%) cases, severe disability – in 7 (23%). The mortality rate was at 60% (18 patients).

Intraventricular haemorrhage was one of the main risk factors affecting the outcome of treatment in both groups. In the main group, when blood was into the ventricular system, 4 times more cases were observed when the patient switched to a vegetative state. Mortality in the main group was 1.5 times higher in patients with intraventricular haemorrhage. In the control group, mortality was 20% higher in patients with intraventricular hemorrhage, and favorable outcomes were 20% less than in patients without intraventricular hemorrhage.

Recurrence of hemorrhages in the main group was observed in 9 (14.2%) patients. All patients were operated again by the same method on the first day after second hemorrhage. Postoperative mortality with recurrent hemorrhage was 56%. The number of patients who switched to a vegetative state after second hemorrhage was 16.5 times greater. In the control group second hemorrhage was observed in 5 patients (16.6%). All patients were operated again on the first day also by an open method, but nobody survived. Repeated endoscopic operations for recurrence hemorrhage were accompanied by half mortality rate in comparison with repeated open operations.

Radical removal of the hematoma by the method of endoscopic aspiration averaged 70% [35-90%], in the control group – 75%.

All patients of the main group without wakefulness before operation survived. In the control group, two patients without wakefulness before operation died.

Conclusions. The method of endoscopic aspiration allows effectively removing hypertensive hemorrhages irrespective of the time of hemorrhage and volume. The radicality of the removal of hematoma by the method of endoscopic aspiration does not concede open method, but is accompanied by a less intraoperative brain injury.

In patients with hemorrhagic stroke hematomas, operated by the method of endoscopic aspiration, postoperative lethality is six times less. Repeated endoscopic operations for recurrence of hemorrhage were accompanied by half the mortality rate in comparison with second open operations.

AVMS AND EPILEPTIC SEIZURES IN CHILDREN: THE RISK FACTORS FOR EPILEPTIC SEIZURE DEVELOPMENT AND EFFICIENCY OF THEIR CONTROL DEPENDING ON THE METHOD OF TREATMENT

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Background. The epileptic seizures are one of the most frequent clinical presentations of the cerebral AVMs in children. The insufficient control on seizures can significantly affect the quality of life in children with the brain AVMs. The factors, associated with epileptic seizures in children with AVMs and affecting their control after treatment are poorly understood and often are underappreciated in treatment planning.

Subjective. To study the risk factors for epileptic seizure development before treatment and the risk factors for seizure free outcome after treatment with various methods.

Material and methods. The study included 89 children aged from 1 to 17 years at the time of manifestation of the brain AVM, who were admitted to the department of pediatric neurosurgery of A.L. Polenov RNRI over the period of 1998-2015.

Results. The factors contributing in epileptic seizure development in children with the brain AVMs are male sex, large size of AVM, superficial topography and localization of the AVM in the frontal and temporal lobes, varicose dilatation of the draining veins. The seizure free outcome was more frequently observed in microsurgical resection and combined treatment (MS+EVE) of AVMs, as well as in small AVMs and their complete resection, in rare seizures and short-time history of the disease before treatment.

Conclusion. The combined treatment of children with the brain AVMs provides effective control of epileptic seizures. After MS and combined MS+EVE treatment the seizure free outcome was achieved much more often and earlier, than in EVE alone, which is first of all connected with the more total resection of the AVM and epileptic focus, that often located nearby the AVM. Thorough preoperative examination of the patients and analysis of the acquired data helping to predict the natural history of the disease, to plan the combined treatment taking into account the individual characteristics of the patients and AVMs. This approach let us achieve maximally good results of the treatment including the effective controlling of seizures.

ENDOSCOPIC ENDONASAL APPROACH FOR COMPLICATED SKULL BASE TUMORS

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Purpose. As the recent advancement of endoscopic surgical technique, some kind of complicated skull base tumors start to be successfully resected via endoscopic endonasal approach(EEA). But surgical radicality of EEA to skull base tumors remains unclear for less surgical experience of EEA compared with that of transcranial approach(TCA).

