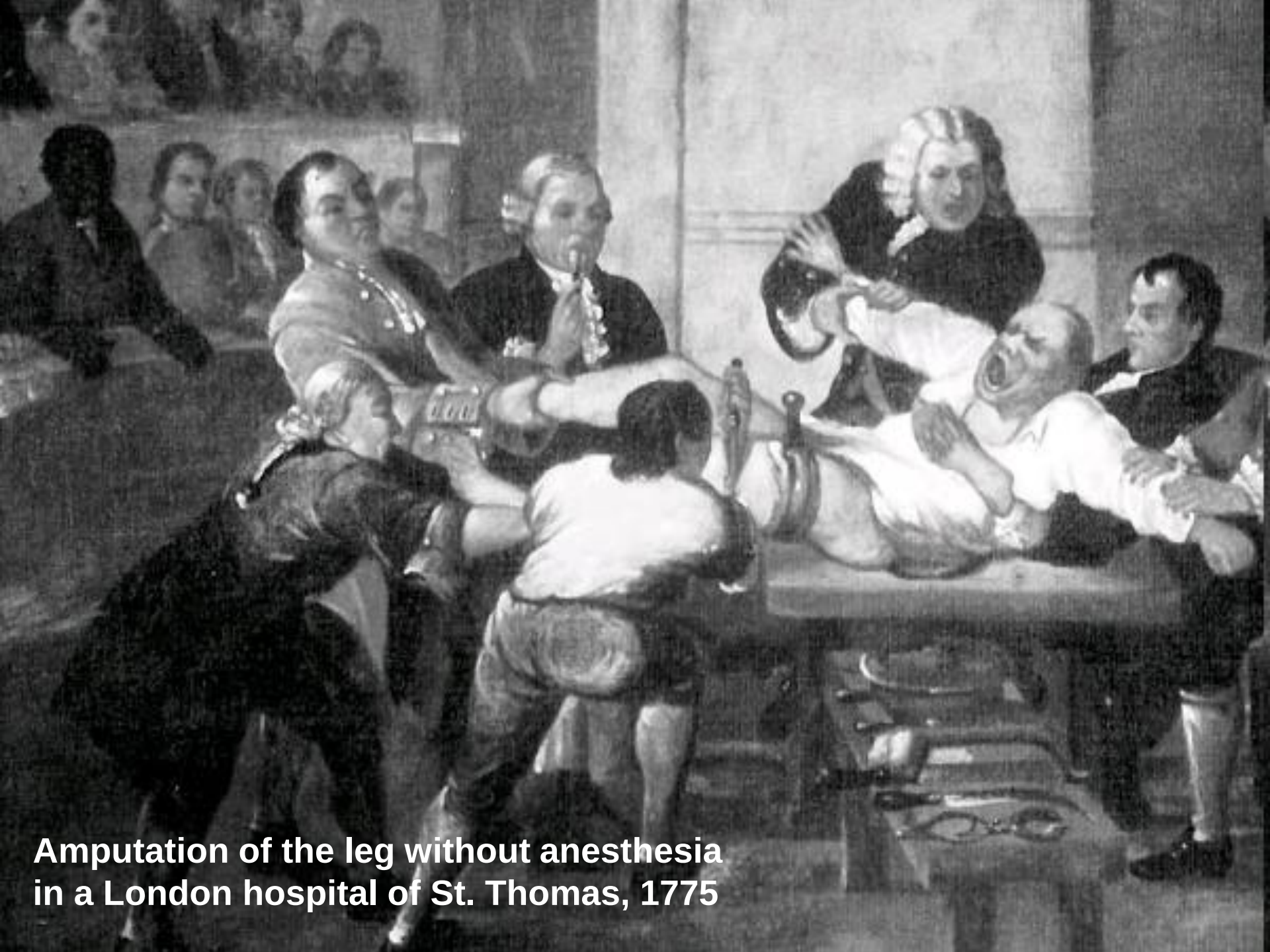

**Kharkiv National Medical University**
**Department of Neurosurgery**

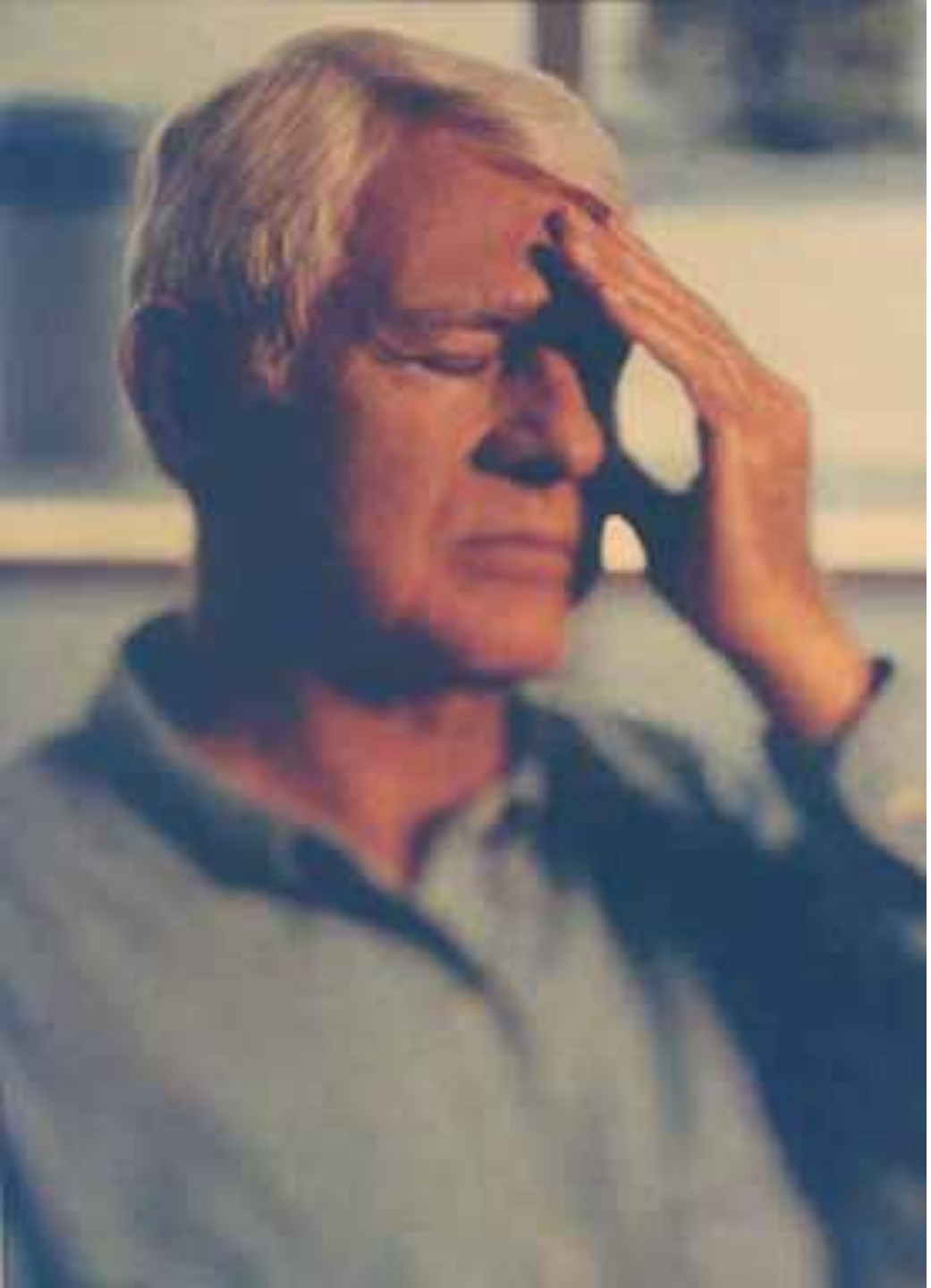
# *FUNCTIONAL NEUROSURGERY, LOW BACK PAIN*

**There are a number of diseases of the nervous system, which are traditionally considered "neurological" or "therapeutic." This is a fairly large group of diseases such as chronic pain syndromes, Parkinson's disease, essential tremor, torsion dystonia, some forms of multiple sclerosis, epilepsy, phantom limb pain, syringomyelia, cerebral palsy, multiple impact injuries of the brain and spinal cord, etc.**

**For a long time, all these diseases have been treated only by conservative methods. Patients with impaired movement, severe pain, sometimes leading to suicidal attempts of patients, gross violations of pelvic functions, practically, throughout later life, taking many different medications, which often had a pronounced side effects, or even lead to irreversible changes in a relaxed and without of the body, even more aggravating for a chronic disease. At present, the whole spectrum of pathology is an area of application of functional neurosurgery**



Amputation of the leg without anesthesia
in a London hospital of St. Thomas, 1775



# Trigeminal neuralgia

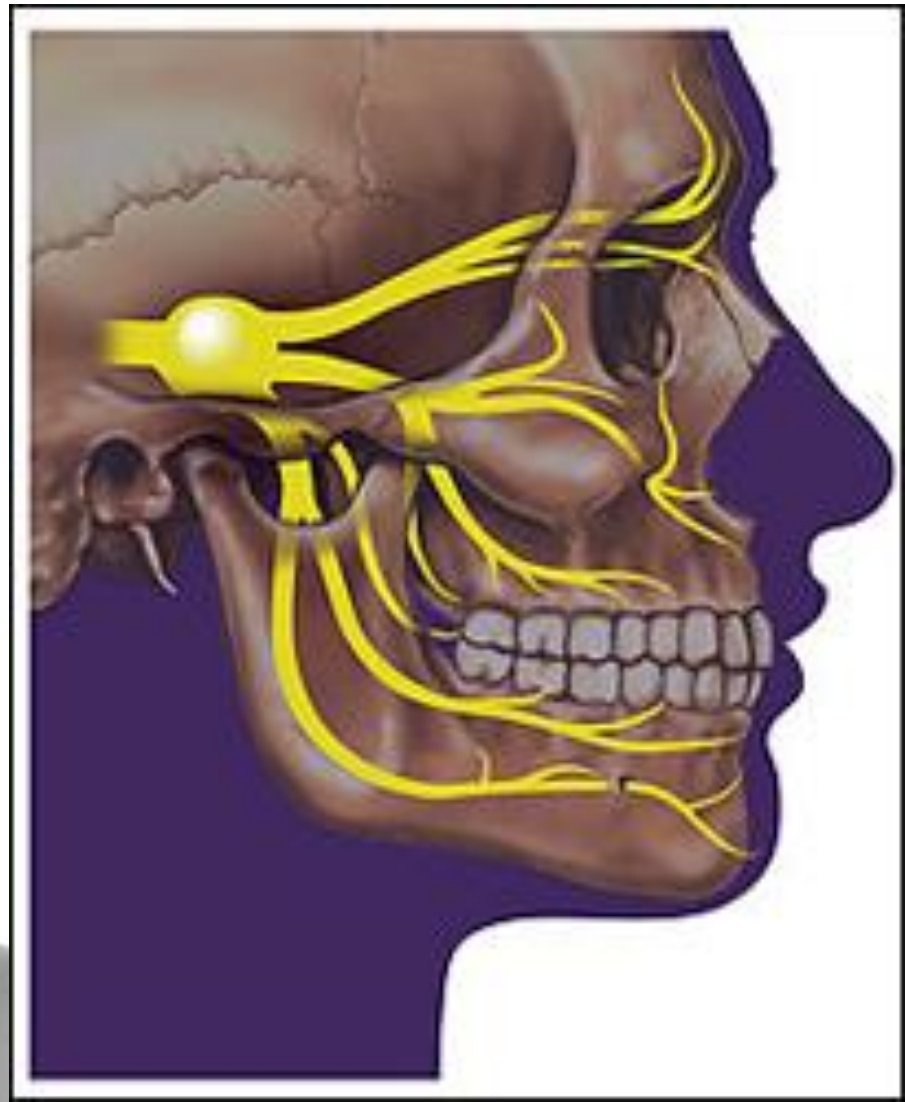
**Paroxysmal trigeminal neuralgia was first described in the XVIII century**

***N.Abdre (1756), J.Fothergill (1776)***

1. Paroxysmal attacks, lasting from several seconds to several minutes
2. Nature of pain (at least 4 criteria):
 - spread over the course of one or more branches of the trigeminal nerve;
 - sudden, intense, sharp, superficial, and burning;
 - severe in intensity;
 - begins with stimulation of certain areas or during eating, talking, washing face, brushing your teeth;
 - complete lack of complaints between attacks
3. Absence neurological deficit
4. Attacks stereotyped for each patient
5. Exception other causes of pain in the collection of medical history survey

# Trigeminal neuralgia

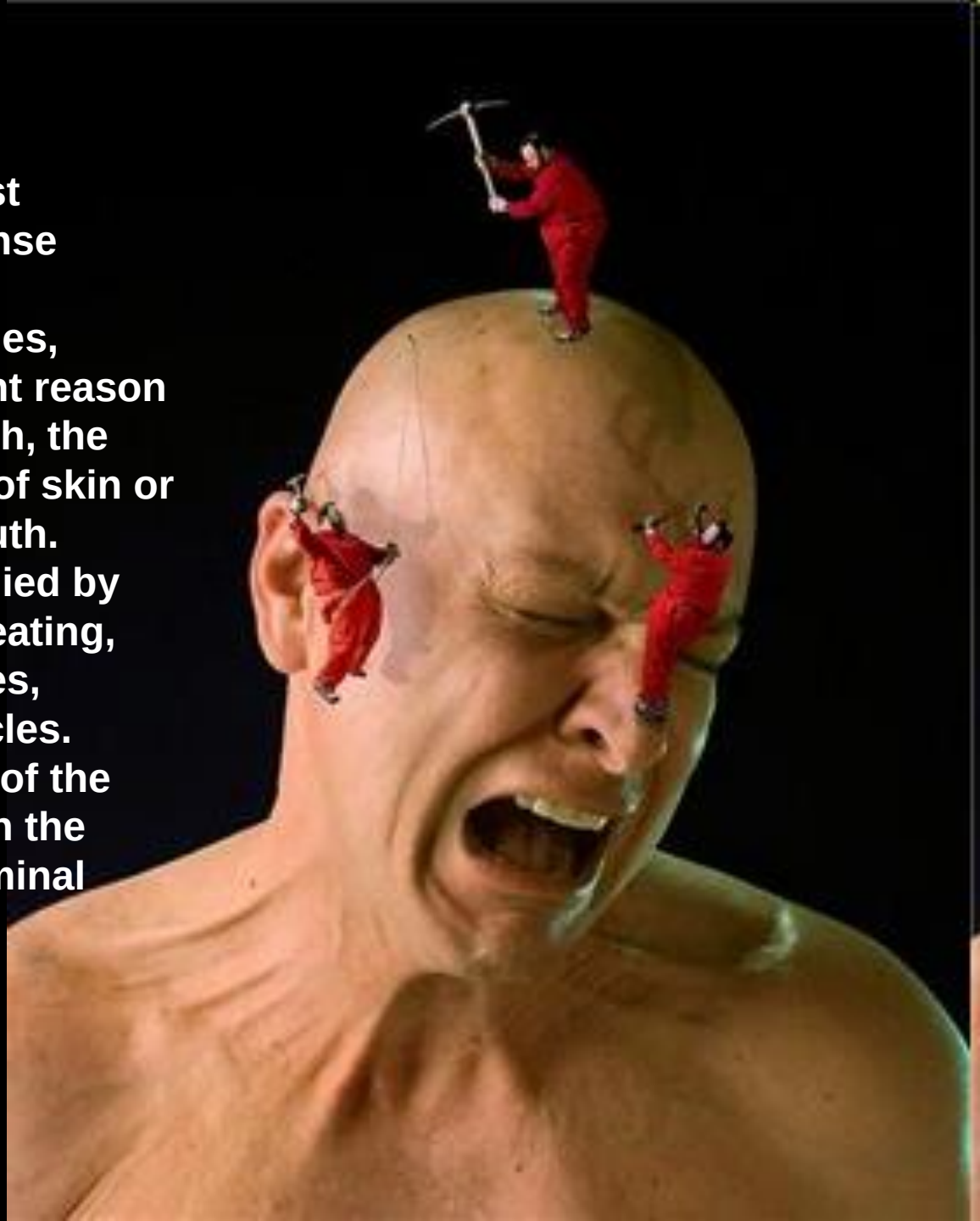
- Incidence: 4-5 cases per 100,000 population per year
- The prevalence of 30-50 cases per 100,000 population
- Women : Men = 2:1
- Most often occurs in people older than 50 years



