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Neurosurgery

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In the manual, according to a new program, problems of traumatic brain injury, pathology of brain vessels are stated. Prominence is given to the descriptrion of brain and spinal cord tumours, hydrocephalus, osteochondrosis of the spine. Types and methods of treating traumatic damages of the spine and spinal cord are considered. Functional and restorative surgery are broadly presented.

For students of higher medical educational establishments of III–IV levels of accreditation.

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Contents

Abbreviations

AA	arterial aneurysm
ADCBC	acute disorders of cerebral blood circulation
AG	angiography
ALS	amyotrophic lateral sclerosis
ASIA	American Spinal Injury Association
ATP-dependent	adenozinetriphosphorus-dependent
ALV	artificial lung ventilation
AVM	arteriovenous malformation
BHA	bifurcationae hemodynamic aneurysm
CCF	carotid-cavernous fistula
CNS	central nervous system
CSF	cerebrospinal fluid
CT	computer tomography
CVD	cerebrovascular diseases
DAI	diffuse axonal injury
DDD	degenerative disc diseases
DIC-syndrome	disseminated intravascular coagulation syndrome
Echo-EG	echoencephalography
EEG	electroencephalography
EMG	electromyography
ENMG	electroneuromyography
GABA	Gamma-Aminobutyric acid
GP	general potential
GSCP	generated sympathetic cutaneous potential
HIV	Human immunodeficiency virus
ICD-10	International Classification of Diseases
ICP	intracranial pressure
MRI	magnetic resonance imaging
PDGF	platelet-derived growth factor
PET	positron-emission tomography
PNS	peripheral nervous system
PSP	primary surgical processing
SAH	subarachnoid hemorrhage
SC	spinal cord

SCI	spinal cord injury
SPE	speed of performing excitation
SPECT	single-photon emission computed tomography
SSGP	somatosensory generated potentials
TIA	transient ischemic attack
TBI	traumatic brain injury
VST	vertebrospinal trauma
WHO	World Health Organisation

Chapter 1. History of Neurosurgery

Neurosurgery (from Greek νεῦρον – nerve + surgery) is a branch of surgery and a field of medical science which deals with problems of diagnostics and treatment of diseases and damages of the nervous system (central and peripheral).

Neurosurgery as a science and a practical branch of medicine is relatively young. It was formed and distinguished as an independent trend in the late 19th-20th centuries on the basis of the integration of neurology and surgery, as well as such disciplines as neuroradiology, pathophysiology, pathomorphology, psychiatry and others. This process of the development and integration of neurosurgery with new trends of medical science is going on nowadays too.

The specificity of the nervous system, neurosurgical methods of investigation and procedures of surgical treatment requires some special training of the neurosurgeons, which takes place for a long time (6–7 years) on his having graduated from a higher medical educational establishments.

The main sections of modern neurosurgery are neurotraumatology, neurooncology, vascular neurosurgery, pediatric neurosurgery, spinal neurosurgery, functional and stereotactic neurosurgery, restorative neurosurgery. In recent years, such new trends as endovascular and endoscopic neurosurgery have been intensively developed.

The object of practical neurosurgeons' activity are patients with traumas of the central and peripheral nervous system, tumours of the brain, spinal cord and peripheral nerves, vascular diseases of the brain and spinal cord, osteochondrosis of the spine, extrapyramidal hyperkineses, epilepsy, intractable pain syndromes, malformations of the nervous system and others.

The history of neurosurgery dates back to high antiquity and is reflected in myths and legends. Archaeological excavations of ancient burial places point out lifetime trepanations which were done in Egypt, India, Peru, in the territory of the modern Ukraine. There were not only trepanations of the skull which could be done with ritual aims but also more difficult neurosurgical interventions, when defects of the skull were closed with gold or silver plates. Apart from archaeological findings, many written evidences of a high enough level of medical and, in particular, neurosurgical knowledge have reached our time. The famous papyrus of G. Ebert (around 1550 B.C.) found in 1873 in the ruins of Thebes (one of two capitals of Ancient Egypt) gives a detailed description of the medicine development level in that, by then the most developed and reachest, country of the world. In the papyrus

of E. Smith (1550 B.C.) contains a description of traumatic brain injuries, spinal trauma, skull fractures, spine fractures, many nervous diseases.

