Craniotomy, was practiced in Africa 12,000 years, and in Europe, 6,000 years ago. However, these cuts were made in the skulls, mostly dead, and this was done, probably because of superstition, for example, to drive out evil spirits. Already in the 1877 French anthropologist Paul Broca made the classification of the ancient transactions on the vault of the skull of man, which even today retains its value. He suggested that craniotomy was performed on living people sometimes - to heal them from certain diseases such as hysteria, epilepsy, convulsions, nervous - disease, the cause of which takes the existing in the head and was attributed to the special spirit resides there. An artificial opening done in the skull, was intended to give vent to the spirit and so contribute to the liberation of the subject from the disease.

More recent studies of other trepan skulls have led to the discovery of a whole set of different methods of surgical technique and pointed out the striking fact is that half of these patients after craniotomy completely cured. This can be seen at the edges of the bone around the hole in the skull, they are completely covered with new bone tissue, smooth and round. Scientists estimate that hundreds of trepan skulls found at present in Peru, exceed the amount of all known prehistoric trepan skulls in the world at large. For many centuries before the arrival of modern medicine in Peru, was born here neurosurgery...

The Incas performed trepanation of the skull operations in approximately every third inhabitant of Cuzco. Of the 420 skulls found, there were 145 holes from prior operations. One skull has seven holes, which means that the patient was subjected to craniotomy seven times.

As a result of examination of the bones, found out that infectious diseases after operations have been extremely rare. Moreover, instead of antibiotics and pain medication, the Incas used a variety of herbs that act is no worse than modern drugs.
The word «trepan» (trypanon) - Greek in origin, it meant a special drill bit that were used to perforate the skull. Scalpel blade served as a strong scraper. In ancient times a wide variety of techniques were used - sawed square or right-angled plates, which are then taken out, drilled holes in a circle outlined by, or just the bone was cut.

Trepanation was considered a promising treatment for migraines, epilepsy and mental disorders since the Neolithic.

In the Middle Ages, and some time later, there was a belief that stupidity and other mental deviations were due to the fact that the human mind have any stone, tumors (Dutch expression “to have a stone in the head” - to be stupid, insane, the head is not in place). And if their removal make the person wiser immediately.

Indeed, there were charlatans who were engaged in such operations, - alone or with assistants, they wandered from city to city, and deceived the simple.

Pieter Bruegel the Elder. “Removing a folly stone”

Hieronymus Bosch. “Extraction of stupidity stones”, 1475

David Teniers the Younger. “Surgical removal of stupidity stones”, 1486
Jan Sanders van Hemessen, “Surgeon”, 1560

A device for opening the skull (19th century) Trephine (1800)

Saw cutting of the skull (1830)

A set of tools for craniotomy (1806)

Charles Bell (The surgeon-artist) (1774-1842)

Neurosurgery separated from the surgery and neurology and was formed as an independent profession at the turn of the XIX and XX centuries. An important milestone in the development of neurosurgery was in 1897 when a prominent Russian Academician Vladimir Bekhterev (1857-1927) opened a clinic for nervous and mental diseases of the Military Medical Academy, the world’s first operating room for surgical treatment of patients with diseases of the nervous system. In opening speech he said that predetermined path of formation of neurosurgery: “If current neurologist even ask for help to the surgeons, the next generation is already probably will not need it. Holding the knife, it will itself do what is rightfully his”
In 1905 V.Bekhterev organized the first neurosurgical department with 20 beds, of which he was appointed head of his student Ludwig Pusseip. In 1909 L.Pusseip led the world’s first department of surgical neurology at Psychoneurological Institute in St. Petersburg. In 1914, with his active participation on the basis of the same institute was opened the first specialized hospital for treatment of injuries with damage of the nervous system.

In 1921, in Petrograd, Andrew Polenov (1871-1947) organized the neurosurgical department, and in 1924 it was recognized to the neurological clinic at the National Trauma Institute. In 1924, in Leningrad, the world’s first institute of neurosurgery was created. A.Polonev played a prominent role in the development of neurosurgery and the creation of the Leningrad neurosurgical school. He produced the world’s first operation in the pathways of the brain during cortical epilepsy, athetosis, and the excruciating pain of extrapyramidal hyperkinesia.

