CONTENTS

LIST OF ABBREVIATIONS

AVM — arteriovenous malformations
HIV — human immunodeficiency virus
ICA — internal carotid artery
ICH — intracranial hypertension
ICP — intracranial pressure
CT — computed tomography
MR — magnetic resonance
MRI — magnetic resonance imaging
NF — neurofibromatosis
PNS — peripheral nervous system
CSF — cerebrospinal fluid
AIDS — acquired immunodeficiency syndrome
US — ultrasound examination
CNS — central nervous system
TBI — traumatic brain injury
GCS — Glasgow coma scale
EEG — electroencephalography
DREZ surgery (Dorsal Root Entry Zone) — surgery aimed at destroying the zone of entry of the posterior roots into the spinal cord

INTRODUCTION

Neurosurgery is a branch of medicine that uses surgical methods to treat diseases of the central and peripheral nervous system. Neurosurgeons always work as part of a large team, which includes anesthesiologists, resuscitators, neurologists, radiologists, ophthalmologists, otoneurologists, physiologists, radiologists, radiotherapists, chemotherapists, pathologists and, if necessary, other medical specialists. Moreover, in some cases, neurosurgical intervention is only one, and not the most important stage of complex treatment of the patient.

The specifics of neurosurgery are determined by the peculiarities of the anatomy and physiology of the nervous system. Main of them is the complex structure of the central nervous system, the high functional significance of many structures, the intensity of blood supply to the brain in combination with the terminal anatomical variant of many small arteries supplying isolated pools of the brain stem and subcortical structures, the difficulty to access deeply located formations, fragility, vulnerability of the brain, especially in conditions of its pathology, and much more.

For a long time, the main problems in neurosurgery were the difficulty and sometimes the impossibility of making an accurate topical diagnosis, the lack of effective bleeding control, adequate wound illumination, convenient optical magnification, and appropriate tools. Based on the needs of neurosurgery, computed and magnetic resonance imaging, angiography and endovascular surgery, an operating microscope, vacuum suction and an ultrasonic aspirator, bipolar coagulation, absorbable hemostatic materials were developed and put into practice.

As a result, not only the techniques were changed but also the principles of performing neurosurgical interventions. While in the last century general surgical principles prevailed, which were fast, rough and risky, modern neurosurgical interventions are distinguished by careful handling of anatomical structures and are minimally traumatic. The principles of minimally invasive interventions formulated in neurosurgery are now being applied in other areas of surgery. The needs of neurosurgery stimulated the development of anesthesiology and intensive care. Ideal anesthesia and respiratory equipment have been developed, drugs for anesthesia that do not increase intracranial pressure have been put into practice, postoperative wards and later intensive care units have been created, and much more.

The contribution of neurosurgery to fundamental medicine is of great importance. It is in the neurosurgical clinic that a number of complex brain mechanisms have been studied. Many details of the mechanism of tumorigenesis were discovered during the study of meningioma — a tumor of the meninges, which is now considered the most studied in molecular biological terms.

Neurosurgery is a complex science, the development of which requires many years, in fact, a lifetime. For some readers, this textbook will be the first on the way to profession. We wish you success, but we warn you that the information contained in the textbook is only a small part of what a novice neurosurgeon should know and be able to do.

Creating this textbook, the authors pursued two main goals. The first one is to familiarize students with the current state of neurosurgery, with its capabilities to diagnose and successfully treat many previously incurable diseases. Therefore, we usually focus only on the basic principles of diagnosis and do not detail the surgical technique. Ultimately, any doctor with the slightest suspicion of a neurosurgical pathology should only refer the patient to an objective examination and then to a neurosurgeon.

However, every doctor can get into a situation where a patient needs emergency neurosurgical care, and there is no neurosurgeon nearby, and no evacuation is possible. This situation is most real in disaster medicine and military field conditions. Therefore, the authors considered their second goal to teach a doctor of any specialty to act adequately in standard situations with traumatic brain injury, spinal injury, with a sharp increase in intracranial pressure. Let us recall that since the 18th century, the mastery of the technique of craniotomy was obligatory for all Russian doctors, and today — ventricular puncture is also a compulsory skill. Therefore, the relevant sections are written in detail and can be used as a guide when performing the described neurosurgical interventions.

It should be borne in mind that the descriptions of neurological symptoms given in this volume are incomplete and are presented to focus attention on the most fundamental aspects from the neurosurgical point of view. The most detailed issues of clinical manifestations, diagnosis and conservative treatment of diseases of the nervous system are covered in Volume 1 of this textbook.

Chapter 1

HISTORY OF NEUROSURGERY

The separation of neurosurgery into a separate medical specialty occurred at the turn of the 19th and 20th centuries, but its roots go back to ancient times. The most ancient skulls with traces of trepanation go back to 12–10 thousand years BC in the Peruvian necropolis left over from the Inca civilization (2000 BC); approximately, 10% of skulls have traces of trepanation, and the nature of bone changes indicates that most patients successfully underwent surgery (Fig. 1.1).