Clay tablets of the library of the Assyrian tsar Ashurbanibal (8th century B.C, medical knowledge apart, give some information about job prices for different types of medical aid, while operations on the brain were considered the most expensive ones.

A special contribution to the development of medicine was made by a Greek doctor Hippocrates (460–377 B.C.), who not only described injuries of the skull and brain, but also recommended to perform trepanations of the skull in traumatic brain injury, epilepsy, acute blindness.

In the period of the Roman empire, medicine continued to develop: intensively Cels presented a detailed description of the anatomy of the skull, cranial and spinal nerves, neuroganglions, Galen performed and described craniotomy at brain tumours and brain hemorrhages. Clearly, in times of permanent wars, neurotraumatology developed first.

In the epoch of Renaissance, A. Pare gave a detailed description of trepanation of the skull for the treatment of intracranial haematomas. Paracels described gunshot and nongunshot wounds of the skull.

Findings of archaeological excavations of the epoch of Kyivan Rus (9th–13th centuries) point out performing lifetime trepanations of the skull on account of traumatic brain injurys. During the excavations on the mount of Knyazha in the area of the village of Gorodyshche in 1891, a skull was found with traces of a trephine hole of the the right parietal bone. It is assumed that the skull belonged to a warrior injured in 13th century. The defect, according to the remark of academician O. I. Arutyunov, is an evidence of the presence of good enough special skills and qualification of the performer of trepanation.

The excavations in the area of Tripil'ya testify to the fact that still earlier, in the period of the culture of Tripil'ya, in the territory of Ukraine trepanations of the skull were performed. The symmetry of the trepanations, as an academician NAMS and NAS of Ukraine Yu. Zozulya asserts, testifies to the fact that most probably they were done them probably with ritual aims.

Neurosurgical operations were performed in the days of Cossack wars (14th -18th centuries). It is known that the Ukrainian Cossacks had a great experience in treating battle traumas, including craniocerebral.

The chronicle of Samiylo Velichko (a participant of the war of 1648–1654 years, and after being wounded – a monk of the monastery of Trakhtemirov) is an evidence that the famous Ukrainian military leader Maksim Kryvonis had a defect of the skull as a sequence of a head wound.

In the 18th century, an English doctor P. Pott gave prominence to injury of the brain but not that of the skull in trauma of the head, and a French surgeon J. Petit singled out and described three forms of injury of the brain (concussion, contusion, compression) which have been retained in the modern classification.

A considerable experience of skull trepanations was accumulated in the years of the Patriotic War of 1812 by N. F. Arendt, E. O. Mukhin, I. F. Bush, D. Larrey. An especially great contribution to the development of the neurosurgery of the Russian empire was made by such well known scientists as V. M. Bekhterev, N. I. Pirogov, V. I. Rozumovskiy, N. V. Sklifosovskiy, L. O. Darshkevich, S. P. Fedorov, V. A. Oppel', I. I. Grekov, L. M. Puusepp and others.

The investigations of G. Fritsch and E. Hitzig who discovered the motor zone in the cortex of the brain, and also a Kyivan scientific professor V. A. Bets who was the first who described the pyramidal cells of these zones, predetermined a scientifically grounded development of topical diagnostics of the nervous system.

An intensive development of neurosurgery in the first half of the 20th century is closely related to the names of the prominent neurosurgeons: H.W. Cushing, W. E. Dandy, C. Vincent, V. Horsley, K. McCune, T. Bergman, F. Krauze, D. Frater, D. Ferster, J. Elberg, Th. de Martell and others.