# Classification of TN (J.Eller, A.Roslan, 2005)

| Allocated symptoms | Diagnostic classification |
| --- | --- |
| **IDIOPATHIC TN** (acute, short-term type of electrical discharge episodic pain) | **TN type I** |
| (Pain, throbbing, burning pain, more than 50% of the time a character constant) | **TN type II** |
| **TRIGEMINAL DAMAGE** | |
| **Indirect** (facial skull trauma, ENT surgery, surgery on the skull base and the PCF, stroke) | **Trigeminal neuropathic pain** |
| **Immediate** (neyroektomii, gangliolizis, rhizotomy, nucleotomy, tractotomy, or other denervating procedures) | **Deafferentation trigeminal pain** |
| **Associated with multiple sclerosis** | **Symptomatic TN** |
| **The resulting myocardial herpes zoster** | **Postherpetic TN** |
| **Somatoform pain disorder** (functional or psychotic) | **Atypical pain in the face** |

In trigeminal neuralgia, the most characteristic feature - the intense paroxysmal pain in the area of innervation of the nerve branches, which can occur for no apparent reason as well as irritation of the launch, the so-called trigger zones - areas of skin or mucous membranes of the mouth. Painful episodes are accompanied by facial flushing, lacrimation, sweating, sometimes - swelling, cold sores, physical activity of mimic muscles. Sometimes there is a decrease of the skin, mainly tactile sensitivity in the area of innervation of the trigeminal nerve



# The classic criteria for TN (K.F.Casey, G.Weigel,2000)

- Acute paroxysmal pain on one side of the face (in 97% of cases);
- Sudden remission and exacerbation of pain;
- Irradiation of pain in the areas of innervation of the branches of the trigeminal nerve (V2 and most V3);
- Lean neurological symptoms;
- The presence of distinct trigger zones;
- The effect of taking carbamazepine

# *Seizures and acute pain triggered by:*

- **Shaving;**
- **Washing;**
- **Brushing teeth;**
- **A gust of wind;**
- **Cosmetics;**
- **Smile;**
- **Touching the person, even a light;**
- **Articulation during speech**

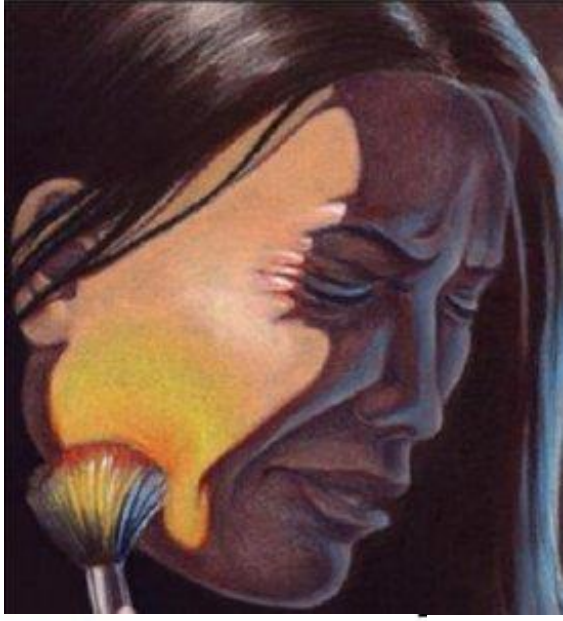
# IMAGE OF THE ARTIST'S OWN TRIGEMINAL PAIN

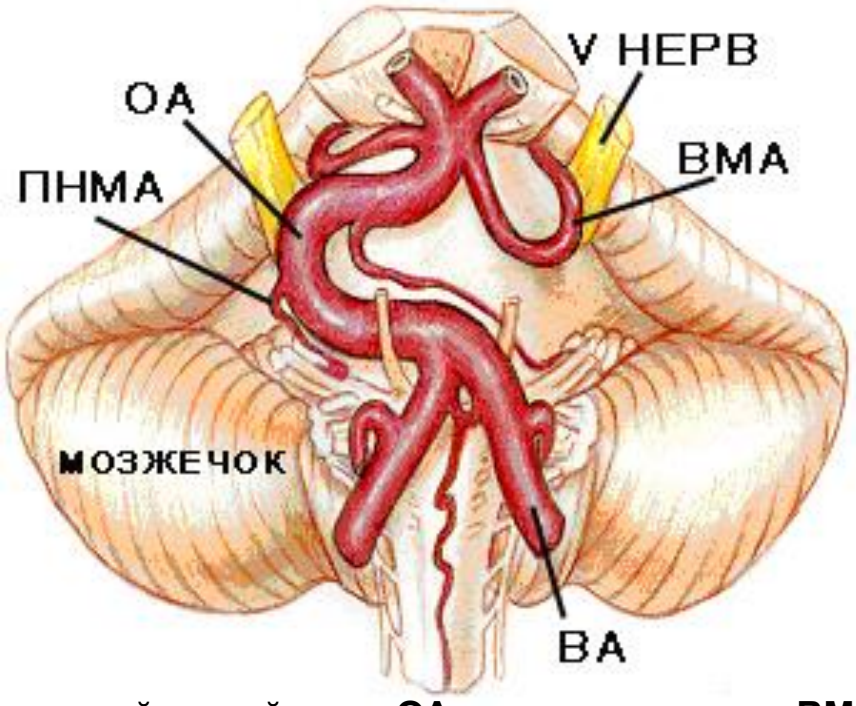
# THEORIES OF TN

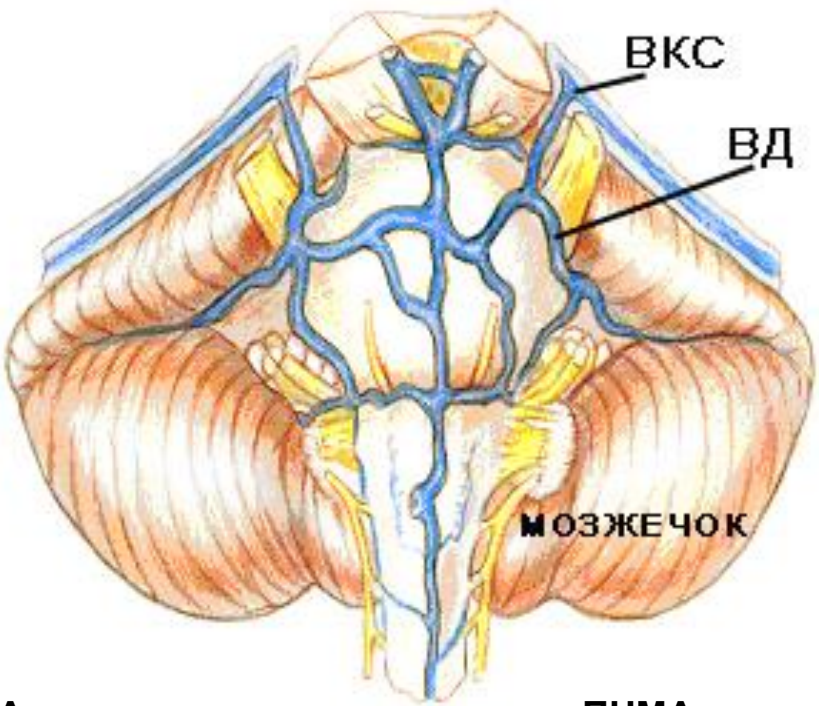
- **Peripheral theory** - defeat is localized in the root-zone a few millimeters at the entrance to the root bridge due to damage (thinning), myelin layer. This leads to chronic irritation of the nerve as a result of the depletion of segmental inhibition in the trigeminal nucleus and increased activity in the trigeminal nerve, causing ectopic action potentials;
- **Central theory** - Irritation of the trigeminal nerve nuclei in the roots due to the unchanged susceptibility of nuclear forces the posterior horns of the spinal cord, the diencephalon, the thalamus and the cerebral cortex to maintain pathological pain stimuli;
  - Notes the role of genetically susceptible weak analgesic system;
  - Attack of pain is considered as an analogue of nuclear seizure

# THE ETIOLOGY OF TN

- **Vascular compression (86-97%);**
  **- Arteries (80-87%);**
  **- Veins;**
- **Tumors of the PCF;**
- **MA basilar and cerebellar arteries;**
- **AVM vessels of the trunk;**
- **Congenital or acquired narrowing of channels and holes of the skull**

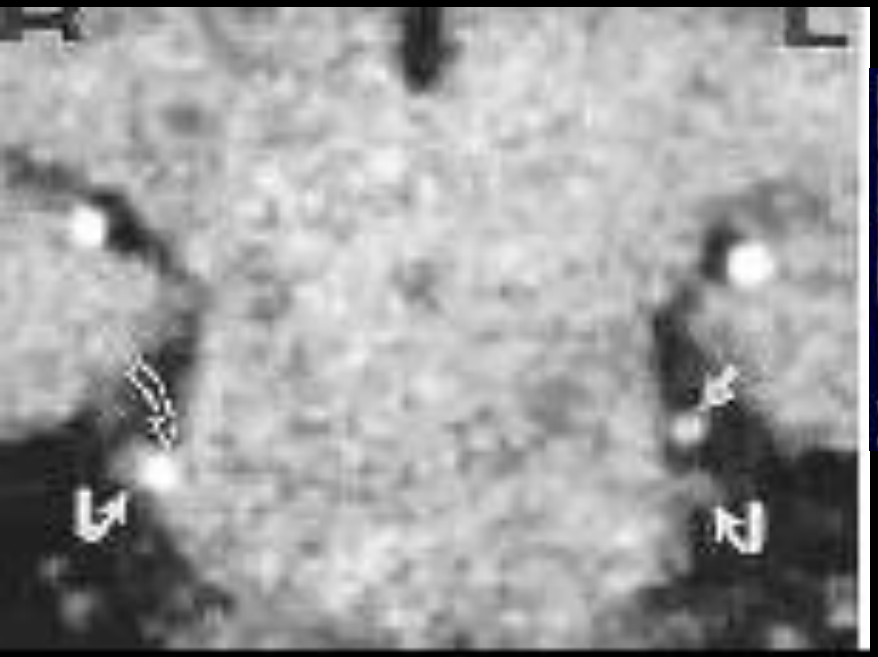


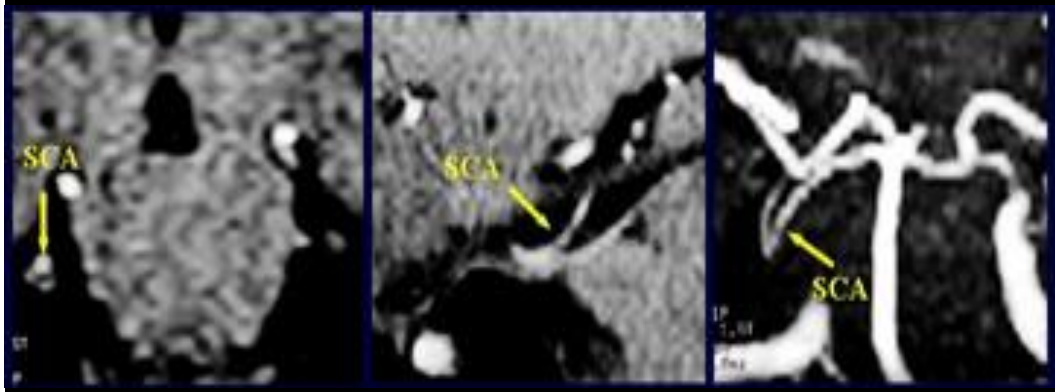


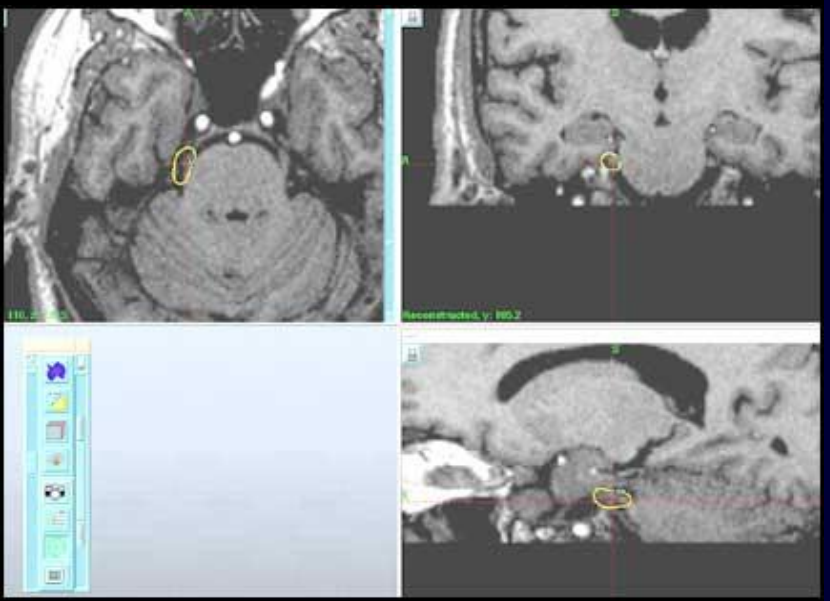



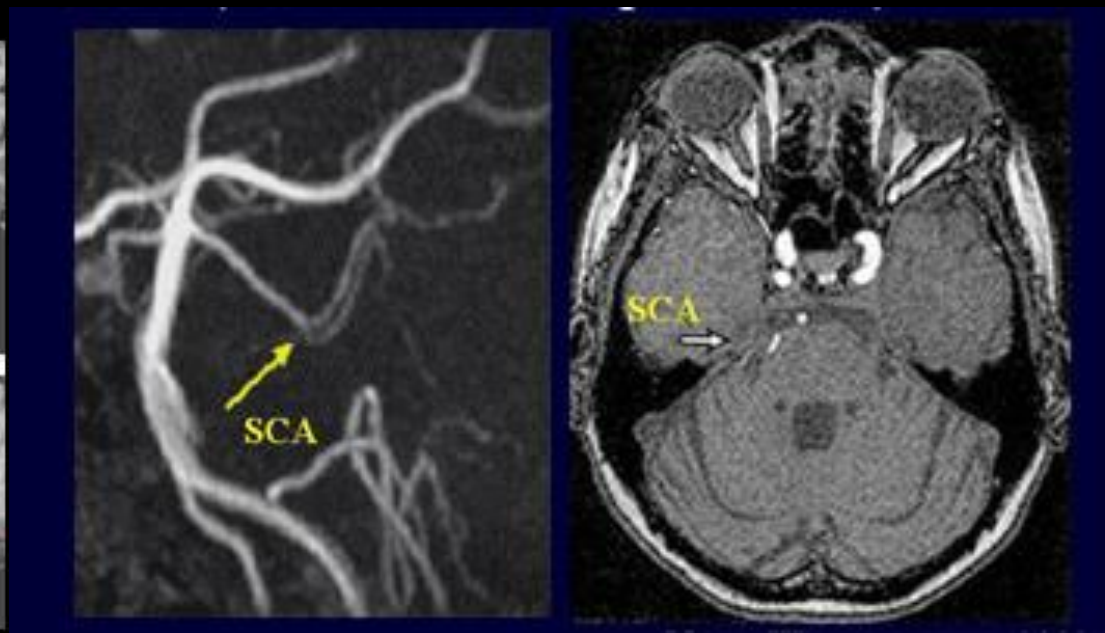

**V нерв**-тройничный нерв, **ОА**-основная артерия, **ВМА**-верхняя мозжечковая артерия, **ПНМА**-передняя нижняя мозжечковая артерия, **ВА**-вертебральная артерия, **ВКС**-верхний каменистый синус, **ВД**-вена Денди