In this paper, we will present our surgical results of EEA to complicated skull base tumors and would like to consider appropriate indication of EEA to these tumors.

Materials and methods. Since January 2013, 61 complicated skull tumors except pituitary adenomas were resected via EEA in our institute. 61 tumors were composed of 26 craniopharyngiomas, 13 chordomas, 10 chondrosarcomas, 6 clival meningiomas, 1 trigeminal schwannoma, 1 vidian nerve schwannoma, 1 hypoglossal schwannoma and 1 cholesterin granuloma. Through our experience of skull base tumors via transcranial and endonasal approach, we made a hypothesis that skull base tumors located within the skull base circle which connects all cranial neural foramens from optic canal, then to superior orbital fissure, to foramen rotundum, to foramen ovale, finally reaching to hypoglossal canal can be safely excised via EEA. Our surgical selection of EEA or TCA was decided on this hypothesis.

Results. In the 26 cases with craniopharynigoma, total resection was achieved in 25 cases. Tumors in the third ventricle and posterior fossa were safely removed with upper clivectomy and posterior clinoidectomy in addition to drilling of the tuberculum sellae. All chordomas and condrosarcomas involving clivus, petrous bone and cavernous sinus were gloss totally removed even they had intradural invasion. Wide exposure of the petrous internal carotid artery and extended bony drilling of pterygoid process and anterior part of petrous bone allowed us to meticulously remove the tumors like microscopic maneuvers. In 5 cases of clival meninigomas, wide clivectomy was effective for early dural detachment of the tumor. Other tumors occupying pterygopalatine fossa, petrous bone and hypoglossal canal also could be totally removed via endonasal route.

CSF leakage appeared in initial 3 cases but neurological function did not deteriorate in all cases.

Conclusions. Skull base tumors within the presented skull base circle can be safely and radically removed via EEA.

NEUROSURGICAL TREATMENT OF DYSTONIA. EXPERIENCE OF THE CENTER OF NEUROSURGERY

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Dystonia is a movement disorder which is specified by involuntary sustained or intermittent muscular contractions, causing abnormal movements and/or postures. Indications for neurosurgical treatment in dystonia include inefficacy of pharmacological treatment, marked impairment of daily living activities and self-service due to dystonic movements. The main goal of the surgery in dystonia is a prevention of permanent disability and improving in quality of life of patients.

Objective. To analyze the experience and long term outcome of neurosurgical treatment of dystonia patients in Burdenko Neurosurgical Institute.

Patients and methods. In the period from 2003 till 2017, 194 patients with different dystonia types underwent surgery. The majority were patients with isolated (formerly primary) dystonia: 73 had generalized dystonia; 37 segmental dystonia, 41 focal/cervical dystonia. Among the other patients, 7 had myoclonic or tremulous dystonia, 4 tardive dystonia, 2 basal ganglia calcification, 17 dyskinetic cerebral palsy (CP), 8 neurodegenerative dystonia, and 5 had other acquired dystonia (posttraumatic, poststroke). Age at surgery ranged from 7 to 67 years. Disease duration ranged from 2 to 57 years. Dystonia severity and disability were measured with Burke-Fahn-Marsden rating scale. For cervical dystonia, TWSTRS and Tsui scale were used. Functional and motor outcome were assessed according to Global outcome scale (GOS). Minimal follow-up was one year; the longest follow-up was 14 years. Complications rate and postoperative clinical course were assessed.