In addition to Moscow and Leningrad, neurosurgical centers are organized in other major cities. For example, in Kharkov in 1937, Professor Vladimir Berezov (1882-1962) opens the neurosurgical department at the base led them to the surgical clinic Medical Institute. Moving to Leningrad in 1930, he organized in the surgical clinic of the Military Medical Academy the neurosurgical department, which later became the basis for the organization of independent neurosurgical department. In 1931, in Kharkov, Zahir Ostymanovich organized at the Ukrainian Institute of psycho-neurological clinic the clinic of neurosurgery. In Kiev, the first neurosurgical department was opened in 1937, at the Kiev Institute of neuropyschiatric institute in neurosurgery, but it was not then been carried out in connection with the outbreak of the Great Patriotic War.

In the postwar period in our country great attention was paid to expanding the network of agencies and departments of neurosurgery. In Kiev in 1950 implemented a government decision in 1949 on the establishment neuropyschiatric institute at the Institute of Neurosurgery. Its creation was associated with the name of Alexander Arutyunov (1904-1975), who headed the agency and the Ukrainian school of neurosurgeons. From 1964 to 1979 A.Arutyunov headed the Institute of Neurosurgery.

In the first years after the revolution in our country, in spite of famine and devastation, begin to form new neurological institutions. In 1925, in Petrograd, Alexander Lotanov (1871-1947) organized the neurological department, and in 1926 it was recognized to the neurological clinic at the National Trauma Institute. In 1924, in Leningrad, the world’s first institute of neurosurgery was created. A.Polonev played a prominent role in the development of neurosurgery and the creation of the Leningrad neurosurgical school. He produced the world’s first operation in the pathways of the brain during cortical epilepsy, athetosis, and the excruciating pain of extrapyramidal hyperkinesia. The first in Russia has developed a surgery of spinal cord pathways - cordotomy in its various versions. A.L.Polenov and his students have made a great contribution to the surgery of peripheral nerves and autonomic nervous system, a case study of trophic disorders, surgical treatment of spastic paralysis. Memory assignment A.Polonev immortalized his name Leningrad Research Institute of Neurosurgery.

In 1924, the faculty surgical clinic of the 1st Moscow Medical Institute, began his neurosurgical operations outstanding scientist, surgeon and healthcare organizer Nikolai Burdenko (1876-1946). In 1920 he, together with a neurologist V.Kramer (1873-1946) organized at the State Institute for X-neurosurgical hospital, which was the base established in 1924 by the Central Neurosurgical Institute headed by Vladimir Bekhterev.

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The development of neurosurgery at the beginning of the XX century closely associated with the activities of major American scientist Harvey Cushing (1869-1939) - one of the founders of modern neurosurgery, the creator of the famous school of neurosurgeons. His great merit is the development of rational methods of surgery on the brain and especially the methods of hemostasis (the use of clips, electrocoagulation, direct suction from the surgical wound), which greatly expanded the possibilities of treatment neurosurgical patients. Together with developed a classification of tumors of the nervous system, which, despite its subsequent amendments, is the foundation of all modern classifications.

Developed diagnostic techniques in neurosurgery. This is suggested by the American neurosurgeon Walter Dandy (1886-1946) ventrikulography, myelography (1918), and then pneumoencephalography (1919) From the standpoint of modern neurosurgery even more important was the method of cerebral angiography, which was first developed and applied in practice, the Portuguese neurologist Egas Moniz and the neurosurgeon in 1927. Diagnostic value of cerebral and spinal angiography increased, and now it is one of the most informative methods of auxiliary neurosurgical investigation. The second important contribution to the development of neurosurgery was lobotomy offered by E.Moniz in 1935 for patients with various mental illnesses. For the development of this operation in 1949, he was awarded the Nobel Prize. From 1935 to 1978 the world was carried out 113,000 such operations on the brain.