# NEUROIMAGING DIAGNOSIS OF TN



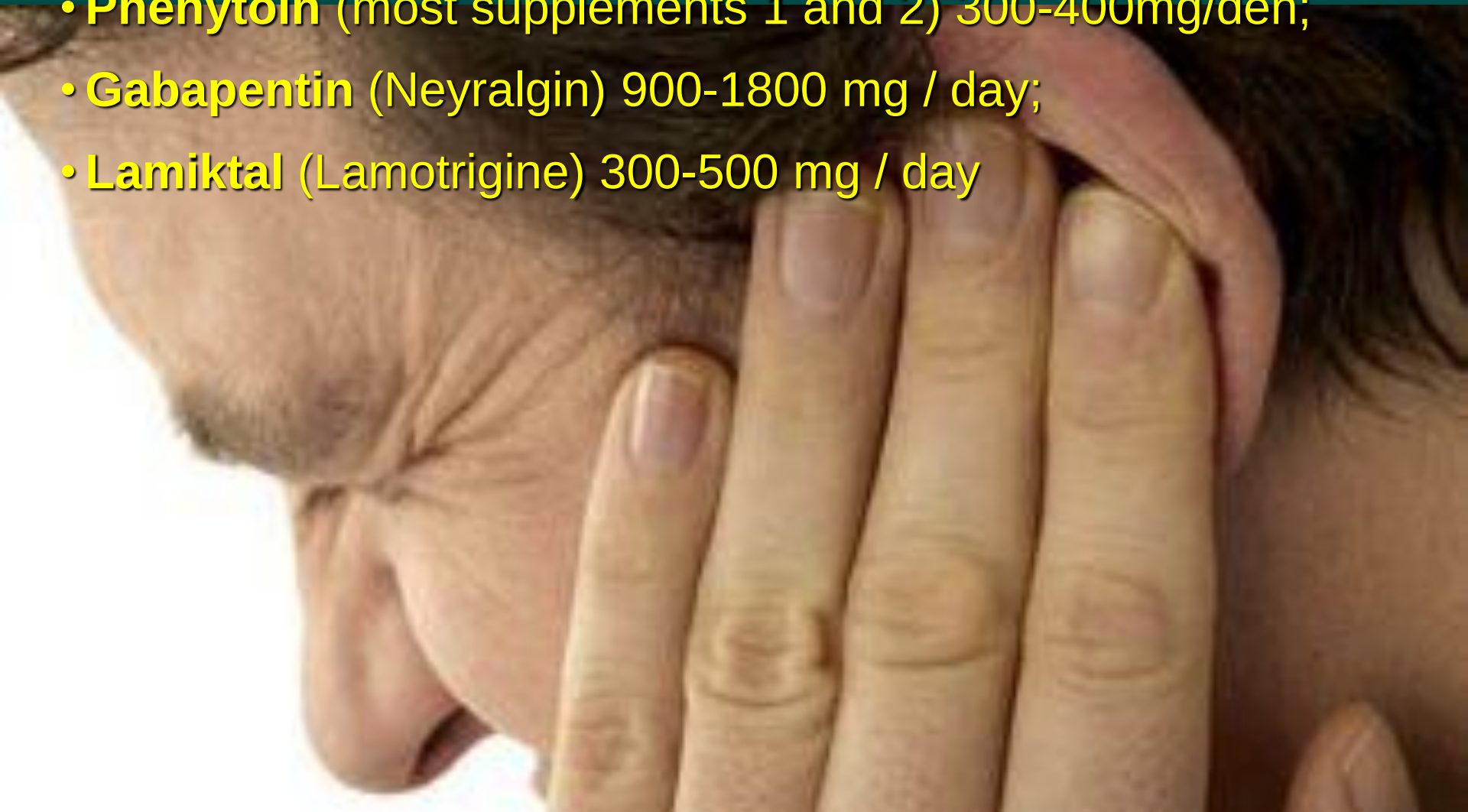




# PHARMACOTHERAPY TN

- **Carbamazepine** (Tegretol, Finlepsin) 600-1200 mg / day;
- **Baclofen** 50-60 mg / day;
- **Phenytoin** (most supplements 1 and 2) 300-400mg/den;
- **Gabapentin** (Neyralgin) 900-1800 mg / day;
- **Lamiktal** (Lamotrigine) 300-500 mg / day



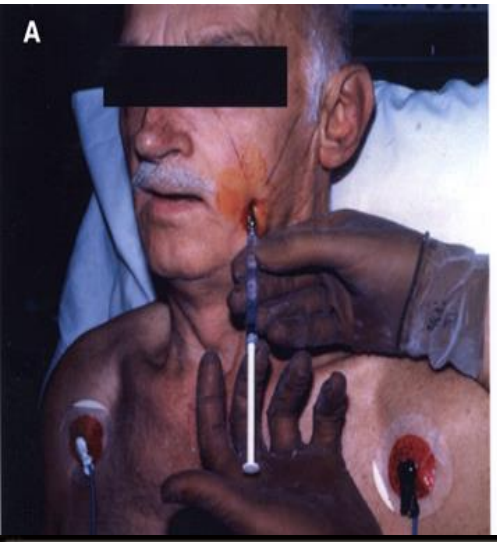
# Treatment of postherpetic TN

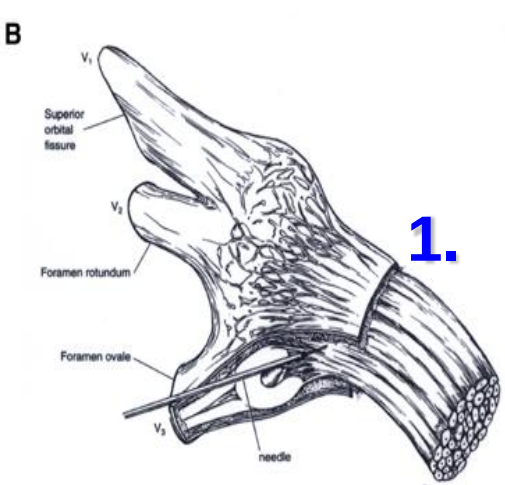
- Antiviral therapy (Cycloferon, Zovirax);
- Epidural steroids in the Mekkelevu cavity (diprospan) and bupivacaine (Merkain);
- Amitriptillin and / or Gabapentin (Neyralgin);
- Vaccination;
- ? intrathecal methylprednisolone

# *Surgical treatment of TN*

1. Alcoholisation and the blockade of the peripheral branches of TN;
2. Blockade of Gasser's node;
3. Neyrotomy peripheral branches of TN;
4. Decompression of peripheral branches of TN;
5. Thermal destruction (cryo-, HF) Gasser's node;
6. Balloon microcompresion of Gasser's node;
7. Microvascular decompression (surgery Jannetta);
8. Stereotactic surgery in the basal ganglia;
9. Stereotactic radiosurgery (Gamma Knife);
10. Electrical stimulation of the cerebral cortex

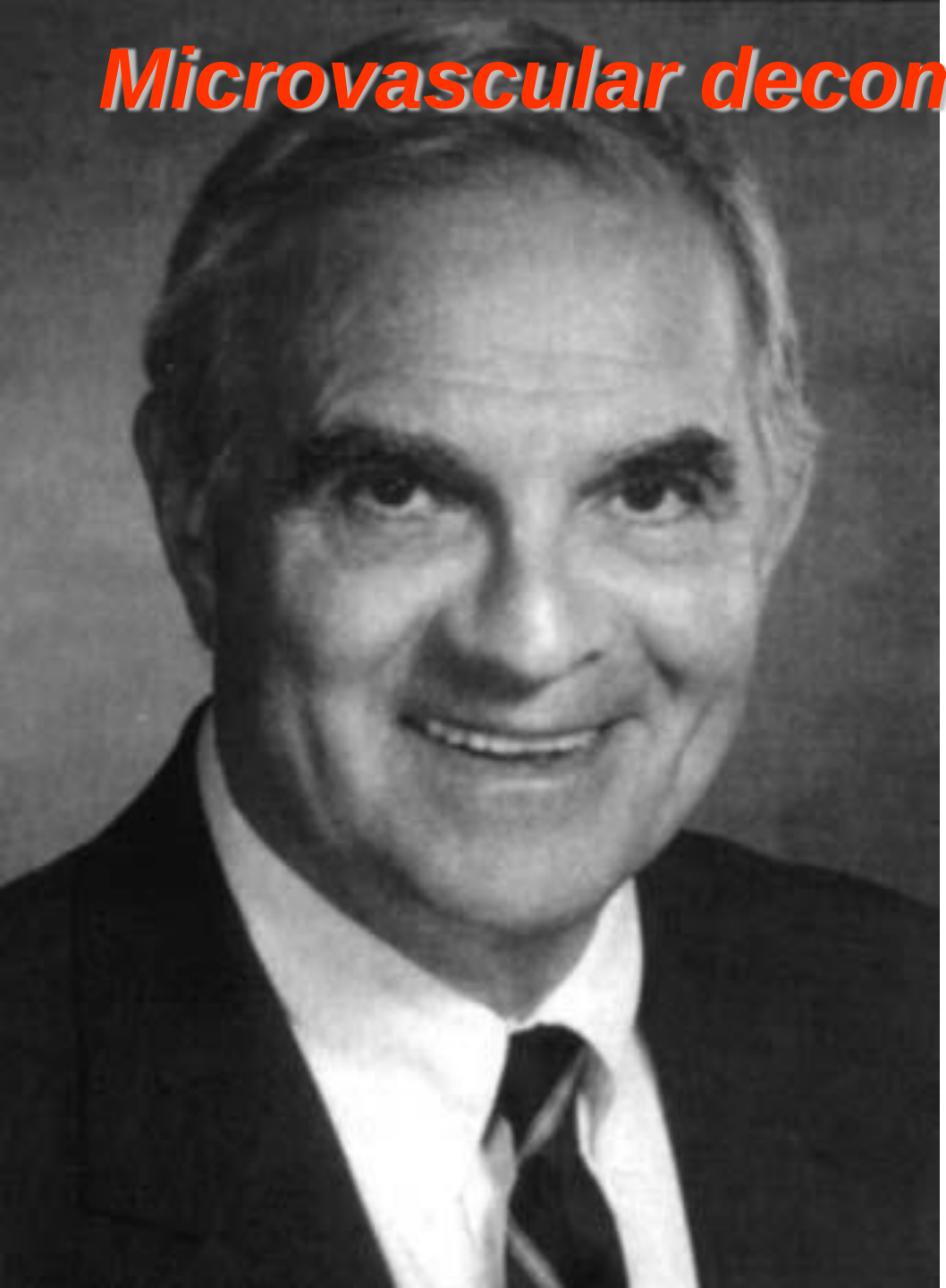
# DESTRUCTION OF SENSITIVE ROOT GASSER NODE




1. Determination of trajectory to the foramen ovale due to scall landmarks;
2. Introduction cryotom in the Mekkel cavity through the foramen ovale;
3. X-ray control location of cryotom in the cranial cavity;
4. Dosage (selective prism) cryosurgery of Gasser's node

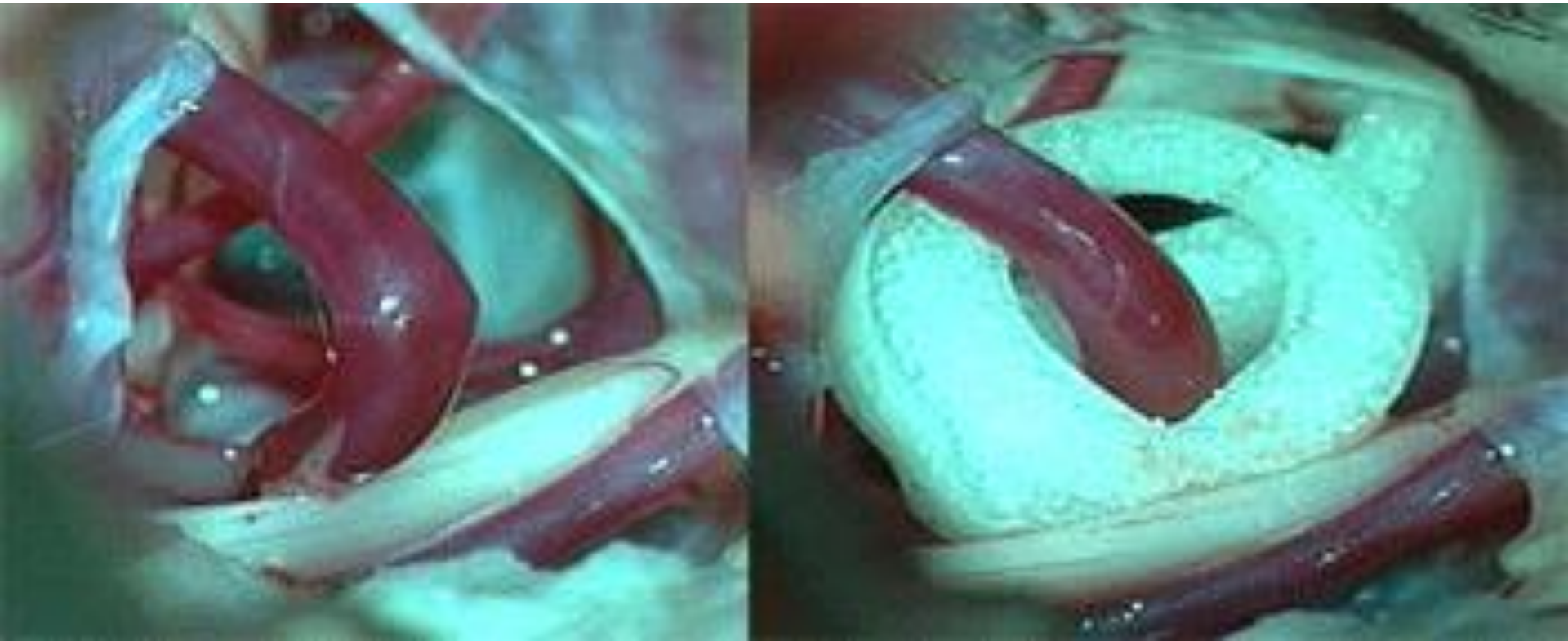
# *Microvascular decompression (MVD)*



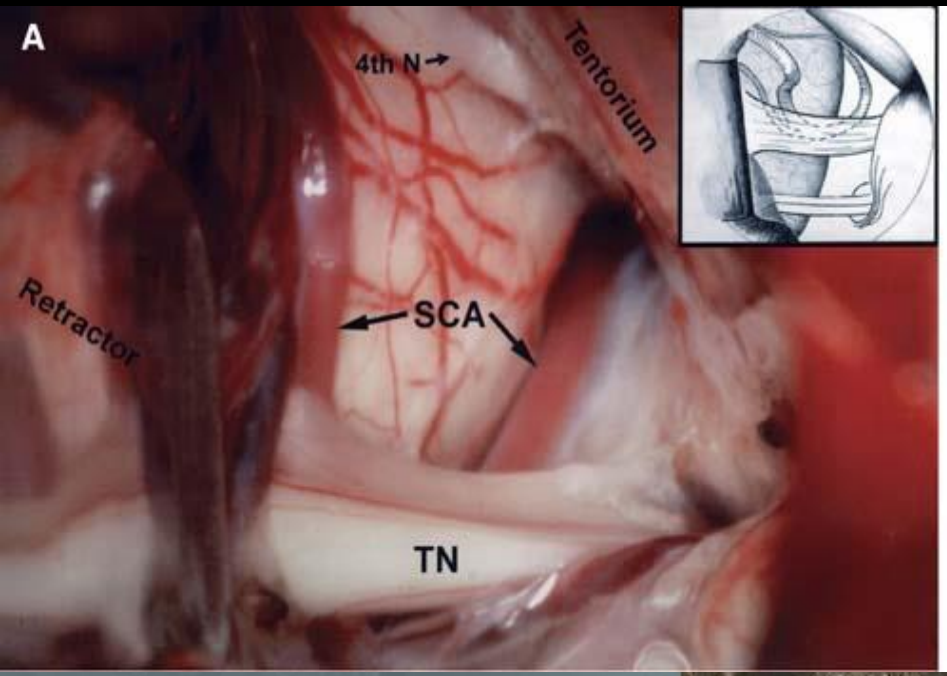
**PETER JEANNETTE - American neurosurgeon. In 1967 he developed and implemented the technology to the operation of the MVD. The operation of MVD named after him (the operation Jannetta). Produced more than 4400 operations MVD**

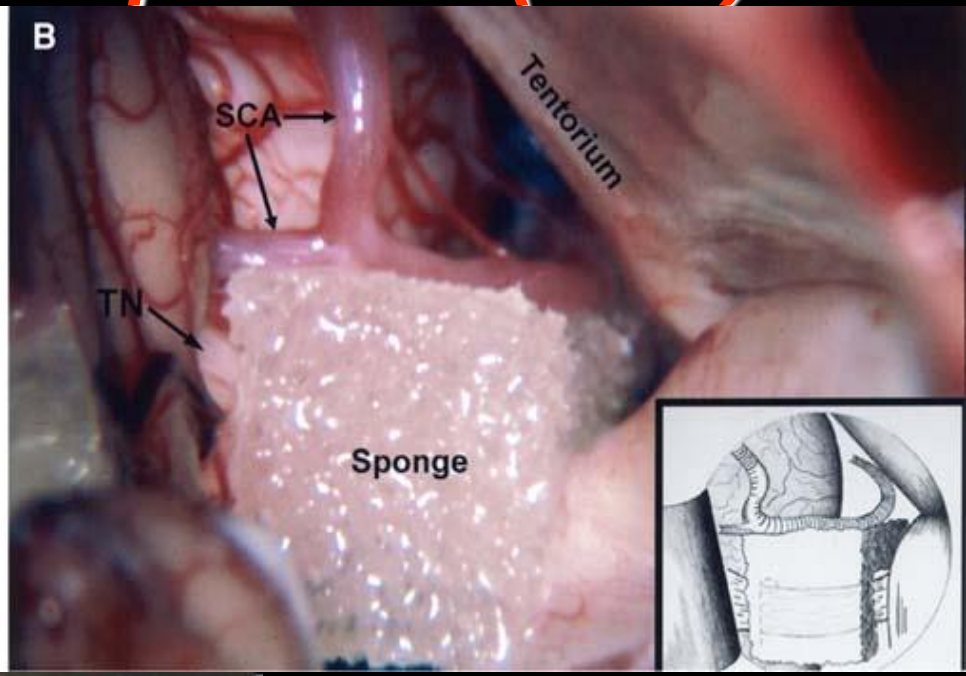
# *THE ADVANTAGES OF MVD (P.JANNETTA, 2004)*