Fig. 1.1. Skull with traces of trepanation and signs of bone regeneration from the Peruvian necropolis

On the territory of Russia (Gorny Altai), three skulls with traces of trepanation dated 5th–3rd centuries BC were found, with two of them showing signs of bone regeneration.

About 1/3 of trepanations were performed for traumatic brain injury (TBI). Indications for skull trepanation in the remaining 2/3 of cases remain unclear. Trepanation was carried out by scraping the bone, using chisels, cutters and conical cutters.

The Incas also carried out the plasty of bone defects with gold or silver plates. The first description of skull trepanation is given by Hippocrates in the essay "On head wounds". In the Middle Ages, the trepanation technique did not undergo significant changes, but trepanation was often performed for the treatment of mental illnesses, and often charlatans turned out to be at the operating table (Fig. 1.2).

In the history of medieval Russia, only trepanations related to TBI are reported. The first proper neurosurgical manual (Tractatus de Fractura Calve sive Cranei a Carpo editus) was published in 1518 in Bologna by Berengario da Carpi (1470–1550) (Fig. 1.3, 1.4). The work is devoted primarily to the description of the successful treatment by the author of a fracture of the occipital bone in Lorenzo de Medici, but there are also generalizing recommendations.

Fig. 1.2. I. Bosch. Extracting the stone of stupidity

Fig. 1.3. The title page of the world's first monograph on neurosurgery. In: Berengario da Carpi. Tractatus de Fractura Calve sive Cranei a Carpo editus. Bologna: Impressum per Hieronymum de Benedictus, 1518

Ambroise Pare made a great contribution to the development of trepanation techniques (Ambroise Pare, 1510, according to other sources 1509 or 1517–1590). He described in detail the tools and methods of trepanation, removal of an osteomyelitically affected bone, drainage of subdural hematomas and empyemas, proposed a technique for reposition of depressed skull fractures (Fig. 1.5).

The development of neuroanatomy in the 17th century is connected primarily with the name of Thomas Willis (1621–1675). "Cerebral anatomy" (Cerebri Anatome) published by him in London in 1664 (Fig. 1.6) was considered by contemporaries to be the most accurate guide. Willis was also the first to propose the term "neurology", understanding it only in the anatomical sense, that is, as the science of neurons (and not as a clinical discipline).

Simultaneously with anatomical science, surgical technique developed. The book by Johannes Schultes (1595–1645) Armamentarium Chirurgicum, translated from Latin into many languages, contains descriptions and images of many tools used for trepanning at that time, among which there are similar to modern raspators, elevators, pliers (Fig. 1.7, 1.8).

By the beginning of the 18th century, in European countries, the handicraft manufacture of medical instruments has given way to industrial. In Russia, the manufacture of medical instruments was also established; and since 1738, all full-time doctors including military ones had full-fledged (for their time) surgical kits, including trepanation instruments. In 1744, Martin Shein published the first Russian anatomical atlas.

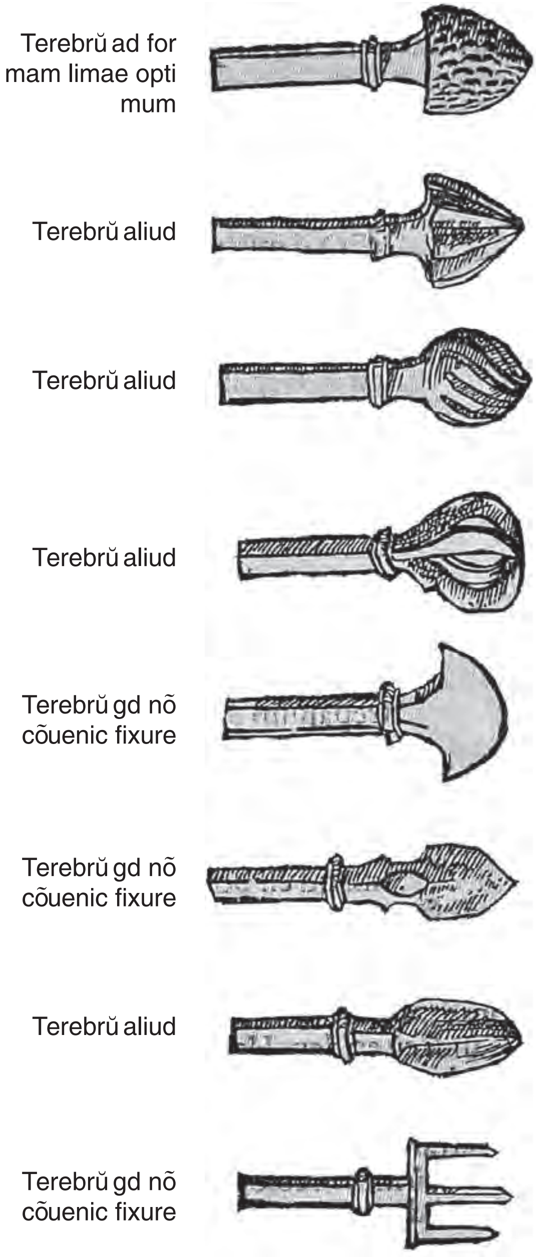


Fig. 1.4. Tools for trepanation dated the beginning of the 16th century (from the same book)