Central and peripheral nervous system

The human nervous system is classified on the conditions of formation and type of management as:
- Lowest nervous activity
- Higher nervous activity by the method of information transfer as:
  - Neurohumoral regulation
  - Reflex regulation
- Localization as:
  - Central Nervous System
  - Peripheral Nervous system of functional accessories like:
    - Somatic nervous system
    - The autonomic nervous system (sympathetic nervous system, parasympathetic nervous system)

The circulation of the cerebrospinal fluid

Anatomy and physiology of the brain

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The total volume of cerebrospinal fluid in adults is approximately 150-200 ml, of which about 30 ml in the spinal subarachnoid space. Products of the daily-induced approximately 500 ml CSF, respectively 20 ml/h.
The system of cerebral ventricles

Involved in the formation of: 1) PSA 2) the initial segment of ACA (A-1), 3) of the ICA Supraklinoid 4) SAR 5) The initial segment of PCA (P-1), 6) distal portion of the basilar artery

Vascularization of the subcortical structures

Arterial Circulation of the Brain, Including Carotid Arteries

Microvascular branches of ACA and MCA

Yellow - ACA;
Pink - MCA;
Green - PCA;
Lilac - Front villous artery;
Blue - SAR
The venous system of the occipital region

1. deep occipital venae
2. vertebral artery
3. atlanto-occipital sinus (suboccipital venous plexus)
4. condylar emissary venae
5. anastomosis of the atlanto-occipital sinus with the occipital vein
6. mastoid emissary venae
7. sigmoid sinus
8. occipital emissary venae
9. transverse sinus
10. jugular vein
11. superior sagittal sinus
12. posterior auricular venae
13. transverse sinus
14. occipital venae
15. posterior auricular venae
16. occipital sinus
17. internal jugular venae
18. occipital sinus
19. vertebral venae

The system of venous sinuses

Methods of investigation in neurosurgery

NONINVASIVE
- Ehoencephaloscopy;
- Radiography of the skull and spine;
- Transcranial Doppler sonography;
- Electroneuromyography (surface and needle);
- Computed tomography of the brain and spine (with contrast);
- Magnetic resonance imaging of the brain and spinal cord (with contrast);

INVASIVE
- Lumbar puncture (liquorodynamic samples);
- Suboktsipitalnaya puncture;
- Ventriculopuncture;
- Cerebral and spinal angiography;
- Myelography (ascending and descending);
- Ventriculography (rentgenpositive or pneumatic);
- Electrocorticography;

AUXILIARY
- Ophthalmologic examination;
- Otoneurologic survey

Ehoencephaloskopy

Method Ehoencephaloskopy was introduced into clinical practice in 1956 by a Swedish neurosurgeon pioneering research L. Leksella, who used a modified apparatus for industrial radiography, well-known in the art as a method of "nondestructive testing", and based on the ability of ultrasound reflected from the boundaries of media with different acoustic impedance.

Electroencephalography - a method for studying brain activity, which is based on recording the total activity of the cells (neurons). EEG is a recording of the difference between the oscillations of bioelectric potentials of the living brain.
The major indications for EEG recordings in neurological practice are:

- suspicion of epilepsy in a new patient
- assessment of epilepsy in a patient with recurrent seizures
- assessment of the risk of epilepsy in a patient who has undergone intracranial surgery or following a severe head injury
- as an aid in the diagnosis of herpes simplex encephalitis and Creutzfeldt-Jakob disease

**ELECTROENCEPHALOGRAPHY (EEG)**

(Records the spontaneous electrical activity of the brain)

**Electromyography (EMG)** - a hardware method of research, which is determined by the degree of electrical activity in muscles and nerve conduction.

EMG can help diagnose many muscle and nerve disorders, including:

- muscular dystrophy
- congenital myopathies
- mitochondrial myopathies
- metabolic myopathies
- myotonias
- peripheral neuropathies
- radiculopathies
- nerve lesions
- amyotrophic lateral sclerosis
- polio
- spinal muscular atrophy
- Guillain-Barre syndrome
- ataxias
- myasthenias
- inflammatory myopathies
EVOKE POTENTIALS

Stimulation of the sensory receptor will evoke a signal in the appropriate region of the cerebral cortex

• Visual evoked potential
• Brainstem auditory evoked potential
• Somatosensory evoked potential

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Cranioigraphy to diagnose:
1) Ossified intracranial hematoma

2) Fractures and defects of the skull bones;
3) Gématosinus;
4) Pneumocéphaly

Metal Shard
Metal pipe

Bullet
Screw

Myelography
1 - The spinal cord;
2 - The contrast in the subarachnoid space;
3 - Intervertebral disc;
4 - Cauda equina roots

Myelography
Partial block of cerebrospinal fluid
Full block of cerebrospinal fluid
CT of the brain allows you to visualize: 1) linear and depressed fractures of the bones of the skull