- **Complete pain relief at once;**
- **The absence of loss of function of cranial nerves;**
- **The absence of mortality;**
- **Resistant result;**
- **Patogenetic intervention;**
- **Availability**



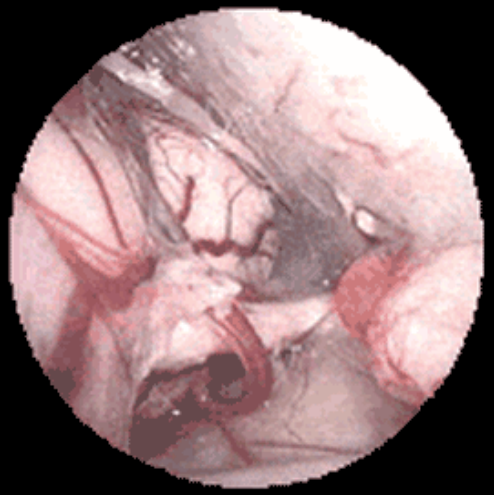
# Microvascular decompression (MVD)



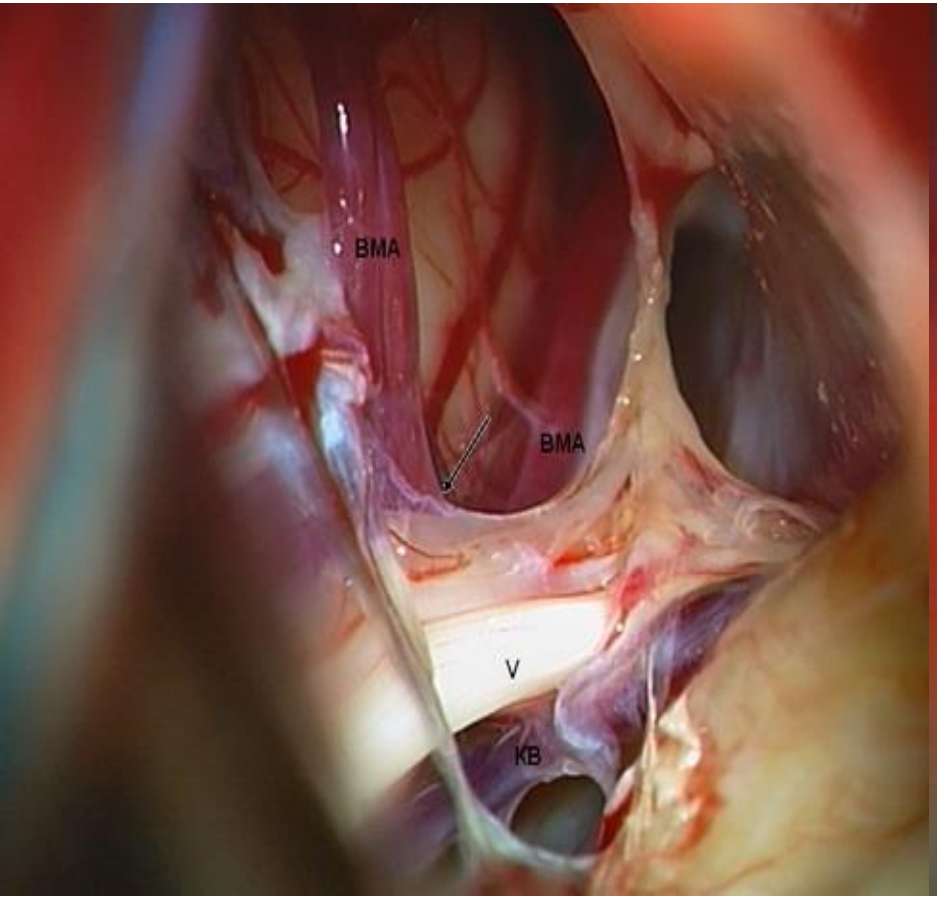





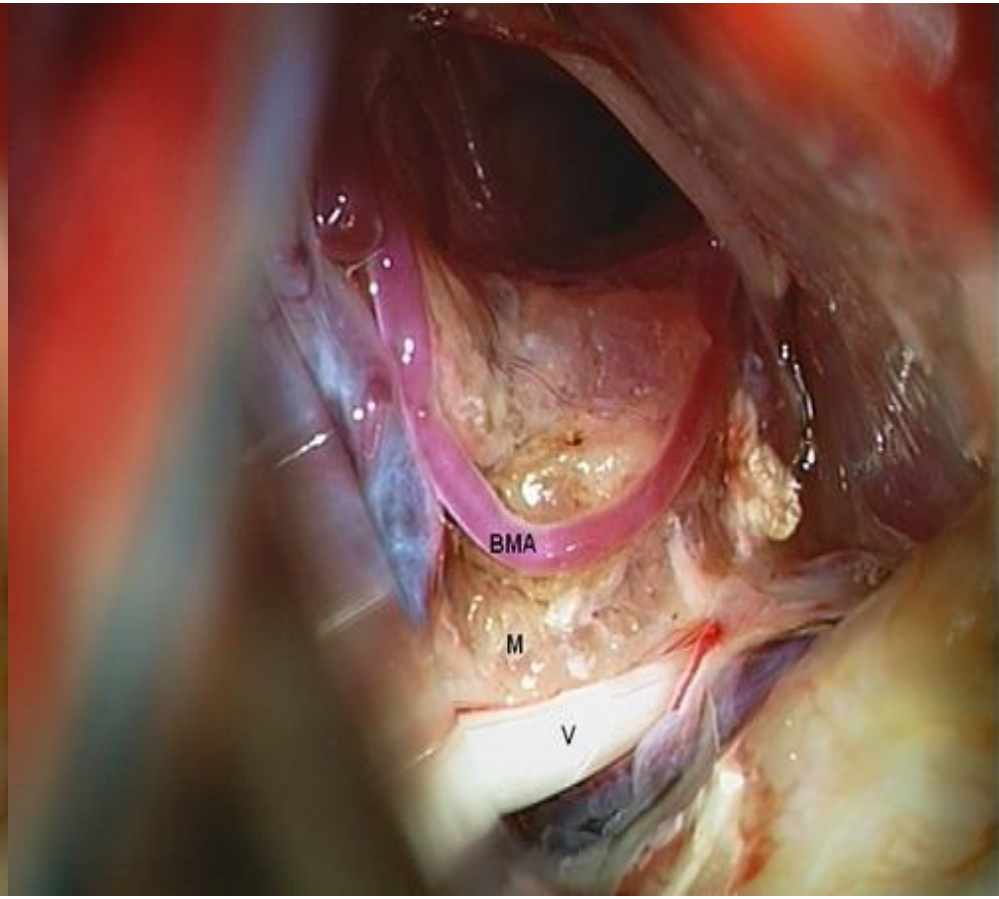
***Microphotograph of the main stage of the installation with Teflon gaskets (P.Jannetta, 2004)***



# *Microvascular decompression (MVD)*




**Neurovascular conflict**




**After decompression**

**Epilepsy** - in Greek - "a sudden fall." The people are called - "epilepsy." Sometimes accompanied by a fall in screaming, convulsions, loss of consciousness, biting tongue, involuntary urination. Attack lasts 3-4 minutes, then the patient falls into a deep sleep. This is a severe form of disease. Frequency of attacks varies - from 1-2 times per year to 10-15 per day

**In developed countries the number of seizures ranged from 24 to 53 cases per one thousand people. In addition, these figures do not include one-time provoked seizures and febrile seizures in children. Each year, the recorded incidence of epilepsy, an average of 70 per 100 thousand people (in children 4.5-5 times higher than in the population). The number of patients with epilepsy on the planet is more than 40-50 million people in Ukraine - about 500 thousand people**

**Looking at epilepsy as an incurable disease has been refuted by modern epidemiological studies that suggest that:**

- **70% of patients after 5 years of adequate therapy did not have seizures in;**
- **20% of patients coming long-term remission (2-5 years);**
- **20-30% of patients suffering from epilepsy all his life**

# SIGNS OF EPILEPSY

- **Convulsive seizures and nonconvulsive;**
- **Epileptic personality changes**

**All epileptic seizures are common symptoms:**
- **short period;**
- **sudden onset and termination of the attack;**
- **the frequency of attacks and their similarity**

# Methods of investigation in epilepsy

**MRI of the brain** - The study is absolutely necessary in all patients with epilepsy, regardless of whether surgery is planned or not. Allows you to diagnose the condition, leading to epilepsy (tumors, AVMs).

**FMRI (functional Magnetic Resonance Imaging)** - Patient is placed in a high-resolution MRI (magnet is not less than 3 Tesla). During the study, patients are asked to perform various tasks: squeezing a fist, saying, look at pictures, and other studies based on the principle that the blood flow to various parts of the brain unevenly, with the active work of the functional areas of the brain blood flow in them is increasing.

**MEG (magnetoencephalography)** - This study allows to accurately determine what part of the brain is epileptogenic focus.

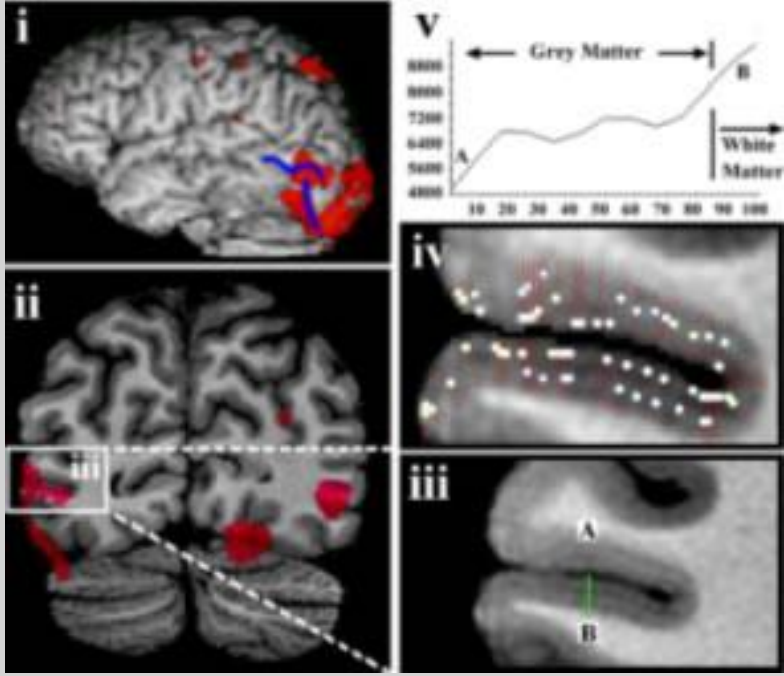
**Video-EEG monitoring** - The study - the most important part of the preoperative patient, as it gives the surgeon information about the localization of epileptogenic focus.

**PET (Positron Emission Tomography)** - and **SPECT (Single photon emission tomography)** study with 18-fluorodeoxyglucose can detect epileptogenic foci, especially in focal epilepsy, and assess the metabolic abnormalities in these centers.

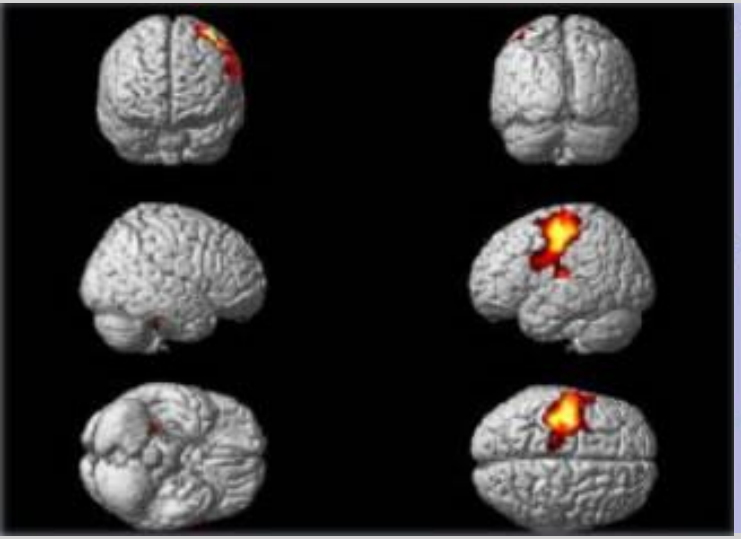
**Neuropsychological testing** results of neuropsychological testing can assess the risks of the planned operation.

**Invasive EEG monitoring** is sometimes these video-EEG, PET, MEG is insufficient to determine the exact location of the epileptogenic focus. In such cases, invasive video-EEG monitoring. The patient underwent the surgery to the imposition of the EEG electrodes directly on the cerebral cortex. The operation is performed under general anesthesia

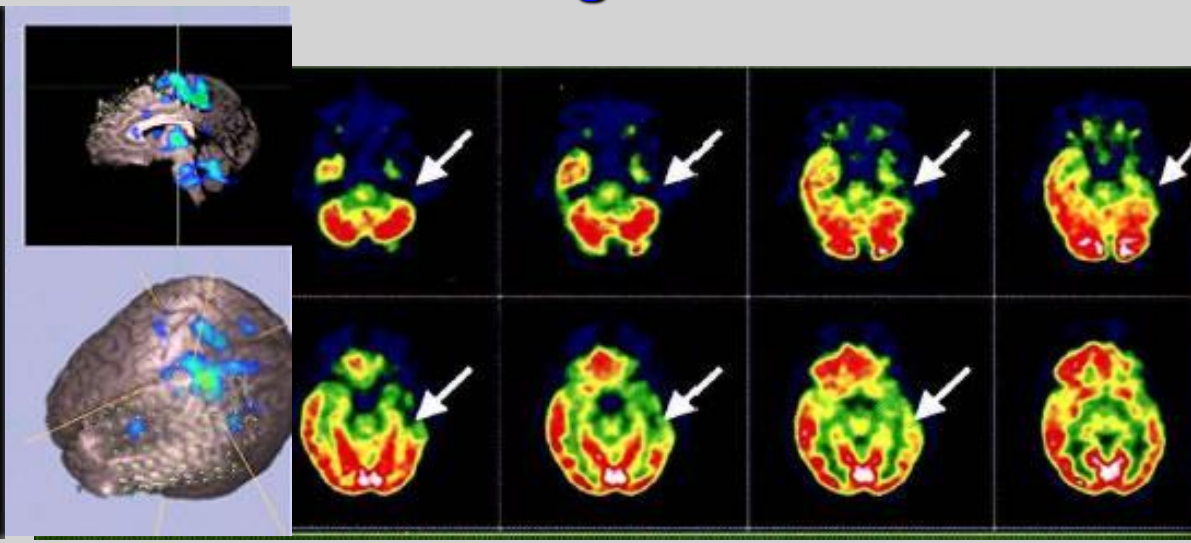
Video EEG




High-resolution MRI



fMRI

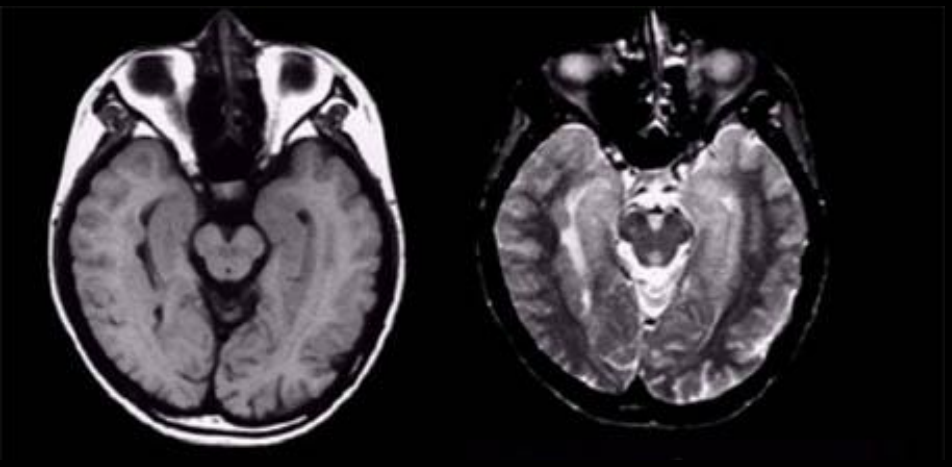


PET

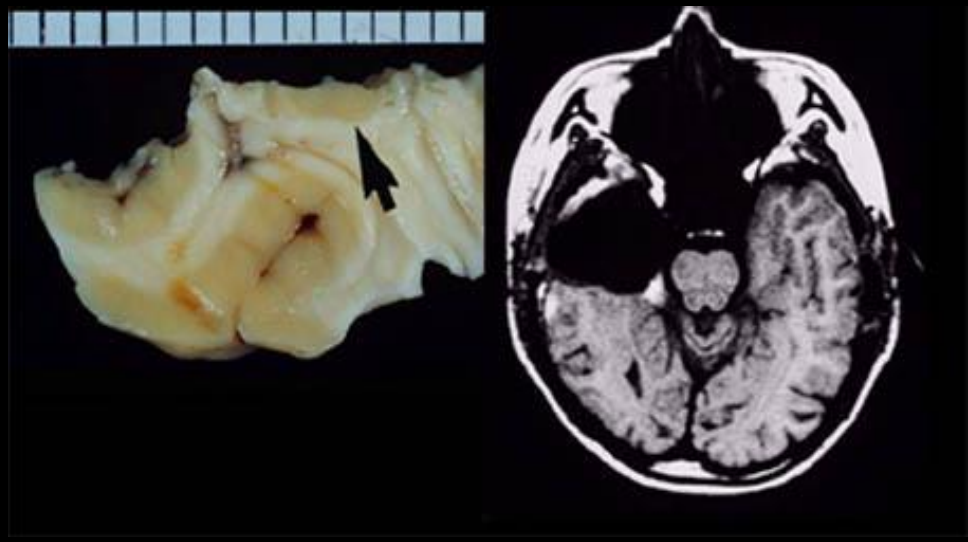
# THE MAIN SURGICAL METHODS OF TREATMENT OF EPILEPSY