A substantial contribution to the development of Neurosurgery was made by Ukrainian surgeons of the late 19th century. Thus, some works devoted to hydrocephalus, nerve sutures and technique of operations on the nervous system were published by Yu. K. Shimanovskiy (1829–1868) in 1865–1866. In the textbook "Operations inside the Human's Body" (1868), he grounded indications for surgical treatment of intracranial traumatic hematomas, methods of their removal, described the treatment of hydrocephalus and surgical tactics in cases of the facial pain. Problems of the puncture of the lateral ventricles of the brain in internal hydrocephalus were field of interest also to V. Kirnitskiy who was working in Kyiv in 1866–1869. A surgeon A. G. Podrez (Kharkiv) in 1878 defended the dissertation "On the Traction of Nerves" – the first work in Russia on this section of neurosurgery. In 1883–1884, the doctor A. L. Rava (Kyiv) reported of the experimental suturing nerves of muscles-antagonists by the method which was suggested by him.

The first investigations of Ukrainian doctors were devoted to traumatic brain injury. Thus, a Kyivan doctor M. Rustitskiy in the article "Resection of the Parietal Bone in Damages of the Brain" (1889) described the basic symptoms of craniocerebral injuries and the phases of the disease. In the work "To the Problem of Fractures of the Skull" (1892), A. Ignatovskiy gave the results of profound investigations of skull fractures. In 1895, the well known surgeon M. M. Volkovich (1858–1928)

was first who carried out the operation of the periosteal closing of the defect of the skull in adults.

In 1897 in Odessa, K. M. Sapezhko (1861–1929) successfully operated the patient with subdural hematoma. Afterwards, operations on brain tumours started to be not only performed by surgeons of Kyiv but also by surgeons of other regions of Ukraine. B. S. Kozlovskiy (Smila) in 1895 published the article "On Methods of Operations in Congenital Encephalic Herniae", and in 1897–1898 he successfully removed brain meningioma in two patients. In 1900, A. V. Tikhonovich (Kharkiv) gave a topographoanatomical estimation of the suggested methods of removing the Gasserian ganglion, and in 1901, A. G. Radzievskiy (Kyiv) published about his method of removing this ganglion. In 1905, a surgeon I. A. Bondarev (Kyiv) reported about successful ablation of two brain tumours (out of the falx and of the calvarial dura mater). A topical diagnosis in both cases was made by a Kyivan professor neurologist M. N. Lapinskiy.

In 1908, in the journal "Neuropathology and Psychiatry named after S. S. Korsakov", the article by A. A. Govseyev "To the Problem of a Reverse Development of Aphasia after the Operation of Encephalic Abscess" was published in which the author mentioned a case of a successful ablation of an encephalic abscess. A Kyivan surgeon O. S. Yatsenko carried out puncture of abscess with pus removal through burr hole. O. I. Arutyunov considered that this operation should be named Yatsenko's operation, as he did it before those foreign authors whose names this method of treatment of brain abscess is associated with.

A powerful development was endowed to Neurosurgery in Kharkiv. Thus, from 1907 to 1913 on the basis of the psychiatric clinic "Saburova Dacha" there were performed 58 neurosurgical interventions (a surgeon E. K. Istomin). E. K. Istomin was first in Ukraine who removed the tumour of the cerebellopontine angle, as well as to perform hypophysectomy and dorsal rhizotomy. In the early 20th century, Kharkiv surgeons B. G. Przheval'skiy and M. B. Fabrikant performed plenty of operations on the peripheral nervous system (rhizotomies, neurotomies, transplantations of nerves).

Ablations of brain tumours were performed in Odessa by V. Sandesco and Ya. V. Zil'berberg. Latter they removed an extramedullar tumour in 1911.

In Kyiv different problems of neurosurgery were dealt with such well-known surgeons as professor M. B. Yukel'son and professor I. M. Ishchenko. Thus, the former, while working in the domain of neurooncology, together with the professor-neurologist V. G. Lazarev suggested an original method of the surgical approach to the cerebellum.