2) 3D CT Scull
Etched many fragmented fracture of the frontal bone with the transition to the roof of the left orbit

Condition after fracture repositioning of bone fragments
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3) Hematomas:
- Epidural hematoma
- Subdural hematoma

4) Pneumcephaly

5) Chronic subdural hematoma

6) Subdural hygroma

7) Subarachnoid hemorrhage

8) Contusion

9) Intracerebral hematoma
A CT-myelogram coronal 2D reconstructed image shows the expanding intraspinal low density mass circumventing the thecal sac posteriorly and displacing the nerve roots to the left of the conus. An arlov cyst (nerve root sleeve cyst or diverticulum) of left S3 is incidentally noted.

A CT-myelogram sagittal 2D reconstructed image shows the expanding intraspinal low density mass surrounding the thecal sac.

**MAGNETIC RESONANCE IMAGING**

It is a valuable investigation in the following neurosurgical conditions:

- Intracranial tumours — meningioma, acoustic neuromas, pituitary tumours, skull base tumours, metastases, lymphoma, meningiial infiltration, glioma
- CNS infection — cerebral abscess, herpes simplex encephalitis
- Arteriovenous malformations
- Venous sinus thrombosis
- Craniospinal abnormalities such as the Chiari malformation
- Syringomyelia
- Hippocampal or mesial sclerosis
- Spinal tumours
- Lumbar disc prolapse, lumbar canal stenosis
- Cervical cord compression — cervical myelopathy, cervical central disc prolapse
- Cervical disc prolapse
- Thoracic disc prolapse

**MRI of the brain (intracerebral hematoma)**

**NORMAL MRI**

**MRI-Myelography**
MR angiography (axial view)

MR angiography (coronary view)

3D CT Angiography

Functional MRI of the brain (fMRI)

to determine the activation of specific brain areas during normal operation it under the influence of various physical factors (eg, movement of the body) and in various pathological conditions.
CSF can be obtained by:

- lumbar puncture
- cisternal puncture
- cannulation of the lateral ventricle

Lumbar puncture

The most common indications for CSF examination by lumbar puncture are:

- meningitis
- subarachnoid haemorrhage
- neurological diseases such as multiple sclerosis
- cytological examination for neoplastic disease
- radiological imaging (e.g. myelography) or radio-isotope investigations
- measurement of intracranial pressure

Position the patient during lumbar puncture

Scheme lumbar, puncture and aspiration suboccipital through a large fontanelle
Complications of lumbar puncture

However, there are several potential hazards and complications; these include:

- progression of brain herniation
- progression of spinal cord compression
- injury to the neural structures
- headache
- backache
- infection — local and meningitis
- implantation of epidermoid tumour (rare)

### Liquorodynamic samples

Samples Kvekkenshtedt (1) and Stukey (2)

### CSF along the cerebrospinal axis

#### Table 2.1 CSF statistics (lumbar).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>140 ml</td>
</tr>
<tr>
<td>Rate of production</td>
<td>0.4 ml/min</td>
</tr>
<tr>
<td>Pressure (recumbent)</td>
<td>Less than 5 cm H2O</td>
</tr>
<tr>
<td>Protein</td>
<td>0.15-0.45 g/l</td>
</tr>
<tr>
<td>Glucose</td>
<td>2.8-4.2 mmol/l</td>
</tr>
<tr>
<td>Chloride</td>
<td>120-130 mmol/l</td>
</tr>
</tbody>
</table>

The values are expressed in SI (Système International) units and the corresponding traditional units are in parentheses.

#### Table 2.2 CSF gradients along the cerebrospinal axis.

<table>
<thead>
<tr>
<th>Region</th>
<th>Ventricle</th>
<th>Cisternal</th>
<th>Lumbar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g/l)</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Glucose (mmol/l)</td>
<td>4.5</td>
<td>4.0</td>
<td>3.4</td>
</tr>
</tbody>
</table>

### Cerebral angiography

The major indications for angiography are:

- investigation of cerebral ischaemia due to carotid artery disease and intracranial atheroma
- investigation of subarachnoid haemorrhage, e.g. cerebral aneurysm, arteriovenous malformation
- investigation of venous sinus thrombosis
- preoperative embolization of meningioma
Cerebral carotid angiography

Endoscopic surgery

Cerebral panangiography

THANK YOU!