Fig. 1.5. Ambroise Pare. Portrait and illustrations of trepanation techniques. In: Pare A. The Works of That Famous Chirurgion Ambroise Parey Translated Out of Latine and Compared with the French by Tho. Johnson. London: Richard Coates, 1649

a  b 

Fig. 1.6. a — Thomas Willis; b — the first image of the arterial circle of the brain. In: Willis T. Cerebri Anatome: cui Accessit Nervorum Descriptio et Usus. London: J. Flesher, 1664

Fig. 1.7. Types and techniques of trepanation. In: Scultetus J. Armamentarium chirurgicum XLIII. Ulm: Typis&Impensis Balthasari Klihnen, 1655. The main indication for trepanation, as can be seen, were craniocerebral injuries. A cruciform incision of the skin without subsequent suturing provided drainage of the wound.

In the 18th century, skull trepanation was traditionally used for TBI, and every certified doctor was obliged to own its technique. Among the examination questions on surgery, skull trepanation was given priority. At the same time, there was no fascination with trepanation as a panacea, as evidenced by those that have come down to us (in the comments to "Surgery" of Platner, compiled by Martyn Shein few clinical descriptions of 1744–1757. In one of these descriptions, it is reported that the wounded man "had his head broken... the skull in the brain was depressed to the depth of two fingers"; in the Admiralty Hospital[1], "these fragments were removed with great difficulty, the dura mater was found torn here"; the wounded, "being used... by chief physician Martyn Shein who scooped up to four ounces[2] of the brain itself, recovered after two months and eight days, his brain was filled, and the dura mater in the broken hole attached".

The second half of the 18th century was characterized by further progress of medical science and practice. The concept of pathological anatomy of Giovanni Battista Morgagni (1682–1771), linking each nosology with a specific pathological substrate, changed the philosophy of all European medicine and, among other things, justified the expediency of removing a tumor of any localization (Fig. 1.8, 1.9).

The first neuro-oncological surgical interventions in the history of medicine have been performed for hyperostotic (causing local thickening of the bone) or bone-destroying tumors of the cranial vault (Fig. 1.10). This is due to the relative simplicity of the lifetime diagnosis of such neoplasms.

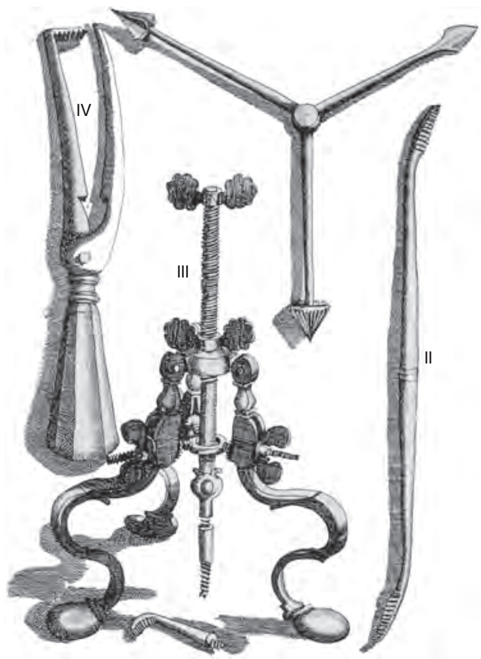
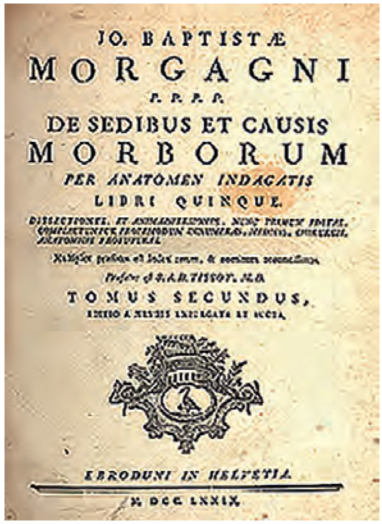


Fig. 1.8. Instruments for trepanation and correction of depressed skull fractures developed by Schultz (from the same book)

[1] The dura mater

[2] The Russian ounce of mass was 29.86 g.

a  

b

Fig. 1.9. Giovanni Battista Morgagni (1682–1771): a — portrait from the title page. In: Morgagni G.B. Adversia Anatomica. Bologna, 1719; b — title page. In: De Sedibus, et Causis Morborum per Anatomen Indagatis Libri. Venetiis: Typog Remondiniana, 1761.

Fig. 1.10. The first extant description of a neuro-oncological intervention performed in 1743. Lorenz Heister (1683–1758). The medical aid consisted in the application of quicklime, the tumor (with soft tissues, adjacent bone and dura mater) was lysed, the patient soon died of infection.