The experience of World War I was generalized by the leading scientists-surgeons V. M. Shamov, A. P. Krymov, I. M. Ishchenko. They formulated the

statement on the necessity of an early primary surgical processing of craniocerebral wounds in the medical establishments of the front area. F. Yu. Roze developed the surgical tactics in ablationof of foreign bodies out of the brain.

An important role in the development of neurosurgery belongs to professor P. S. Babitskiy who performed the first operation of excision of brain tumour in Kyiv in 1911.

N. N. Burdenko, L. M. Puusepp, A. L. Polenov, and then their followers B. G. Egorov, A. I. Arutyunov, V. M. Ugryumov, D. G. Shefer and others coordinators are justly considered to be the founders of Neurosurgery in the former Soviet Union.

In the early 20th centrury, problems of Neurosurgery in Ukraine were deal with by individual surgeons-enthusiasts. There was no certain program of its development yet. It was needed to establish a specialized neurosurgical institution which would take the function of organizer and coordinator. One of the first establishments of the such kind became the neurosurgical clinic for 75 beds, created in 1922 in the Psychoneurological Institute of Kharkov by the well-known scientists the Geymanoviches brothers. There worked experimental laboratories and the Department of Topographical Anatomy of the Nervous System at the clinic. Z. I. Geymanovich ran the clinic till 1948. For 10 years, over 1500 neurosurgical operations were performed in this clinic.

In 1935, professor V. M. Shamov (1882–1962) opened the Neurosurgical Department on the basis of the surgical clinic of the medical college headed by him. V. M. Shamov made a substantial contribution to the development of Neurosurgery of Ukraine. While working in Kharkiv from 1923 to 1939, he developed new operations on the sympathetic nervous system, published the works "Damages and Diseases of Peripheral Nerves", "The errors, dangers and complications of operations on Peripheral Nerves", as well as the data referred to the first operations on the ventricles of the brain and choroid plexuses done in the USSR.

In Kyiv many efforts on the application of Neurosurgery to the practice of general surgeons were made by one of the pioneers of Neurosurgery in Ukraine professor P. S. Babitskiy who published the monographs "Clinic of Brain Tumours" (1928) and "Clinic of Spinal Cord Tumours" (1930). He operated much, demonstrated patients at meetings of scientific societies. P. S. Babitskiy considered to be necessary the creation of an establishment where one could integrate the experience of different specialists, foremost, neuropathologists, surgeons, neuroophthalmologists, and otorhinolaryngologists. In 1937, he organized and headed the Neurosurgical Department for 40 beds on the basis of the City Psychoneurological Hospital of Kyiv. This department became the basis of the Psychoneurological Institute of Kyiv.

An energetic activity on the organization of the Neurosurgical Service of Ukraine was carried out by L. A. Koreysha who was working in Kyiv in 1939–40. In 1940, he headed the Department of Surgery of the Medical Institute of Kyiv. In 1939, professor L. A. Koreysha created the Neurosurgical Department for 120 beds on the basis of the Psychoneurological Institute of Kyiv which became the basis of the future Institute of Neurosurgery.

In 1940, the government of Ukraine adopted the the resolution on the reorganization of the Psychoneurological Institute of Kyiv into the Institute of Neurosurgery, but this decision was not realized because of the World War II started.

Substantial landmarks in the development of Neurosurgery before the War were scientific sessions and works of the Psychoneurological Institutes of Kharkiv and Kyiv: "Problems of Trophic Innervation" (Kharkiv, 1935), "Tumours of the Central Nervous System" (Kharkiv, 1937), "Problems of Neuroroentgenology" (Kyiv, 1939), "Problems of Neoplasia of the Central Nervous System" (Kiev, 1940), and the monographs of a pathomorphologist L. I. Smirnov "Foundations of the Nervous System Morphology in a Nomal and Pathological State" (1935), a neurosurgeon Ya. M. Pavlonskiy of Kharkiv "Tumours of the Spinal Cord and Spine" (1941), a roentgenologist I. G. Shlifer of Kyiv and coauthors "Roentgenodiagnostics of Head Diseases" (1941).