- **Focal cortical resection;** efficiency techniques for isolated use - 40-50%, when combined with resection of the medial structures - up to 80%;
- **Temporal lobe resection**, when the dominant hemisphere resection borders constitute 4.5-5 cm in the non-dominant hemisphere resection border - 7-8 cm, (upgraded appliances selective amygdala-gippokampectomy transilviev transcortical microsurgical approach is effective in 75-80% of cases);
- **Extratemporal resection;** effectiveness of techniques - 64% - clinical improvement of the disease, 36% - the liberation of the attacks. Favorable prognostic factor in the success of surgery is to record epileptic activity that is restricted to a fraction of the brain;
- **Hemispherectomy;**
- **Callosotomy**, best results are observed in the attacks "drop attack" (improvement occurs in 75-100% of cases);
- **Multiple subpial notches;**
- **Stereotactic techniques;**
- **Stimulation of the cerebellum;**
- **Stimulation of the nervus vagus**

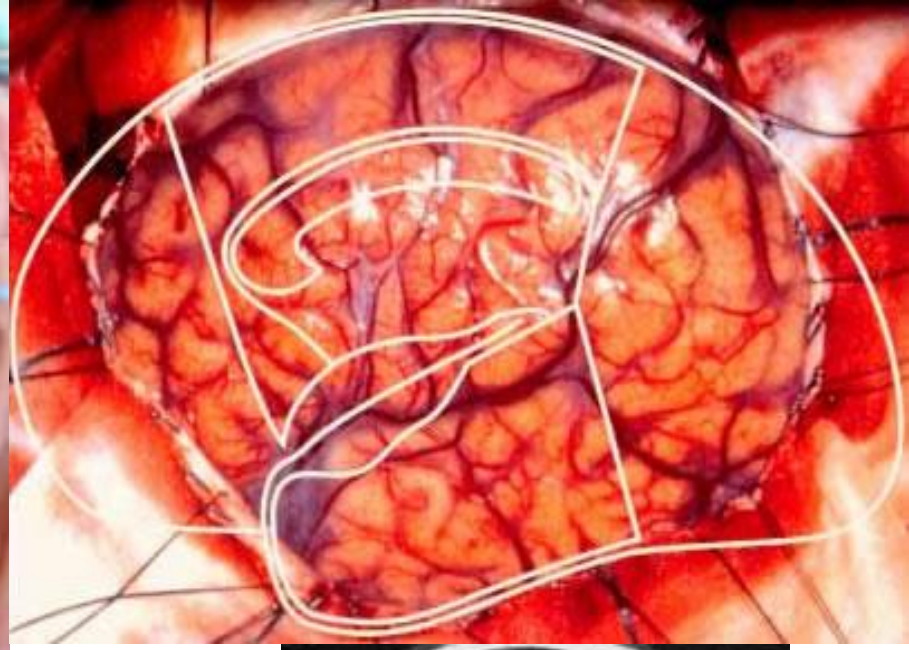
# Amygdala-gippocampectomy



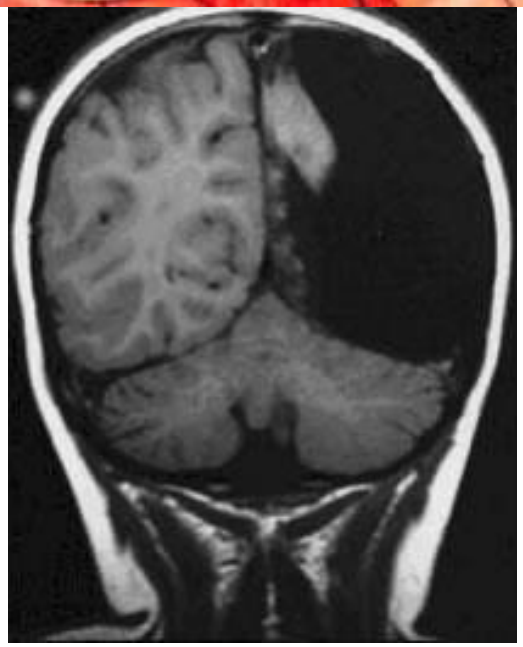
MRI of the brain the patient with epilepsy, a latent conservative therapy. The center of the epi-activity on the EEG is in the right temporal lobe



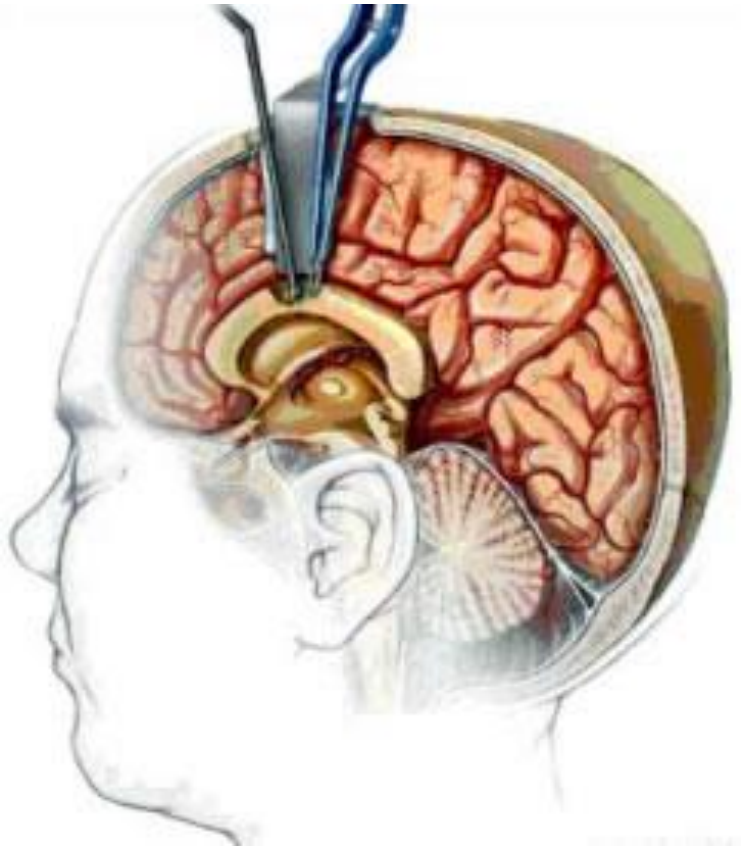
Part of the brain resected during surgery (left) and MRI of the same patient (right) 2 months after the operation - a selective amygdala-gippocampectomy



**Extratemporal resection**



**Hemispherectomy**



**Calosotomy**



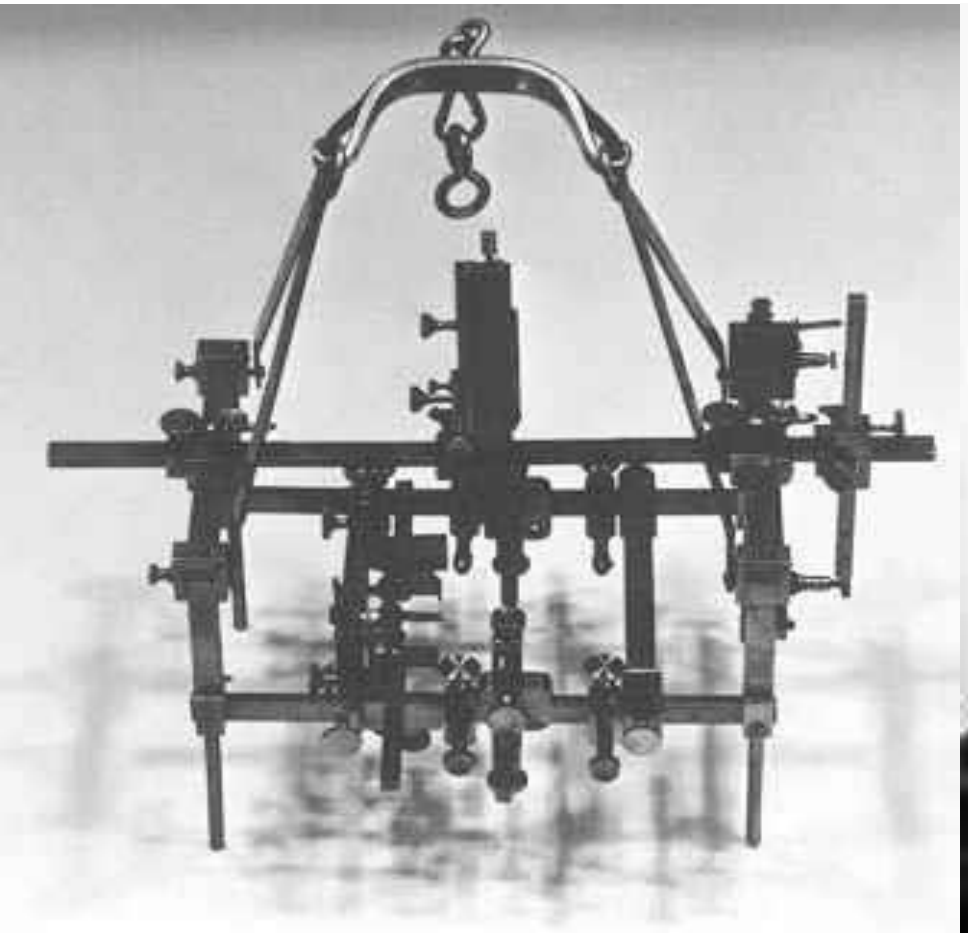
**Stimulation nervus vagus**

# *STEREOTAXIS*

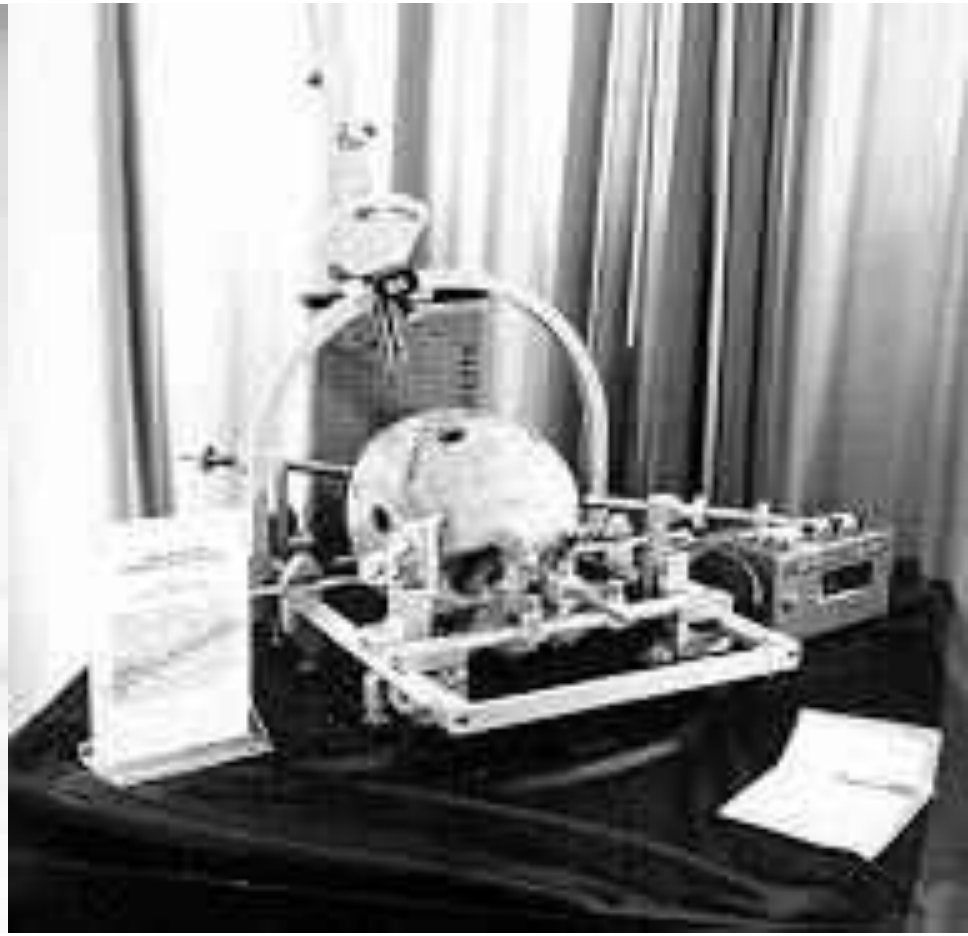
**«STEREOTACTIC» - "Moving in space" (Greek)**

**Determination of stereotaxy is a set of methods and calculations that allow using special instruments and methods of X-ray and functional control with high precision type electrode (cannula) into a predetermined depth of the structure of the brain or spinal cord to influence her with a diagnostic or therapeutic purposes**

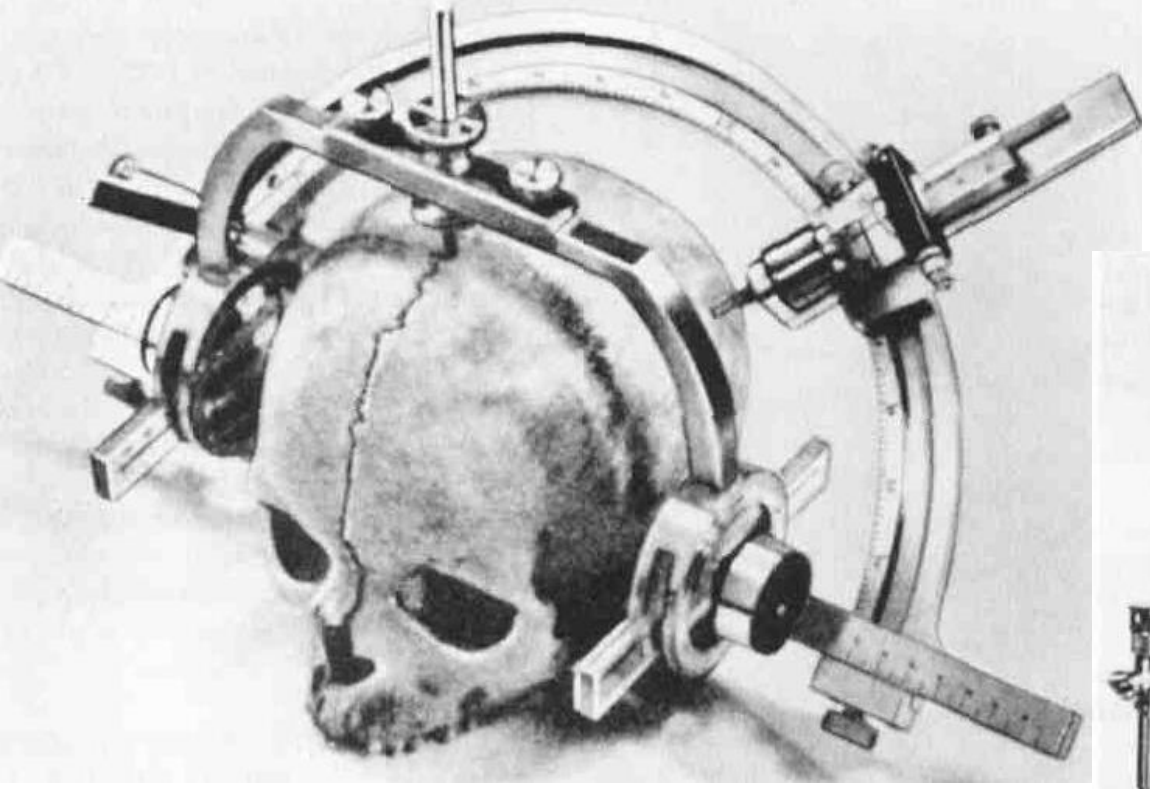
# *Modifications of the stereotaxic apparatus (frame)*