Fig. 1.11. Antoine Louis (1723–1792) — author of the world's first manual of neuro-oncology (1773), secretary of the French Surgical Academy and inventor of the guillotine (1792)

This experience was summarized in 1773 by an outstanding French surgeon Antoine Louis (1723–1792) (Fig. 1.11) in the manual Memoire sur les Tumeurs Fongueuses de la Dure-mere, where 20 cases are given, the first of which is dated to the middle of the 16th century. Basically, the operations were carried out either by the author or by his contemporaries.

Despite some exceptions, the mortality rates during neurosurgical interventions in the first half of the 19th century were catastrophic. So, in Paris in 1835–1841, all the patients who underwent skull trepanation died. There was an opinion that trepanation, even without dissection of the dura, is more dangerous than TBI itself, not to mention a tumor; often, apologists for trepanation were accused of mental ill health.

In 1807–1808, the original “Manual for Teaching Surgery” was published in St. Petersburg by Ivan Fedorovich Bush (Fig. 1.12). In the section “On skull injuries”, the author recommended dissection of soft tissue wounds with the removal of small free-lying bone fragments, foreign bodies and blood clots; large bone fragments were ought to be repositioned, and intracranial hemorrhages detected — to “outlet”. Performing trepanation, that is the expansion of an existing bone defect, was recommended only in the presence of such symptoms of brain compression as headache, convulsions, inflammation and fever, and — with hemorrhages — pupil constriction, slowing of the pulse and respiratory affection.

In the first half of the 19th century, in Russia, trepanations were rarely performed, mainly for strictly justified indications. Thus, N.F. Arendt who performed about 1,000 major operations carried out only 15 to 20 trepanations, after which three trauma patients survived.

Published in 1840 “Guide to operative surgery” by Academician Christian Salomon (1797–1851) was the quintessence of the experience of Russian surgery before N.I. Pirogov. With regard to skull and brain injuries, C.C. Salomon mainly shared the views of I.F. Bush. It is noteworthy that this manual for the first time contained a recommendation on the use of beeswax for hemostasis during trepanation.

Fig. 1.12. Ivan Fedorovich Bush (1771–1843), author of the first Russian manual of surgery

Probably, the first operation in Russia for an intracranial tumor was performed in 1844 by a professor of Kharkov University, a Venetian by origin Tito Vanzetti (1809–1888). The author described the observation of a patient with a giant neoplasm in the right half of the head and the base of the skull without signs of brain dysfunction. During the operation, instead of the supposed cyst, a dense tumor was found, which the surgeon removed within the bounds of possibility. The patient died on the 32nd day from infectious complications.

The experience of Russian surgery in the middle of the 19th century was reflected in the “Principles of general military field surgery” by Nikolai Ivanovich Pirogov, published in Dresden in 1865–1866. Pirogov (1810–1881, Fig. 1.13) presented a comprehensive analysis of morphological changes, pathophysiological and restorative mechanisms accompanying TBI. In total, he performed about 20 trepanations, both in the acute and in the long-term period of TBI. Outcome statistics are unclear. Of particular importance for the development of neurosurgery was the famous “ice” atlas (1851–1854) by N.I. Pirogov who laid the foundations of topographic anatomy. The drawings of head cuts published in the 1st part of the atlas (1851) are striking in accuracy and resemble modern computed tomograms.

Fig. 1.13. Nikolai Ivanovich Pirogov (1810–1881)

By the middle of the 19th century, the anatomical and technical base for the development of neurosurgery was created, some clinical experience was accumulated. General anesthesia made it possible to prolong the operation time and better navigate the wound. In 1844, Horace Wells (1815–1848) proposed nitrous oxide; in 1846, chemist W.T.O. Morton (1819–1868) and surgeon J.C. Warren (1778–1856) applied ether; J.Y. Simpson (1811–1870) in 1847 presented chloroform. However, the opening of dura mater still entailed catastrophic consequences in the form of infectious complications.

London surgeon Charles Ballance (1856–1936) (Fig. 1.14) who diagnosed and successfully removed the neurinoma of the auditory nerve in 1894 described the situation of the 1870s in a Lister lecture in 1933 like "the paralysis of surgery ... in the presence of suppuration, cellulitis, erysipelas, septicaemia, pyaemia, acute traumatic gangrene, and tetanus, for which diseases there was as yet no means of prevention and no remedy". Demonstration operations were carried out in an auditorium for several hundred people. "The surgeon operated in a frock coat, which had for a long time been kept in the theater. It was stained with blood and pus of previous operations. The instruments were placed in a tray lined with green baize. When a ligature was required the theater attendant pulled it with his left hand, holding the other end in his teeth, rubbed it with wax and handed it to the surgeon".