Results. Deep brain stimulation (DBS) was performed in 185 patients. The majority of patients with isolated/primary dystonia received DBS of globus pallidus internus (GPi, 144 patients). 11 of these patients experienced previously stereotactic lesioning procedures. Following DBS GPi, amelioration of dystonia was gradual over the time. In patients with isolated generalized and segmental dystonia, the main motor improvement was achieved during the first year of DBS GPi. Clonic dystonic movements ameliorated faster than tonic ones. According to BFMDRS, dystonia symptoms decreased by 49% to the 6-month follow-up, and by 60% to the 12-month follow-up. Afterwards, dystonia symptoms remained stable with the overall motor improvement 64% at the last follow-up. For optimizing the clinical outcome, 4 patients required implantation of the second neurostimulator in GPi. In patients with isolated cervical dystonia, motor improvement at the last follow-up was 56%, according to TWSTRS, and 61%, according to Tsui scale. Better results were observed in patients with anterocollis and retrocollis, less prominent – in patients with laterocollis (65% versus 45% improvement in Tsui scale, respectively). Up to 90% of patients with isolated dystonia had stable excellent or good motor and functional outcome in long-term follow-up (GOS). Negative predictive factors for DBS GPi efficacy in isolated dystonia appeared to be longer disease duration, earlier age of onset, and severity of motor impairment. Regarding intraoperative complications, in one patient symptomatic intracranial hemorrhage occurred. The most frequent side effect of DBS GPi was dysarthria.

Besides GPi, STN or combined targets were used for DBS in single patients with isolated generalized dystonia resulting in good functional outcome.

For non-primary dystonia, the highest efficacy of DBS GPi was achieved in patients with tardive (neuro-

leptic-induced) dystonia. In dystonia associated with basal ganglia calcification, initial response to DBS GPi was good, however, deteriorated over the time course. In the other neurodegenerative and acquired dystonia associated with structural brain lesions (including cerebral palsy), functional outcome of DBS GPi was poor with minimal motor improvement.

In patients with predominant dystonic tremor or myoclonus and distal limb dystonia, DBS of ventral lateral thalamic nuclei was performed. Five patients with unilateral limb dystonia underwent unilateral Vop-thalamotomy.

5 patients with tonic cervical dystonia underwent selective peripheral denervation of cervical muscles - alone (in 3 patients) or after DBS GPi (in 2 patients).

For patients with dyskinetic cerebral palsy, intrathecal baclofen pump therapy or selective combined (dorsal and ventral) rhizotomy were also used, either alone or in combination with stereotactic procedures (DBS or lesioning) and peripheral neurotomy.

Conclusions. DBS GPi has the largest evidence of efficacy and relatively safety in treatment of pharmacoresistant dystonia. Selection of the other surgical targets and procedures is possible on the individual basis. Thalamic targets may be considered in tremulous dystonia or limb dystonia. Stereotactic lesioning has limited application and needs to be performed unilaterally to avoid neurological complications. Clinical outcome in non-primary dystonia ranges individually. In cerebral palsy, often staged surgical procedures are beneficial. Evaluation of surgical candidates should be carried on by experienced multidisciplinary team. For the optimal outcome personalized well-timed approach is crucial.

CROSS-POLARIZATION OPTICAL COHERENCE TOMOGRAPHY AS A PROMISING IMAGING TOOL FOR GLIOMA SURGERY

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Optical coherence tomography (OCT) is a promising method of glial tumors borders diagnostics. Nowadays it is possible to use hand-held and microscope mounted OCT devices during tumor removal. But still there are no clearly qualitative (visual) and quantitative assessment criteria of OCT images for good differentiation between glioma and white matter. This work presents such criteria for cross-polarization OCT (CP OCT), which can detect both the scattering and polarization properties of tissues.

The study was aimed to evaluate qualitative (visual) and quantitative assessment criteria of microstructural ex vivo CP OCT images for differentiation glioma and white matter

Materials and Methods. The study was performed on ex vivo specimens of 30 patients with gliomas with different degrees of malignancy: Grade I-II (n=8), Grade III (n=7), Grade IV (n=15). Using the CP OCT device developed the Institute of Applied Physics of the Russian Academy of Sciences (Nizhny Novgorod, Russia) 176 samples of different tissue types were studied. In CP OCT device polarized light is used as probing radiation, therefore, in addition to a standard structural OCT image (co-polarization image), the second image complementary to the first one was created in the orthogonal polarization (cross-polarization image). The CP OCT images were compared with histological data seen in sections coincident with the planes of the OCT scans.