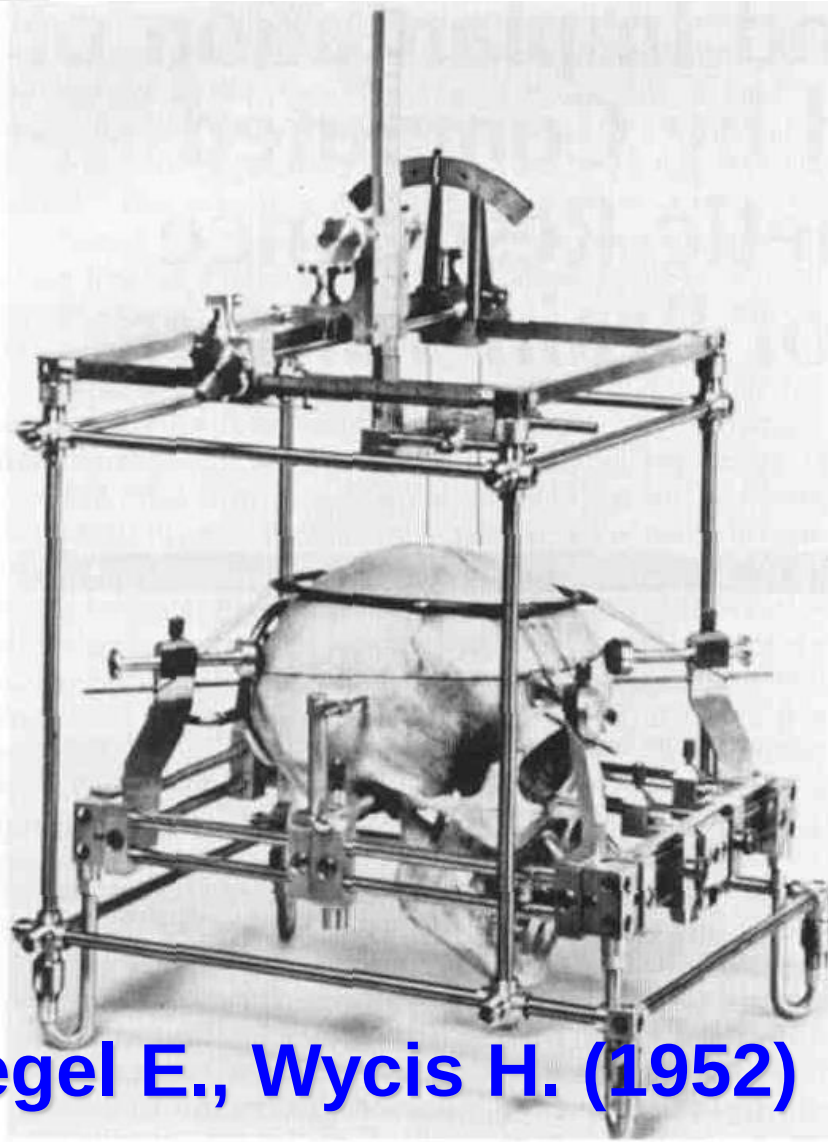
**Horsley-Clarke (1908)**



**Robert Heath (1952)**

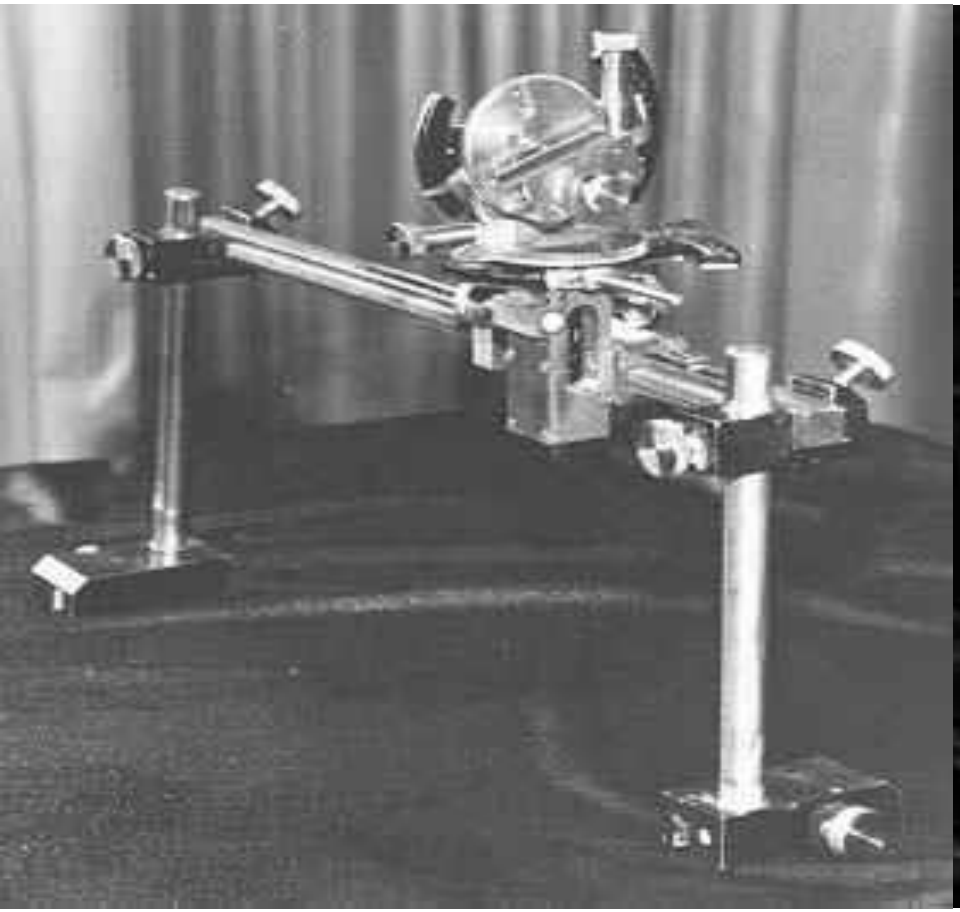


Leksell (1949)



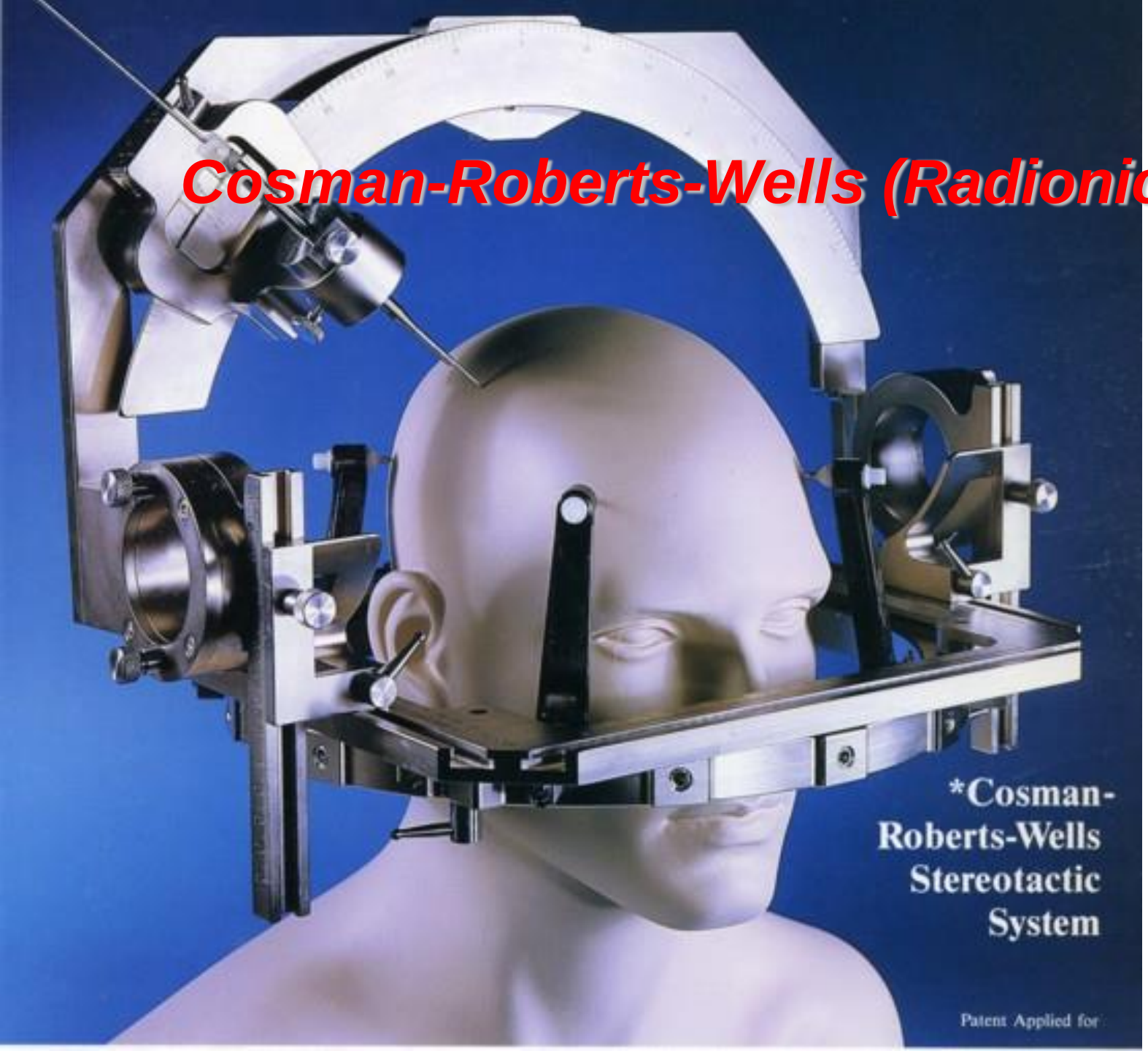
Spiegel E., Wycis H. (1952)

# *Modifications of the stereotaxic apparatus (frameless)*



**Dr.Irving Cooper (1955)** **David Fairman (1976)**

# Cosman-Roberts-Wells (Radionics)



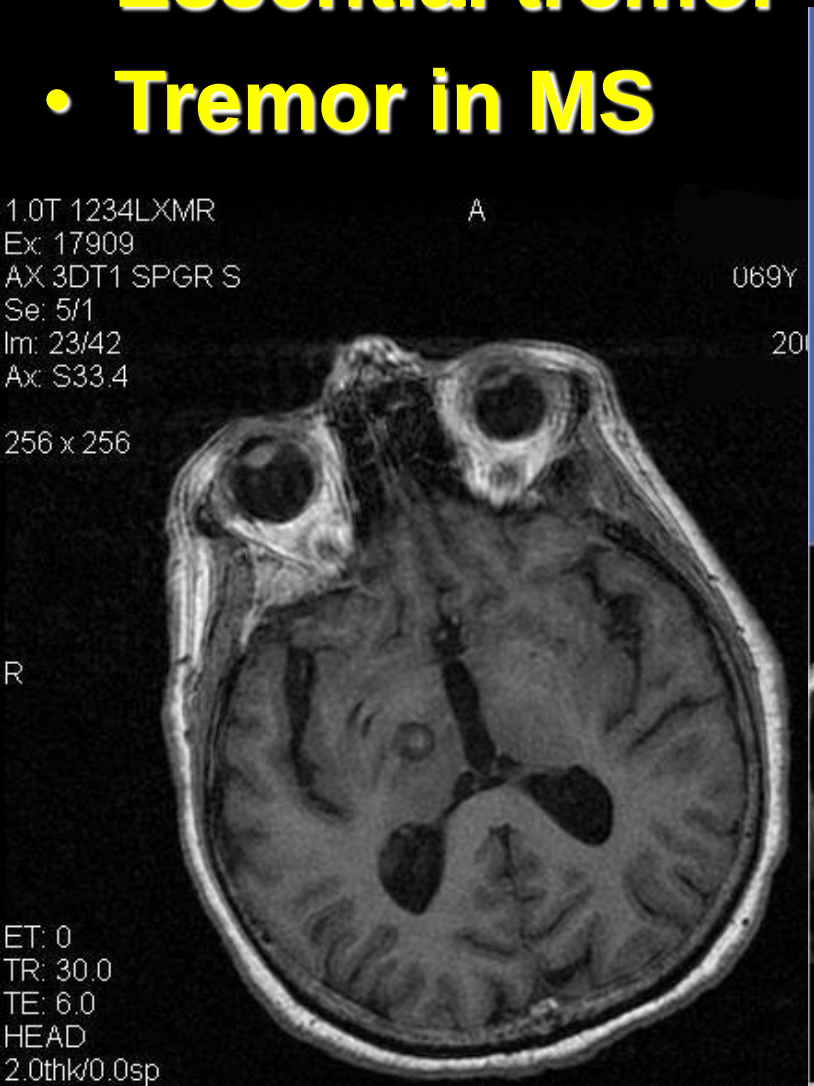

Equipped with modern stereotactic operating

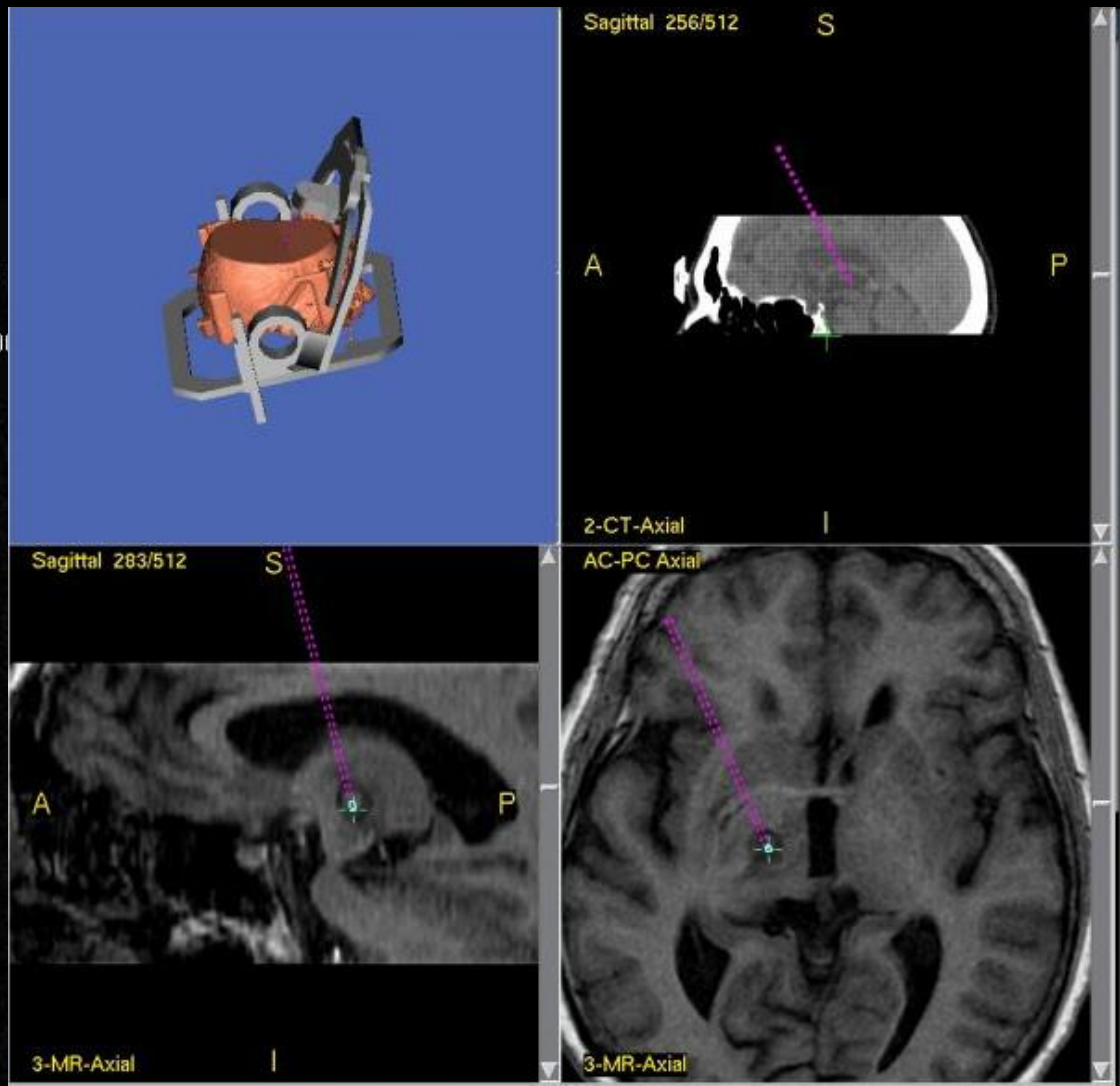
# Cryotom

# Stereotactic surgery using the standalone crioprobe controlled computed tomography intraoperative electrophysiological monitoring