In the years of the World War II, all forces of neurosurgeons were directed at providing a specialized aid for the wounded both in front-line and base hospitals. The Psychoneurological Institute of Kharkiv was evacuated to Tyumen' and worked as a neurologo-neurosurgical hospital. In 1943, the experience of his work was generalized in the collections "Traumatic Damages of the Nervous System", "Gunshot Wounds of Peripheral Nerves and Their Teatment" and in the monograph of Z. I. Geymanovich "Military-traumatic Damages of the Spine and Spinal Cord" (1943).

The main task of Neurosurgery in the post-war years was to provide aid for patients with outcomes of gunshot damages of the central and peripheral nervous system. The major bases for training of neurosurgeons of Ukraine were neurosurgical departments of Kyiv and Kharkiv.

In 1945, the Neurosurgical Service in Ukraine become to be headed by professor O. I. Arutyunov who was the Chief Surgeon of the front during the war. Experienced neurosurgeons V. A. Korochanskiy, P. G. Tananayko, Ya. I. Faynzil'berg, O. A. Krister worked together with him.

O. I. Arutyunov (1904–1975) was a talented scientist and organizer of the Ukrainian school of neurosurgeons, the author of 200 scientific works, including 4 monographs. Under his guidance 8 dissertations for a Doctor's degree and 48 dissertations for a Candidate's degree were accomplished and defended.

His disciples (A. P. Romodanov, Yu. P. Zozulya, I. D. Virozub, G. O. Pedachenko, B. A. Pel'ts, P. O. Pronzelev, V. S. Mikhaylovskiy, T. M. Sergiyenko and others) provided the development of Neurosurgery in Ukraine. O. I. Arutyunov understood that for training of neurosurgeons it was necessary to create the main specialized establishment which would take not only medical but also scientific and organizational work.

In 1950, he created the Ukrainian Research Institute of Neurosurgery on the basis of the Psychoneurological Institute of Kyiv. In the Institute, along with neurosurgical operation, investigations were carried out on Morphology (professor B. S. Khominskiy), Neuropathology (professor A. D. Dinaburg, professor O. L. Dukhin, M. K. Brotman), Roentgenology (I. S. Glushkova, L. P. Pankeyeva, A. E. Rubashova, Ya. I. Geynisman), Psychiatry (professor O. L. Abashev – Konstantinovskiy, A. G. Dzevaltovska, professor L. P. Rozumovskaya – Molukalo).

From 1945 to 1960 academician A. I. Arutyunov was also head of the Department of Neurosurgery of the Institute of the Post-Graduate Education of the Doctors of Kyiv. In 1964 he moved to Moscow, where he headed the Institute of Neurosurgery named after M. N. Burdenko of the Academy of Medical Sciences of the USSR which he was headid to his death (1975).

During almost 30 years (1964–1993), academician A. P. Romodanov (1920–1993) – a neurosurgeon and worldwide-known scientist – was the Director of the Institute of Neurosurgery of Kyiv.

A. P. Romodanov considerably reconstructed the Institute, reorganized the Neurosurgical service of Ukraine. By now the Institute created by him is one of the world's largest neurosurgical cente. The Institute of Neurosurgery took the function of managing the Neurosurgical Service in Ukraine, training and retraining of specialists.

On the initiative and under the direction of A. P. Romodanov, the following priority directions of Neurosurgery developed and have been going to develop: endovascular, functional and stereotactic, restorative neurosurgery, congenital traumatic brain injury, mild traumatic brain injury, chemotherapy of brain tumours etc.

A great significance was given by A. P. Romodanov to the development of fundamental researches: patho- and sanogenesis of traumatic brain injury, the study of immune peculiarities in neurosurgical pathology, the influence of small doses of radiation on the brain and others.