The typical characteristics of images parameters of white matter and tumor CP OCT images of were dedicated. The 100 CP OCT images were selected to measure association degree between each parameter of CP OCT image and the histological data using qualitative (visual) "blinded" evaluation by three investigators, whereby the cropped and damaged images and the images according to samples with large necrotic or hematoma areas were excluded. For evaluation of association ratio the coefficients Q (Yule) and ϕ(phi) were used, with statistically significant value for $Q \geq 0,5$ and for $\phi > 0,3$. The inter-rater reliability rate between investigators was counted by Fleiss' kappa (κ) and Krippendorff's alpha (α) coefficients: $\kappa\ (\alpha) \geq 0,8$ - perfect agreement; $0,7 \leq \kappa\ (\alpha) < 0,8$ - substantial agreement; $\kappa\ (\alpha) < 0,7$ – poor agreement. Due to ascertained visual CP OCT criteria the diagnostic test for differentiation white matter and tumor were performed by three neurosurgeons and diagnostic test parameters (sensitivity, specificity, accuracy) were calculated.

The quantitative assessment based on the calculation of the attenuation coefficient (μ) from 3D CP OCT images using Anaconda 4.3.1 (Python v. 3.6) software. The attenuation coefficients were calculated for 4 groups (95 3D CP OCT images) of tissues: white matter (n=22), astrocytoma Grade I–II (n=13) and Grade III (n=15), glioblastoma Grade IV (n=46). ROC-analysis was performed to evaluate cutoff thresholds for attenuation coefficient for differentiation between white matter and tumor and according to its value diagnostic test parameters (sensitivity, specificity, accuracy) were calculated.

Results. The visual analysis of CP OCT images of samples with typical histological structure of white matter and gliomas allowed to separate the typical signal signs of tumorous and non-timorous tissue using four parameters for both co- and cross-polarization with two response options: (1) the signal intensity ("intense"/"non intense"); (2) the homogeneity of intensity ("homogeneous"/"heterogeneous"); (3) attenuation rate ("high"/"low"); (4) the evenness of attenuation

("even"/"uneven"). Between all investigators the values of coefficients Q and ϕ were high for parameter "signal intensity" in both polarizations (Q_{co}=0,91-0,92; ϕ_{co}=0,64-0,65; Q_{cross}=0,92-0,94; ϕ_{cross}=0,64-0,7) and also statistically significant for parameters "the homogeneity of intensity" (Q_{co}=0,86-0,94; ϕ_{co}=0,47-0,5) and "the evenness of attenuation" (Q_{co}=0,58-0,82; ϕ_{co}=0,3-0,44) in co-polarization. The inter-rater reliability rate between investigators was perfect for parameter "signal intensity" in both polarizations (κ=0,9; α=0,9) and substantial for "the homogeneity of intensity" (κ=0,79; α=0,79) and "the evenness of attenuation" (κ=0,75; α=0,75) in co-polarization. Therefore most powerful criteria of visual assessment of microstructural CP OCT images for differention between glial tumor tissue and white matter is signal intensity in both polarization. Due to ascertained visual CP OCT criteria the diagnostic test parameters were following: sensitivity 82-85%, specificity 92-94%, accuracy 87-88%. The inter-rater reliability rate between participating neurosurgeons was great (κ=0,92; α=0,91).

The quantitative assessment of CP OCT data showed statistically significant differences between white matter (μ=10,0) and astrocytomas Grade I-II (μ=5,3; p=0,00001), Grade III (μ=4,8, p=0,000004), Grade IV (μ=7,8, p=0,000001). The cutoff thresholds for attenuation coefficient were chosen subject to high test specificity (more than 90%) and equaled 7,5 and 9,5 for gliomas Grade I-III and glioblastoma respectively. Based on quantitative assessment the diagnostic accuracy of CP OCT was 96% for gliomas Grade I-III and 89% for glioblastoma.

Conclusion. The most powerful criteria of visual assessment of microstructural CP OCT images for differention between glial tumor tissue and white matter is signal intensity in both polarization. The diagnostic accuracy using ascertained visual CP OCT criteria was 87-88%. The quantitative assessment based on calculating attenuation coefficients can improve the diagnostic accuracy of the method (96% for gliomas Grade I-III and 89% for glioblastoma). Therefore developing qualitative (visual) and quantitative assessment criteria allows considering CP OCT is as a promising imaging tool for glioma surgery. For introduction of CP OCT into clinical practice further clinical studies are needed.