In 1843, Oliver Holmes (1808–1894) and in 1861 Ignaz Semmelweis (1818–1865) showed that obstetricians transferred "puerperal fever" with dirty hands, and simple hand washing before and after each study significantly reduced the frequency of this pathology. Nevertheless, the concept of the bacterial nature of purulent complications developed by surgeons Louis Pasteur (1822–1895) and Robert Koch (1834–1910) was not perceived as an interesting theory. Its practical application was not discussed before the development of theories and practices of antiseptics by Joseph Lister (1827–1912). Soon, antiseptics began to be supplemented with aseptic elements, in particular, autoclaving of part of surgical materials, washing of the surgeon's hands and the patient's skin with brushes, putting on rubber gloves proposed by William S. Halsted (1852–1922), etc. The introduction of asepsis into practice in full is associated with the name of Emil Theodor Kocher (1841–1917, Fig. 1.15), whose surgical clinic in Bern has become a leading center for the development and implementation of this technology, which seems to be completely natural today. Doctors from many countries came to study under Kocher including Cushing, who later became an outstanding neurosurgeon. Having introduced asepsis and a number of general surgical operations, Kocher improved the technique of skull trepanation, methods of treating spinal injuries, proposed an original operation for epilepsy. The implementation of asepsis and antiseptics in Russia happened very quickly, and from the beginning of the 1880s, this technique was already used routinely not only in most large clinics but also in zemstvo hospitals.

As without anesthesia and asepsis, the development of neurosurgery was impossible without topical diagnostics. Until the beginning of the second half of the 19th century, the concept of the functioning of the brain as a whole prevailed. Only after the works by Pierre Paul Broca (1824–1880) published in 1861, in 1870 — by Gustav Fritsch and Edward Hitzig, and in 1874 — by Carl Wernicke (1848–1904), the concept of localization of functions in certain parts of the brain was established. The first operation to remove a meningioma diagnosed by clinical manifestations without convexital hyperostosis in the history of medicine was performed in 1884 by an Italian doctor Francesco Durante (1845–1934). The patient survived and was successfully operated again 11 years later for continued tumor growth. The possibility of localization of lesion, the accuracy of which has significantly increased with the appearance of V.M. Bekhterev's works, has posed an equally urgent task today of choosing the optimal surgical access to the identified mass lesion. However, the absence of any neuroimaging techniques made it extremely difficult.

Fig. 1.14. Sir Charles Ballance (1856–1936) — a surgeon who managed to diagnose and successfully remove neurinoma of the cranial nerve VIII in the pre-X-ray era

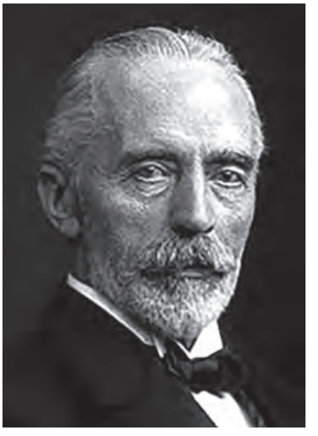


Fig. 1.15. Emil Theodor Kocher (1841–1917), an outstanding surgeon. His even greater contribution to medicine is considered to be the development and promotion of asepsis

The original solution to the problem of projection of the focus on the surface of the skull belongs to D.N. Zernov (1834–1917) who in 1889 proposed a device called an encephalometer to determine the projection of various parts of the brain on the skull. The device was fixed at standard points, almost parallel to the orbitomeatal line, which provided a comparison of all measurements with the atlas (Fig. 1.16).

a

b

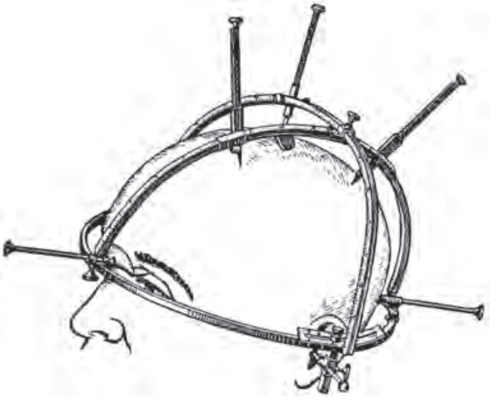


Fig. 1.16. a — Dmitry Nikolaevich Zernov (1834–1917); b — encephalometer (1889) — the prototype of neuronavigation and stereotaxis

Until the last decades of the 19th century, all trepanations in the world were resection. In 1873, Yu.A. Kosmovsky (1844–1908) showed the possibility of successful engraftment of a free bone flap. German surgeon Wilhelm Wagner (1848–1900) in 1889 proposed to preserve the “leg” of the periosteum and temporal muscle, which provides nutrition to the bone flap, and this technique remained classic for many years.

Technically, performing bone-plastic trepanation of the skull until the end of the 19th century was difficult. The chisel and hammer remained the main tools. In 1891, professor

Jean Toison from Lille (France) used a chain saw to connect the milling holes. The saw was quite rough and was not widely used.

Leonardo Gigli (published his main work in German, so German pronunciation of the surname was established in many languages) (1863–1908), an obstetrician from Florence, proposed in 1894 a wire saw for symphysiotomy. As now, Gigli saws were disposable. Russian professor Alfred Obalinski from the University of Krakow soon used a Gigli saw for trepanation.