A. P. Romodanov became one of the founders of neurosurgery in Ukraine and the founder of a neurosurgical school. Under his guidance 30 dissertations for a Doctor's degree and 52 dissertations for a Candidate's degree were accomplished and defended. He was an author of 25 monographs and over than 400 scientific

works. Presently, his disciples are going on to develop the trends which were initiated by their tutor and teacher. After A. P. Romodanov's death, the Institute of Neurosurgery of Kyiv was named after him.

Since 1993, the Institute has been headed by academician of the National Academy of Sciences of Ukraine, the National Academy of Medical Sciences of Ukraine, an Honoured Worker of Science of Ukraine, a Laureate of the State Prize of Ukraine, vice-president of the National Academy of Medical Sciences of Ukraine professor Yu. Zozulya, and from 2013 by Academician of National Academy of Medical Sciences of Ukraine E. G. Pedachenko.

The Institute is incessantly grows and develops. The trends of its research work and the range of current problems expand.

In recent years, the main attention is focused on such problems as diagnostics, surgical and combined treatment of brain tomours; pathogenesis, diagnostics and treatment of the traumas of the central nervous system and their consequences; surgical treatment of the most complicated forms of vascular pathology of the brain, as well as to problems of functional and restorative neurousrgery; to the investigation of immunopathological reactions in patients with neurosurgical pathology, to the study of the influence of small doses of radiation on the brain, to the creation of effective methods of prophylaxis and therapy of infectiously inflammatory complications in neurosurgical patients, to the experimental study of the formation of the epileptic focus, to the treatment of congenital malformations and hydrocephalus in children, to medical rehabilitation of neurosurgical patients, to the study of mechanisms of action of embryonic nervous tissues and stem cells in the conditions of their transplantation into the brain and spinal cord.

The complexity of treatment of patients, workings out of current problems of Neurosurgery are provided by the work of research and diagnostic departments and laboratories – neuroradiological, neurophysiological, biochemistry, clinicodiagnostic researches, neuromorphology, neurosurgical anatomy, electronic microscopy, culture of tissues and others.

At the end of 1993 in Kyiv, they held the Constituent Congress of neuro-surgeons of Ukraine, at which the program of the development of Neurosurgery in our country was worked out. At the Congress they created the Ukrainian Association of Neurosurgeons which was affiliated to the European and World Association of Neurosurgeons.

The network of the Neurosurgical Service of Ukraine consists of regional and city neurosurgical departments in which about 80.000 patients get a skilled help, more than 25.000 operative interferences are performed annnually. In addition, neurosurgical and neurotraumatological departments are also open in many district

centers (district and inter-district departments). To date, neurosurgical departments are equipped with modern diagnostic and medical technique.

Teaching Neurosurgery as an educational discipline is carried out in Ukraine within three lines:

1. Teaching students at departments and courses of Neurosurgery of Medical Universities.
2. Training and retraining of specialists (internship, primary specialization, postgraduate courses) on the basis of departments of Institute Neurosurgery of raising the level of doctors' skills.
3. Residency, post-graduate study, Master's programme, PhP programme (opened at the Department of Neurosurgery of the Bogomolets National Medical University since 1994).

The progress of Neurosurgery in 21st century will be related to its subsequent integration with fundamental and applied sciences: biological sciences (neurophysiology, molecular genetics, neurochemistry, neuroimmunology, neuromorphology); technical and technological (electronics, cybernetics, science of materials); informatics and bionics; humanitarian and social sciences (psychology, jurisprudence, social science). To date Neurosurgery is one of the most technologically developed and most dynamically developing branches of medicine.

У підручнику відповідно до нової навчальної програми викладені питання черепно-мозкової травми, патології судин головного мозку. Особлива увага приділена опису пухлин головного і спинного мозку, гідроцефалії, остеохондрозу хребта. Детально розглянуті види і методи лікування травматичних пошкоджень хребта і спинного мозку. Широко представлена функціональна і відновна нейрохірургія.

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