MINIMALLY INVASIVE NEUROSURGERY IN THE HYBRID OPERATION ROOM

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Purpose. To review the experience with a hybrid operation room for minimally invasive neurosurgery, acting as a common platform to provide the integration of multimodal image, Neuronavigation, Endoscope and key hole surgery in a consecutive series of skull base surgery, vascular surgery and minimally invasive spine surgery.

Materials and methods. The procedure was performed in a hybrid operating room using C-arm cone-beam computed tomography equipped with a laser-guided navigation system (Artis Zeego, SIEMENS and CURVE navigation system, Brain Lab). Since Nov 2016, 157 consecutive patients underwent neurosurgical procedure (Skull base surgery, vascular surgery, Bypass surgery, Endoscopic surgery, Keyhole surgery and Spine surgery including fixation. Cases were selected for image guidance when the referring surgeon felt that there would be benefits for pursuiting the procedure with each minimum invasive concepts. The efficacy and safety of the procedure were assessed through a retrospective chart review.

Results and discussion. Hybrid OR can provide real-time imaging and enhance the possibility of success for procedures. It gave us benefits in operative planning, appreciation of anatomy, lesion location, safety of surgery and greatly enhanced surgical confidence. We can use the intraoperative CT which is needed for registration for neuronavigation. Furthermore we were able to use the fusion image of the intraoperative CT, angiography and preoperative planning data (iPlan). It enables us perform keyhole surgery or target bypass. It is also useful for recovery or revision from possible accidents. In the spine surgery it give us improved workflow not only for decompression but also a variety kinds of fixation techniques (ALIF, TLIF PLIF, and percutaneous multilevel fixation).Especially It might be necessary for some dedicated method (i.e., partial corpectomy, multilevel oblique corpectomy, anterior pedicle screw). Multidisciplinary use increases utilization of the system (i.e. Navigation assisted endoscope surgery with multimonitor, navigationiguidied screw placement with minimum use of X-ray).

Conclusion. Hybrid operation room enables us to integrate the minimally invasive techniques and concepts, such as preoperative planning, intraoperative navigation, multimodal image fusion, image guided surgery, endoscopic procedure and the keyhole concept.

EC/IC BYPASS IN THE TREATMENT OF COMPLEX CEREBROVASCULAR DISEASE

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Purpose. The therapeutic options for complex intracranial aneurysm and Moyamoya Disease (MMD) are debatable. According to our long-term experiences, we suggest that extracranial/intracranial (EC/IC) bypass plays a very important role in the therapeutic arsenal of such complex cerebrovascular diseases.

Materials and methods. Our experience for EC/IC bypass surgery was summarized based on last 30 years' typical cases, radiological images, operation videos and multiple technique application. Literature review was also performed to present diverse opinions in this field.

Results and discussion. Intracranial intractable aneurysms are always big, irregular formed and without enough collateral compensation. So they are difficult for clipping or embolization, leading to high fatality rate as 68-85%. Our group used radial artery as bypass vessel to set parent artery free and re-establish brain circulation, achieving postoperative morbidity at about 4%. Chronically and progressively, MMD blocks bilateral cerebral arteries, causing repeated brain ischemia and hemorrhage. It is common in eastern Asian but no standard treatment has been established. Our group combined both direct (superficial temporal artery - middle cerebral artery) and indirect (encephalo-dura-myo-synangiosis) bypass surgery, achieving rapid and persistent circulation recover. Long-term follow-up showed both operated and unoperated hemispheres were improved, with hemorrhage rate at 1.87% per person per year. Bypass surgery always causes hyper- or hypo-perfusion, which limits its application. Aiming at comprehensive and individualized treatment, our group imported CT perfusion with BOT, functional MRI, neurophysiological monitoring as well as other novel techniques, evaluated various hemodynamic characteristics and established specific strategy. With a better indication, postoperative morbidity decreased to 24.3%.