A great contribution to the development of neurosurgery was made by Sir Victor A.H. Horsley (1857–1916); he developed a method of stereotactic interventions (Fig. 1.17), various variants of operations, removed a spinal cord tumor for the first time. Horsley's suggestion to sew up the surgical wound, which was considered optional by his predecessors, was also important.

The discovery of X-rays by W.C. Röntgen on November 8, 1895 fundamentally changed the possibilities of lifetime diagnosis of various diseases including pathological processes in the cranial cavity.

Before the beginning of the 20th century, neurosurgical operations were performed by general surgeons. For the first time, the need to separate neurosurgery into a separate specialty was justified by professor L.A. Malinovsky of Kazan University (1854 – ca. 1916). In February 1893, in the report "On the surgical treatment of diseases of the central nervous system" read at a meeting of the Society of Neuropathologists and Psychiatrists at Kazan University Malinovsky clearly formulated the basic principles of neurosurgery and raised the question of special training of a surgeon operating on the central nervous system (CNS).

In practice, this provision was implemented by Vladimir Mikhailovich Bekhterev (1857–1927) (Fig. 1.18), on whose initiative the Nervous Clinic of the Imperial Military medical academy was established, which for the first time in the world included a special neurosurgical operating room and a "separate room for operated patients" (neurosurgical department). A student of V.M. Bekhterev, Ludwig Martynovich Pussep

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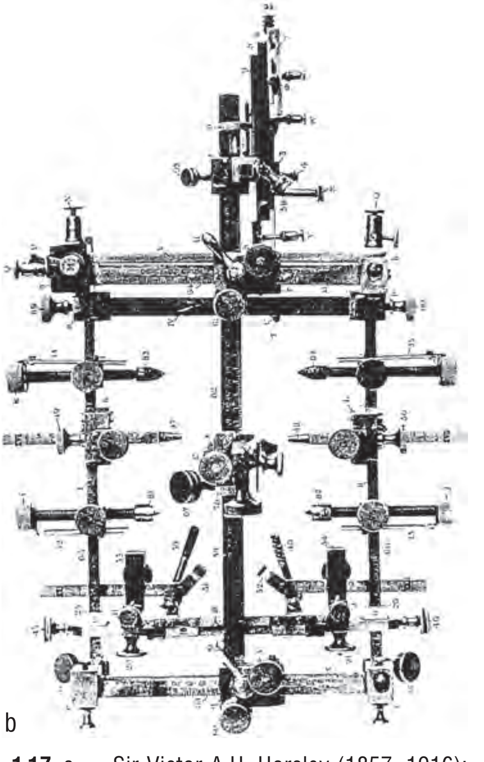

b

Fig. 1.17. a — Sir Victor A.H. Horsley (1857–1916); b — stereotactic apparatus of Gorsley and Clark (1908). In: Horsley V.A.H., Clarke R.H. The structure and functions of the cerebellum examined by a new method. Brain, 1908

(1875–1942) (Fig. 1.19, left), the first professional neurosurgeon in Russia and the second in the world, made a great contribution to the development of neurosurgery as an independent specialty. In 1910, he organized the world's first department of neurosurgery.

Fig. 1.18. Vladimir Mikhailovich Bekhterev (1857–1927) — a founder of the world's first neurosurgical department (1897)

Fig. 1.19. Ludvig Martynovich Pussep (1875–1942), in Estonian transcription Puusepp (left), A.L. Polenov (center) and I.S. Babchin

Thierry de Martel (1875–1940) made a great contribution to the development of neurosurgical techniques (Fig. 1.20). His main inventions are considered to be the metal guide for the Gigli saw used to present time, an electric trepan, a self-retaining retractor, a special surgical table for operations in a sitting position and an appropriate chair for the surgeon; all this was proposed in 1908. Also, de Martel was the first to provide film documentation of operations and one of the first to provide intraoperative photography.

Fig. 1.20. T. de Martel (Thierry de Martel, 1875–1940) — inventor of tools and devices, without which modern neurosurgery is unthinkable. Promoting a safe electric trepan, he claimed that “an imbecile can work with it”. Many were offended, and Cushing did not use this tool

His contemporary, an outstanding German neurosurgeon and neurologist Otfrid Foerster (Otfrid Foerster, 1873–1941) (Fig. 1.21), developed the technique of intraoperative electrical stimulation of the motor cortex and electrocorticography, i.e., methods that significantly improve the functional results of operations. He also described dermatomes for the first time, mapped the motor cortex of the brain, proposed a hyperventilation test to detect convulsive activity by electroencephalogram in epilepsy, developed operations for spasticity and pain syndromes.

Harvey William Cushing (1869–1939) is recognized as one of the founders of world neurosurgery (Fig. 1.22). After completing his training with the leading surgeons of America and Europe, in 1902, he became the world's first professional neurosurgeon. His works on the treatment of pituitary tumors (1912), cerebellopontine angle (1917) and intracranial meningiomas (1938) have become classic, and modern neurosurgeons also use them. The vacuum aspirator, washing the wound during surgery with saline, cotton strips to protect the brain and many other innovations proposed by Cushing are still used today in neurosurgical interventions.