# Talamotomy

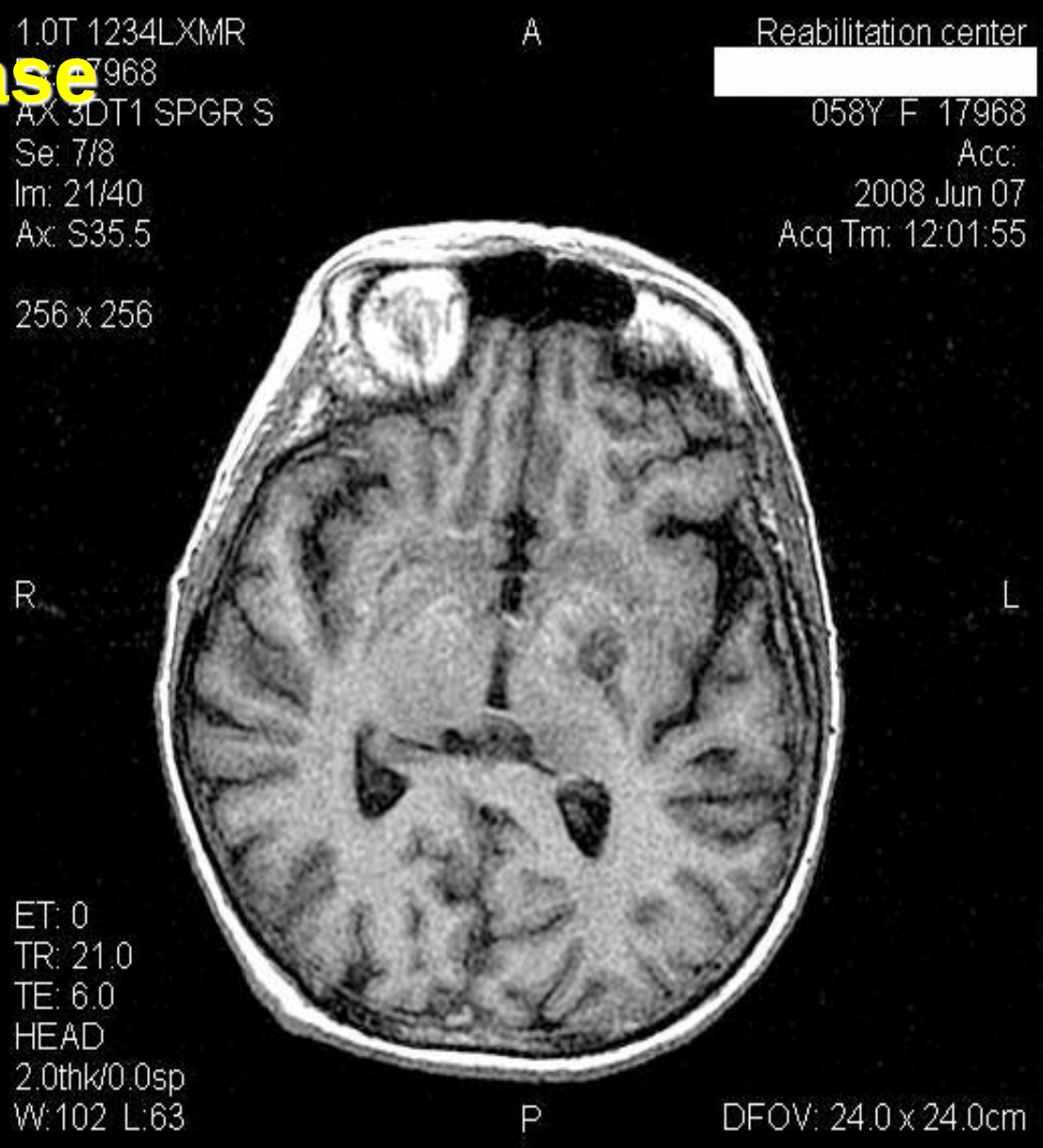
- Parkinson's Disease
- Essential tremor
- Tremor in MS

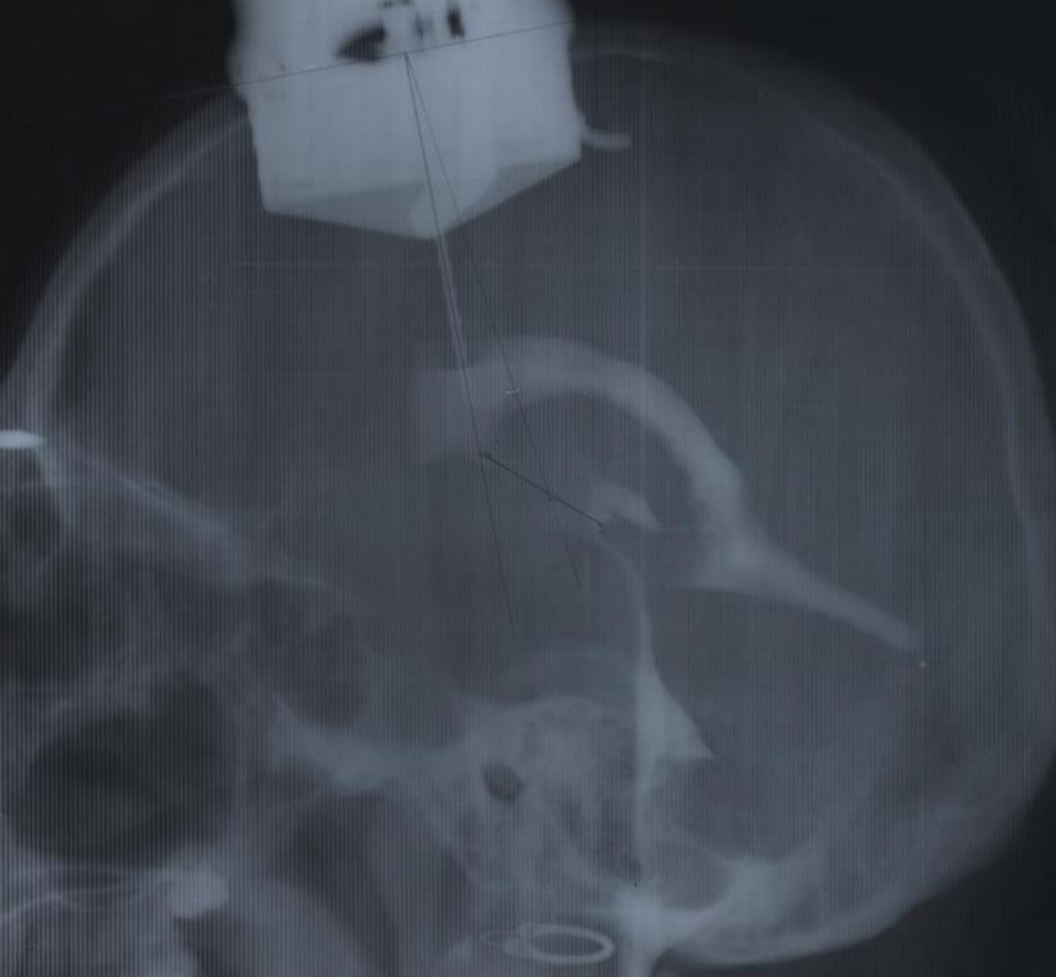


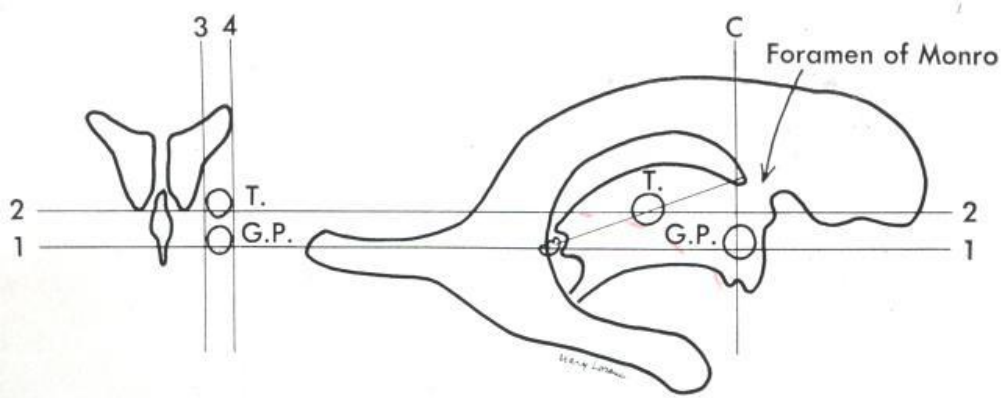



# Palidotomy

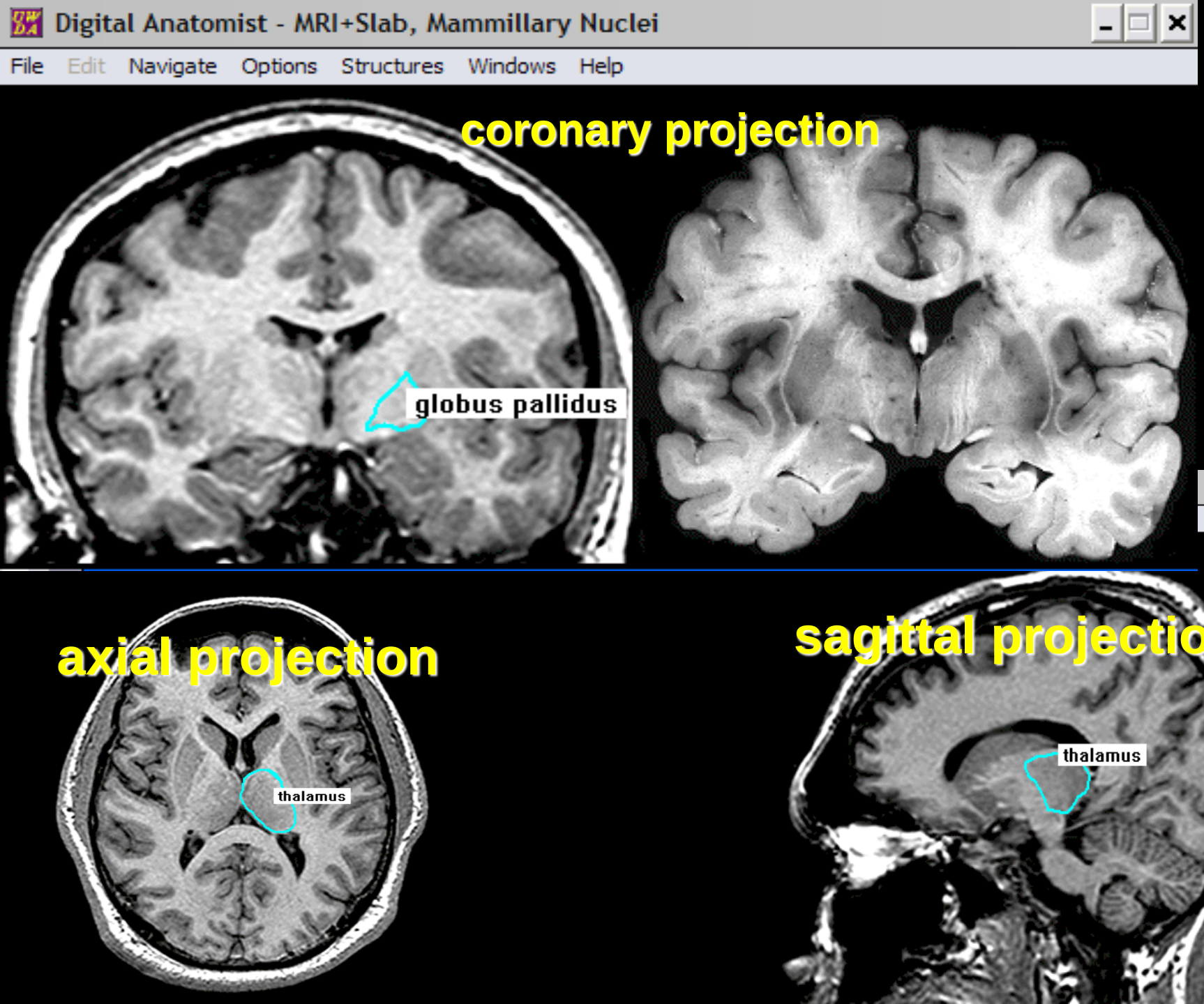
- Parkinson's Disease
- Tics Tourette's
- Dystonia



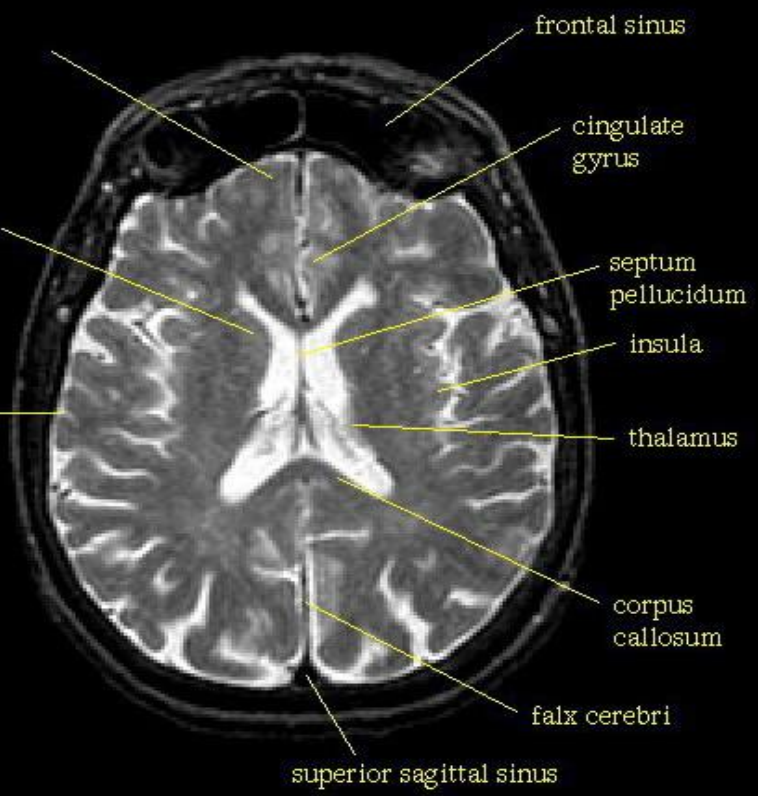


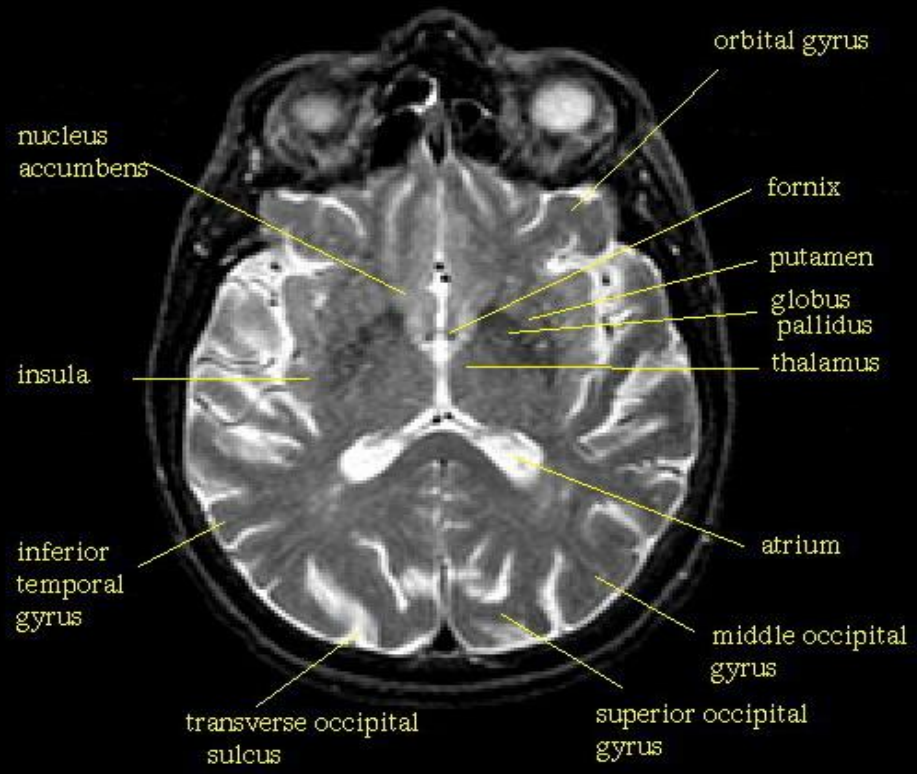


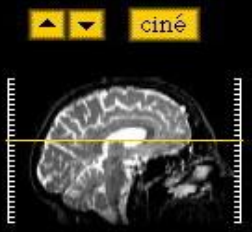

**Earlier calculations of the subcortical nuclei was performed using a solution of Omnipak ventriculography (layout of the subcortical nuclei)**


Digital Anatomist - MRI+Slab, Mammillary Nuclei
File
Edit
Navigate
Options
Structures
Windows
Help
coronary projection
globus pallidus
axial projection
thalamus
sagittal projection
thalamus