Conclusion. In spite of the rapid development of interventional therapy, EC/IC bypass still serves as a choice for complex cerebrovascular diseases, especially intractable aneurysms and MMD. Individualized hemodynamics should be evaluated by various techniques to achieve a better surgical strategy.

MINIMALLY INVASIVE TRANSPEDICULAR FIXATION OF THORACIC AND LUMBAR VERTEBRA WHEN INJURED

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Purpose of research. The traditional technique of transpedicular fixation comes amid extensive surgical exposure to the posterior elements of the vertebral bodies, which is accompanied by denervation and devascularization of the paravertebral muscles to a large extent, which subsequently affects its functional state. There are a number of pathological conditions which treatment requires only fixation from the back surgical approach, without the need for extensible approach to the posterior elements of the vertebrae. For these purposes various manufacturing companies of metal structures have developed assembly instruments for minimally invasive interventions for transpedicular fixation of the spine recently. However, the cost of the assembly instruments as well as the structures themselves remains rather high. Meanwhile, domestic producers lack such instruments at the moment. Therefore, the basic idea of the interventions performed was to reduce the trauma of paravertebral muscles sometimes against the cosmetic effect. The aim of the research was to contemplate the possibility of performing transpedicular fixation of the spine with domestic implants with minimal trauma of soft tissues, in particular paravertebral muscles. Evaluation of the fixation accuracy of metal structures. Diagnosis of difficulties in the implementation of such interventions and ways to overcome them.

Objectives of research. To choose the optimal variant of performing the surgical intervention, which enables to achieve the main goal - reduction of intraoperative trauma of paravertebral muscles, improving accuracy of the hardware fixation and simplification of its assembly. To detect the trouble spots in the technique in operation, and methods of their solving.

Materials and methods. 13 surgical interventions for fractures of the thoracic and lumbar vertebrae were performed using a less traumatic technique. The Belarusian Medbiotech constructs with tools for the installation of screws and a number of lumbar retractors were used for the operations. 8 surgical interventions were performed using a COMPUTER-ASSISTED NAVIGATION (CAN) on the basis of a preoperative CT- examination, 5 under C-arm control.

Surgery technique. After the CAN system is adjusted and linked to the projection of the screw insertion points determined by the system, small linear incisions are made above each injection point, or a single skin incision goes paravertebrally in the projection of the points of the screws insertion, arched joints are extracted through the muscles by blunt dissection, injection points are fixed, the initial section of the channel is shaped, a pin is installed, along which a screw tap forms the channel, the screw is inserted along the pin. After all screws are installed, the structure is assembled.

Research results. Correct screw fixation was assessed on the basis of postsurgical CT scans on the degree of penetration of the cortex arch root. All patients showed the satisfactory standing of the screws of the metal structure. Within a month, three patients presented with disassembly of the hardware on the one side, which required a repeated surgical intervention.

During the surgical interventions, a number of problematic points were detected: thus, when installing screws from individual incisions, the visualization of the screw insertion point decreased due to limited access, so it was difficult to determine the spatial orientation of the installed screws, which in its turn had an impact on the correctness of rod modelling and its correct fixation. There is a high probability of soft tissue interposition during the assembly. These problems are in some measure solved by means of

navigation - the fixation of the insertion point, the same incision in the view of the injection points of all the screws on each side makes it possible to visualize all the screw heads and determine their spatial relations toward one another, which certainly slightly deteriorates the cosmetic effect. The duration of the interventions was comparable to that of the traditional technique, and sometimes was longer, which is explained by the above-mentioned reasons. However, the loss of blood was much lower; there was no need to drain the surgical wound. In the postoperative period the pain condition of the patient was better, which made it possible to activate them at the earliest possible date.

Conclusion. Minimally invasive surgical interventions for transpedicular fixation of the spine are possible with the use of domestic implants, but it requires the enhancement of both the structure itself and the assembly instruments.

ENDOSCOPIC SURGERY FOR PITUITARY ADENOMAS INVADING THE CAVERNOUS SINUS

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Surgical treatment of the pituitary adenoma, extending beyond the sella, is quite a challenge.