Modern neurosurgery owes a lot to the American neurosurgeon Walter E. Dandy (1886–1946) (Fig. 1.23). He studied under Cushing, then began to work independently and achieved brilliant results, primarily in terms of the radical nature of neuro-oncological interventions. Dandy was the first who began to use intraoperative monitoring of vital functions, developed and implemented the concept of a wake-up room, where appropriate equipment and a permanent nursing station were provided, then he created an intensive care unit. An equally important contribution of Dandy to neurosurgery was the development of such diagnostic methods as pneumoventriculography (1918) and pneumoencephalography with endolumbar air injection (1919). These methods have radically changed the diagnosis of various brain lesions.

The next revolutionary invention in neurosurgery is considered to be the technique of cerebral angiography developed in 1927–1934 by E. Moniz (1874–1955). It provided an opportunity for accurate diagnosis and differentiated treatment of cerebrovascular lesions. Taking into account the data of cerebral angiography, Dandy first performed clipping of an intracranial arterial aneurysm (1936).

The World War I forced us to solve the issues of providing assistance to the wounded with damage to the nervous system. In 1915, the world's first specialized hospital for victims with nervous system injury was established in Russia — the Petrograd first local military Infirmary named after N.I. Pirogov for the patients with nervous system injuries (with 900 beds). An important stage in the development of neurosurgery in Russia was the creation by A.L. Polenov (1871–1947) of the Physico-Surgical Institute in Petrograd in 1917, transformed in 1924 into the State Traumatology Institute with a Neurosurgical Department, which he headed in 1931. Thanks to the efforts of L.I. Poussep's student, A.G. Molotkov (1874–1950), the Institute of Surgical Neuropathology was founded in 1925, after the merger of which with the neurosurgical department of the Traumatology Institute in 1938, the Russian Neurosurgical Institute, now named after A.L. Polenov, was established.

In the early 1920s, neurosurgical departments began to open in the USSR on the basis of surgical or neurological clinics (V.N. Shamov and A.M. Grinstein opened such a department in 1923 in Kharkov, V.N. Shamov and S.S. Goldman — in 1924 at the Military Medical Academy in Leningrad, S.I. Spasokukotsky and A.N. Bakulev — in 1924 in Saratov, P.O. Emdin and V.A. Nikolsky — in 1925 in Rostov-on-Don,

Fig. 1.21. Otfrid Foerster (1873–1941) participated in the treatment of V.I. Ulyanov (Lenin)

Fig. 1.22. Harvey William Cushing (1869–1939), founder of neurosurgery

Fig. 1.23. Walter E. Dandy (1886–1946), an outstanding American neurosurgeon

etc.), general surgeons and neuropathologists worked there. A number of manuals have been published, among them it should be noted that V.V. Kramer's manual "The Doctrine of Localizations" (1929) played a great role in improving the quality of neurological diagnostics.

Of particular importance for the national neurosurgery was the creation by N.N. Burdenko (1876–1946) (Fig. 1.24) of neurosurgical wards on the basis of the Clinic of Faculty Surgery of the 1st Moscow Medical Institute (1924). Having correctly assessed the prospects of a new specialty and having prepared a group of specialists, in 1929, N.N. Burdenko and V.V. Kramer organized a neurosurgical clinic on the basis of the State Radiological Institute. In 1932, it was transformed into the Central Neurosurgical Research Institute (now the National Medical Research Center of Neurosurgery named after academician N.N. Burdenko of the Ministry of Health of Russia).

Fig. 1.24. Nikolai Nilovich Burdenko (1876–1946), the creator of the USSR neurosurgical aid system, the first director of the Research Institute of Neurosurgery of the Russian Academy of Medical Sciences; Chief Surgeon of the Soviet Army, one of the founders of the USSR Academy of Medical Sciences (1944)

The system of neurosurgical care established in the USSR made it possible to plan scientific research, organize training and standardize medical and diagnostic measures throughout the vast country. For this purpose, a Neurosurgical Council was created at the Central Neurosurgical Institute, on the basis of which the Society of Neurosurgeons of the USSR, and then of Russia, arose. In 1937, the efforts of N.N. Burdenko created the world's second professional journal "Voprosy neirochirurgii" (the first since 1935 was published in Germany).

In the war and post-war years in the USSR, the main attention, of course, was paid to the treatment of CNS injuries. Colossal economic damage and insufficient funding hindered the development of such a high-tech science as neurosurgery.

Fig. 1.25. Alexander Ivanovich Arutyunov (1903–1975), chief surgeon of a number of fronts during the World War II, founder of the Kiev Institute of Neurosurgery and director of the Burdenko Institute of Neurosurgery from 1964 to 1975

Nevertheless, through the efforts of A.I. Arutyunov (Fig. 1.25), in 1950, the Institute of Neurosurgery was established in Kiev. From 1964 to 1975, he was the director of the Neurosurgery Research Institute named after academician N.N. Burdenko of the Russian Academy of Medical Sciences.

There were created neurosurgical centers in Belarus, Georgia, Uzbekistan and other republics of the USSR.

In the second half of the 20th century, there was a rapid improvement of neurosurgical technologies. W.F. House's proposal to use a microscope and special microsurgical instruments (1963) for brain surgery radically changed neurosurgery. Almost simultaneously, W. Lougheed, Th. Kurze, R. Rand, J. Jacobson, M.G. Yasargil and other neurosurgeons began to use the surgical microscope. A significant role was played by the proposal of L.I. Malis to use bipolar coagulation to stop bleeding.

Ch. Drake (Canada), M.G. Yaşargil (Switzerland), K. Sugita (Japan) made a significant contribution to the development of methods for the treatment of vascular lesions, Endovasal surgery of the brain, primarily arterial and arteriovenous aneurysms. A breakthrough in vascular surgery is associated with the invention of F.A. Serbinenko (Russia, 1928–2002) (Fig. 1.26), a detachable balloon catheter (1971). However, the industrial production of balloon catheters and other instruments for endovasal surgery in the USSR was never created. The technology of endovasal interventions is being successfully improved and is increasingly being used to treat a number of vascular diseases of the CNS including such dangerous ones as arterial aneurysms and arteriovenous malformations.

Fig. 1.26. Fedor Andreevich Serbinenko (1928–2002) — founder of endovascular neurosurgery

Stereotactic and functional interventions are important areas of modern neurosurgery. Stereotactic neurosurgery uses spatial calculations and allows to insert special instruments with great accuracy — biopsy cannulas, electrodes for destruction or stimulation, etc., — into specified areas of the brain. To perform such operations, special stereotactic devices are used with a frame fixed on the patient's head, one of the prototypes of which is considered to be the encephalometer proposed by D.I. Zernov. Stereotactic method has been successfully used for the treatment of Parkinsonism, other hyperkinesis and muscle tone disorders, severe pain syndromes, deep-seated tumors. A great contribution to the development of stereotaxic neurosurgery in the Soviet Union was made by E.I. Kandel (1923–1990) (Fig. 1.27).

Simultaneously with general neurosurgery, pediatric neurosurgery, as its relatively independent section, has been developing since the middle of the last century. In our country, the pioneer of pediatric neurosurgery was A.A. Arendt who headed the first pediatric neurosurgical department in the USSR. Important for the development of pediatric neurosurgery was the proposal of a number of authors to use valve bypass systems that ensure the removal of cerebrospinal fluid outside the CNS (into the venous system, abdominal cavity) for the treatment of hydrocephalus — a disease common in childhood.

Among the technical innovations that have significantly expanded the possibilities of treating diseases of the nervous system, it is necessary to include endoscopic techniques.

A true breakthrough in the development of neurosurgery is associated with the emergence of neuroimaging methods — computed tomography (CT) (G. Hounsfield, J. Ambrose, 1971), digital angiography and then magnetic resonance imaging (MRI). The radioisotope testing methods that emerged earlier in combination with CT made it possible to create positron emission CT, which provided an assessment of metabolism both in a healthy brain and in a pathological focus. The possibility of visualization of the pathological focus allowed the use of gentle, minimally invasive approaches, which significantly reduced mortality and improved the quality of life of patients after neurosurgical interventions.

Fig. 1.27. Eduard Izrailevich Kandel (1923–1990) — founder of stereotactic neurosurgery in the USSR

At the same time, it became possible to influence an individually defined “target” during stereotactic interventions, rather than relying on averaged atlas data.

Computerization of medical devices has led not only to the expansion of diagnostic capabilities but also to the creation of new implantable computer devices used in the treatment of pain, hyperkinesis, spasticity, hearing disorders.

Development of neurosurgery in the second half of the 20th century provided the technical possibility of intervention on any structures of the CNS and peripheral nervous system (PNS). However, it is clear that the malignant nature of many tumors does not allow us to count on surgery as the only way of treatment. Under these conditions, precision, stereotaxically oriented radiation techniques are intensively used, allowing a high dose of radiation energy to be brought to the focus of the pathological process with minimal impact on healthy tissues: a gamma knife proposed by L. Lexell in 1951, linear accelerators and installations providing irradiation with a beam of protons or heavier particles.

Finally, a significant role in the development of neurosurgery was played by the development of the pharmaceutical industry: doctors received means to combat brain edema, anticonvulsants and many other drugs, cytostatics, successfully used in the treatment of previously incurable tumors of the CNS, for example, medulloblastoma.

Thus, if at the end of the 19th century, the level of neurosurgery in general corresponded to the one described by I.S. Shmelev in the book “The Summer of the Lord”: “... it is impossible to cure, and if an operation is done, the head is opened ... then it is unlikely that the patient will survive ... out of ten, nine die under the knife”, then today the situation has changed dramatically. In recent years, the postoperative mortality rate at the Burdenko National Center of Neurosurgery does not exceed 0.3%. The goal of neurosurgical treatment, especially in a planned situation, is no longer considered an attempt to save the patient's life at any cost but to ensure its high quality and duration.