Despite on the significant progress in the development of new methods of performing operations, the introduction of new instruments and the use of various widened approaches, the results of surgical treatment not always remain satisfactory.

There are many factors influencing on surgery consequences. The main ones are the structure of the tumor (dense tissue or soft tumor), features of the arterial blood supply of the tumor (hypervascularization or hypovascularized tumor) and the invasive potential.

When the tumor has a laterosellar spread with cavernous sinus invasion, an important role is played by the extent of carotid artery capture by tumor. Knops classification allows to divide adenomas depending on the degree of invasion into the cavernous sinus space.

Materials and methods. We presented in our research 86 patients with laterosellar adenomas. Among them were 3 microadenomas and 83 macroadenomas. The distribution of adenomas according to Knosp classification: Knosp 1 – 24 (27,9%), Knosp 2 – 31 (36,0%), Knosp 3A – 18 (20,9%), Knosp 3B – 5 (5,8%), Knosp 4 – 8 (9,4%). We used the endoscopic transnasal approach to remove pituitary adenomas invading the cavernous sinus. Neuronavigation was also applied in the course of surgery.

Results. The MRI data, endocrinological examination, visual functions and neurological disorders obtained 6 months after the surgery were evaluated as the results of the operation.

When the tumor invaded the cavernous sinus, total removal (GTR) was achieved in only 51 patients (59.3% of cases). The number of complications was 9.3%: 3 patients had CSF leak, 1 patient had epistaxis, neuropathy of the oculomotor nerves (III, VI CN palsy) was observed in 4 cases. There were no lethal outcomes.

Conclusion. Endoscopic endonasal surgery seems to be the most effective technique to remove adenomas with CS invasion.

STEREOTACTIC IRRADIATION FOR HEAD AND NECK PARAGANGLIOMAS AS THE PREFERABLE METHOD OF TREATMENT

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Objective. Head and Neck Paragangliomas (HNPs) are highly vascular, predominantly benign, slowly growing neoplasms related to the parasympathetic nervous system. Despite the fact they are less than 1% of all head and neck tumours, they are the most common ones of the middle ear, and they take the second place among temporal bone neoplasms after vestibular schwannomas.

Methods. Clinical and radiological data were retrospectively reviewed for 332 patients (65 males and 267 females) treated between 2005 and December 2017 at the Radiosurgery and Radiotherapy Department of N.N. Burdenko National Medical Research Center of Neurosurgery. At the same period of time, 62 patients were operated on at our Center. Most of the surgical treatments were performed only because neurosurgeons took HNP for another type of tumour.

Results. The mean follow up at the time of the present analysis was 32 months (67 patients had it as long as 60 months). 97 lesions underwent a single-session radiosurgery, while multisession radiosurgery or radiotherapy were performed in 247 cases. On the last follow-up MRI, 99 tumours (42%) had decreased in size, 116 (50%) lesions were unchanged, and 19 (8%) had increased in size. Neurologic conditions were generally maintained or improved.

Conclusions. It was confirmed that stereotactic radiosurgery and radiotherapy were safe and effective treatment modalities for such difficult for surgical removal tumours as HNPs.

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The Organizing committee and Technical partner sincerely thank the International scientific committee, all invited speakers, guests, sponsors, numerous friends, correspondents and everyone involved in ISMINS-2018 Congress organization for help of various kinds and financial support

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4th ISMINS
INTERNATIONAL CONGRESS ON MINIMALLY INVASIVE NEUROSURGERY

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«People & Health» Press
P.O. Box 2, Saint-Petersburg, 191025
Phone/Fax: +7 (812) 380 3154, 380 3155, 380 3156
welcome@congress-ph.ru
www.congress-ph.ru

ISBN 978-5-6040648-0-1

Technical editor: E. Sysoeva
Design: S. Kudelin, T. Kudelina

Signed to print on 03.04.2018
The format is 60x90 1/8. Coated paper.
Headset "Myriad"
Offset printing. Total print 700 copies.