# Stereotactic Atlas of MRI

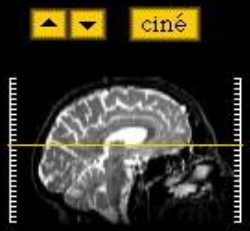



Slice 31

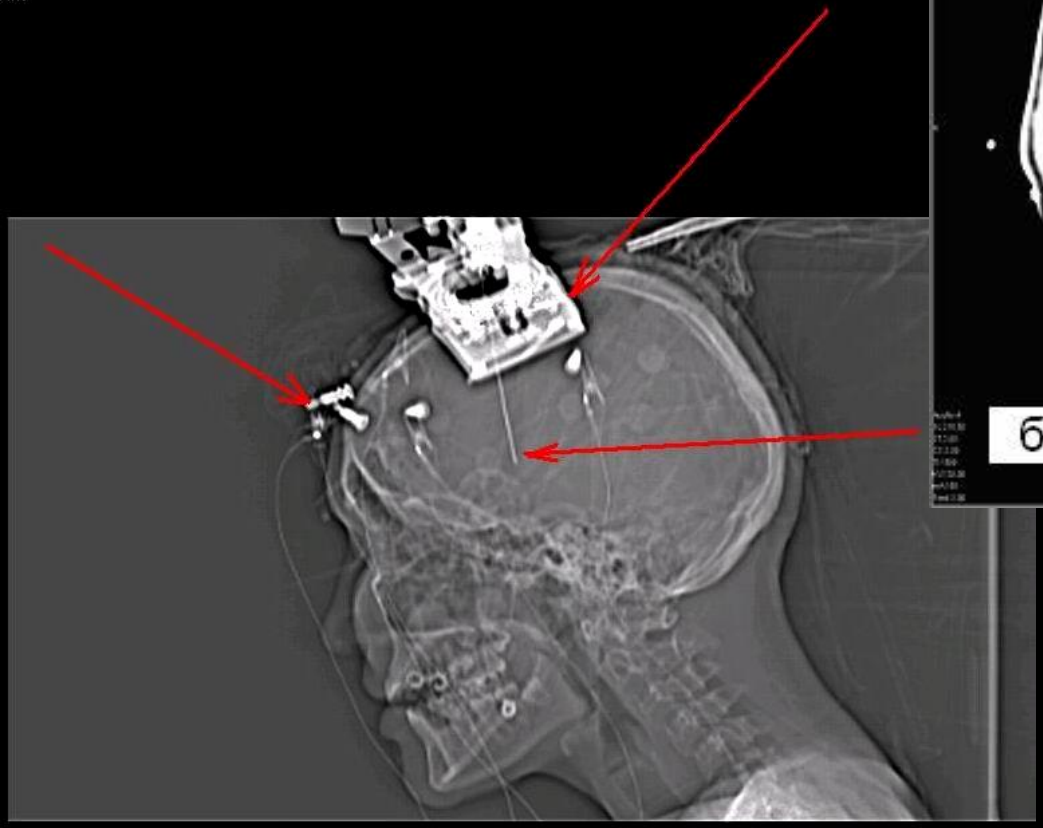
| | MR | | | CBF | CBF with | | |
|---|---|---|---|---|---|---|---|
| | T1 | PD | T2 | | T1 | PD | T2 |
| Unlabeled | | | | | | | |
| Pointers | | | | | | | |
| Labeled | | | | | | | |

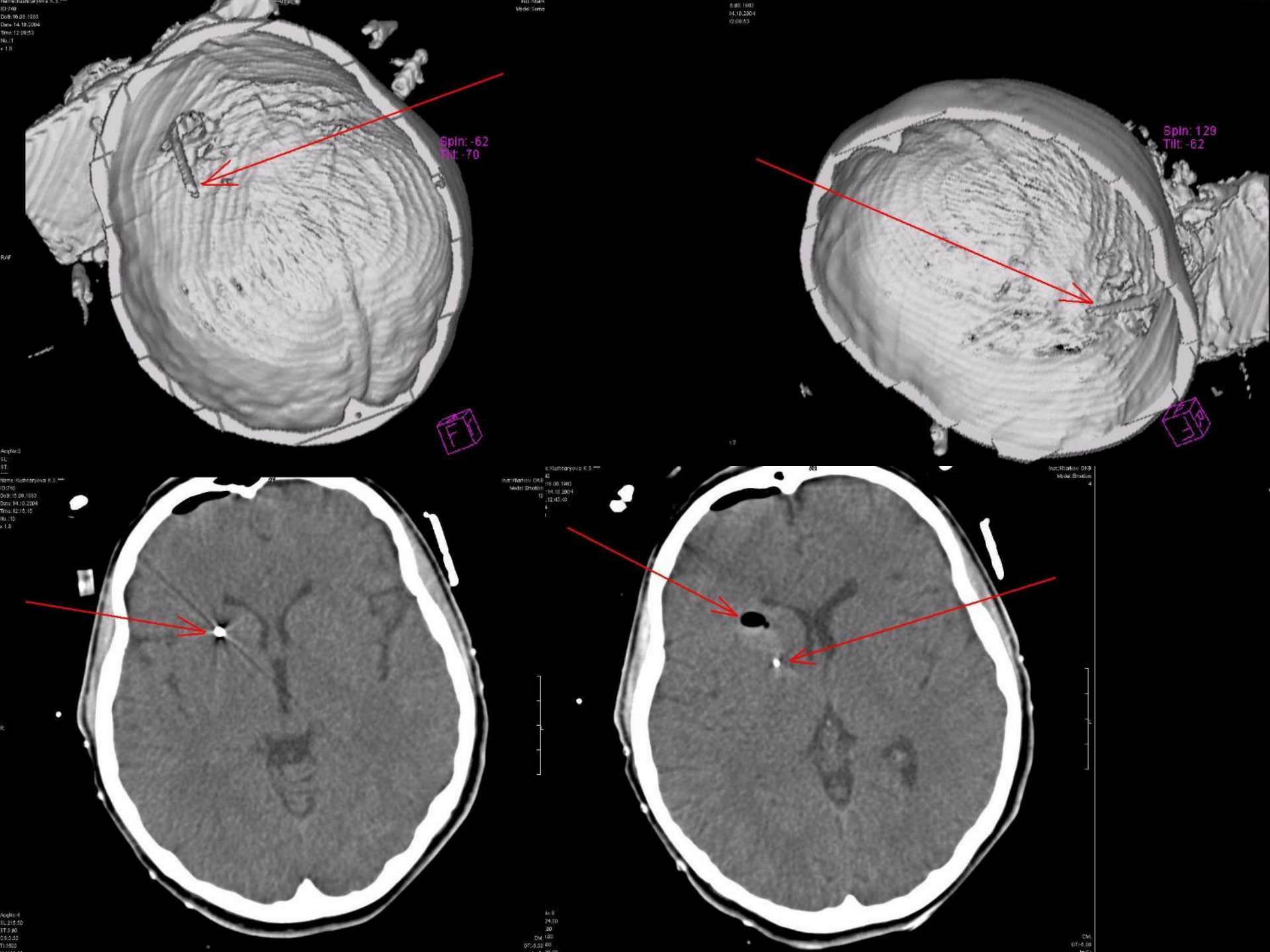



Slice 28

| | MR | | | CBF | CBF with | | |
|---|---|---|---|---|---|---|---|
| | T1 | PD | T2 | | T1 | PD | T2 |
| Unlabeled | | | | | | | |
| Pointers | | | | | | | |
| Labeled | | | | | | | |

# Stereotactic surgery under the supervision of CT SOMATOM Siemens

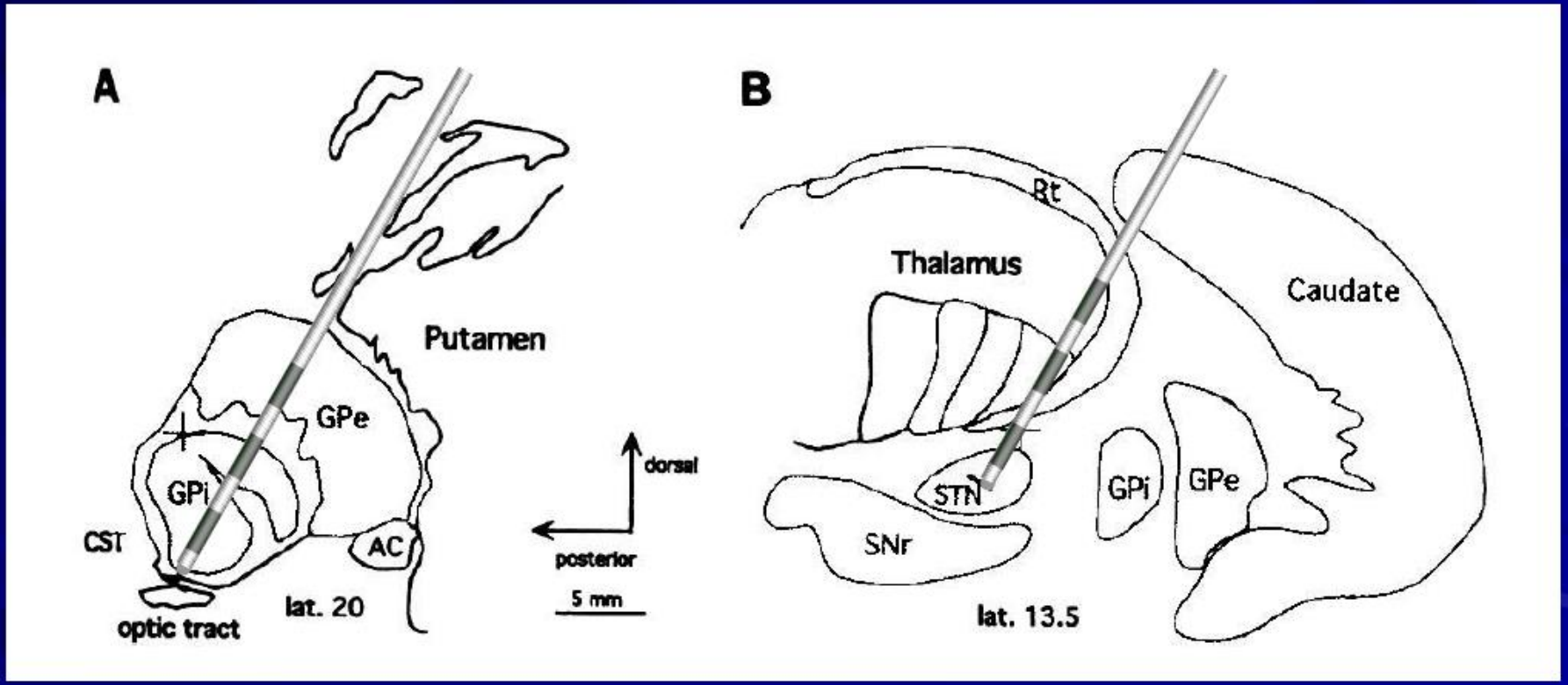




Spin: -62
Tilt: -70
Spin: 129
Tilt: -62

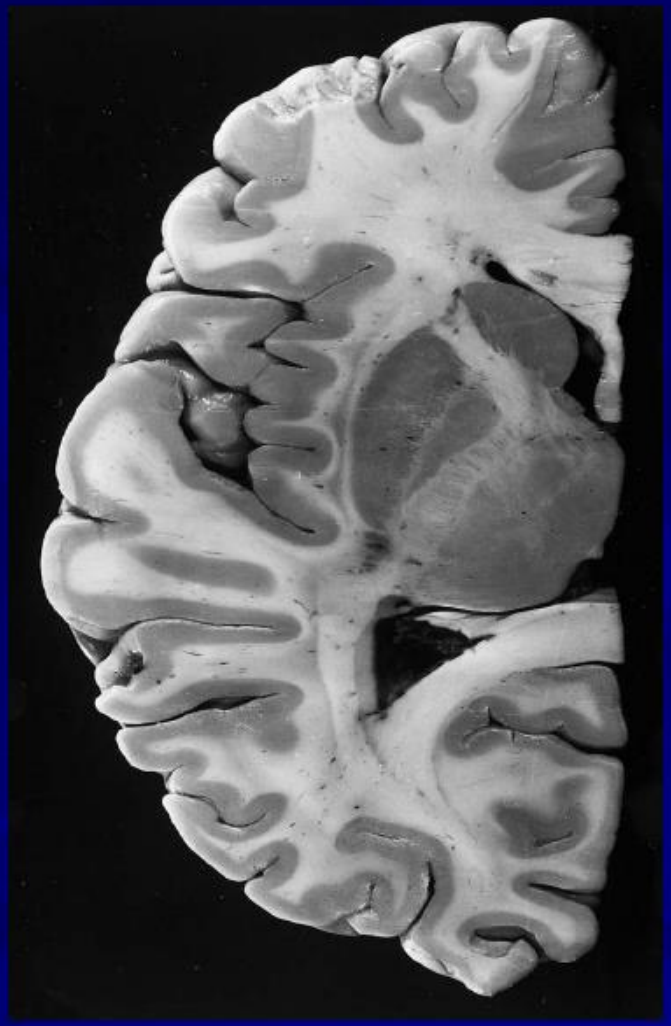
# For the purpose of electrical stimulation of deep brain structures used implantable cerebral electrostimulators


# Точки цели для глубокой электростимуляции

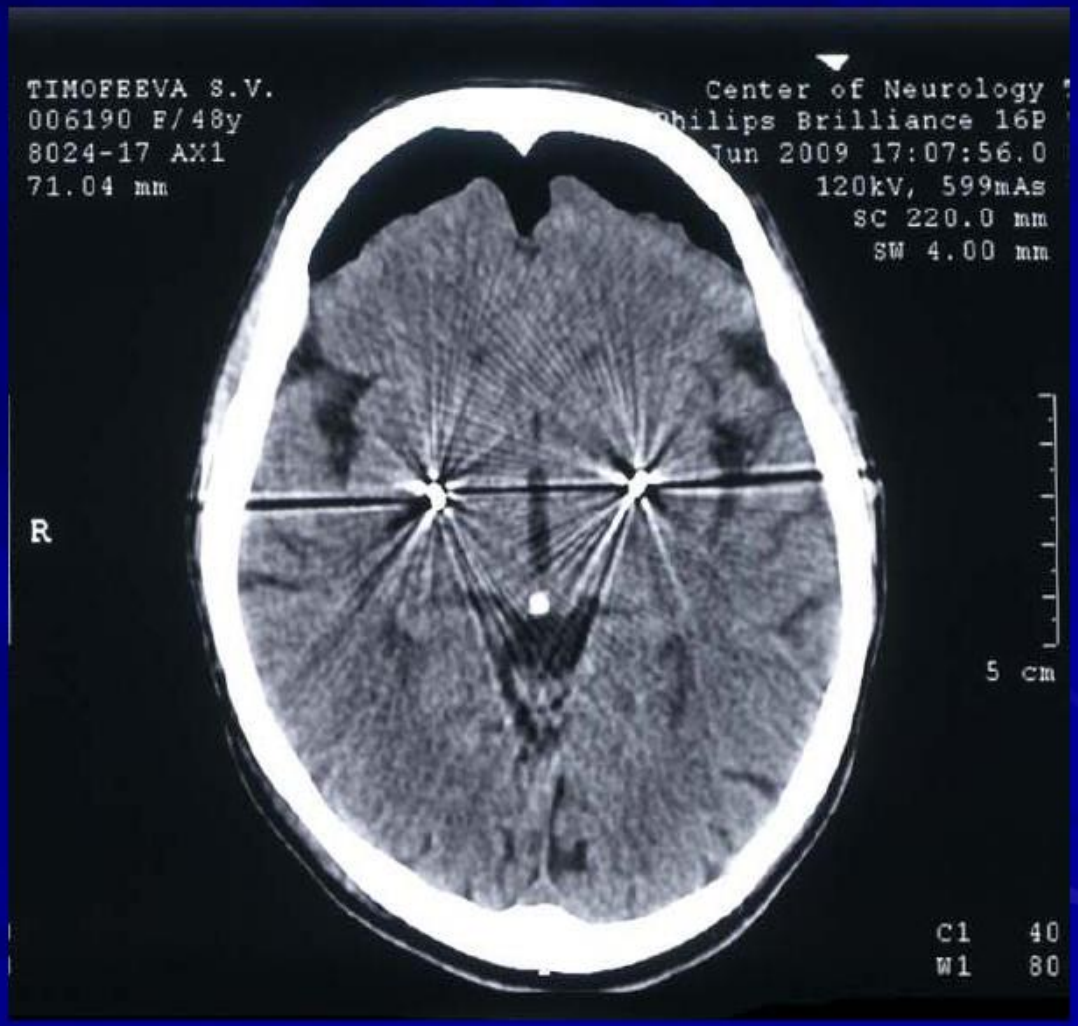
**Globus Pallidus** **Subthalamic Nucleus**



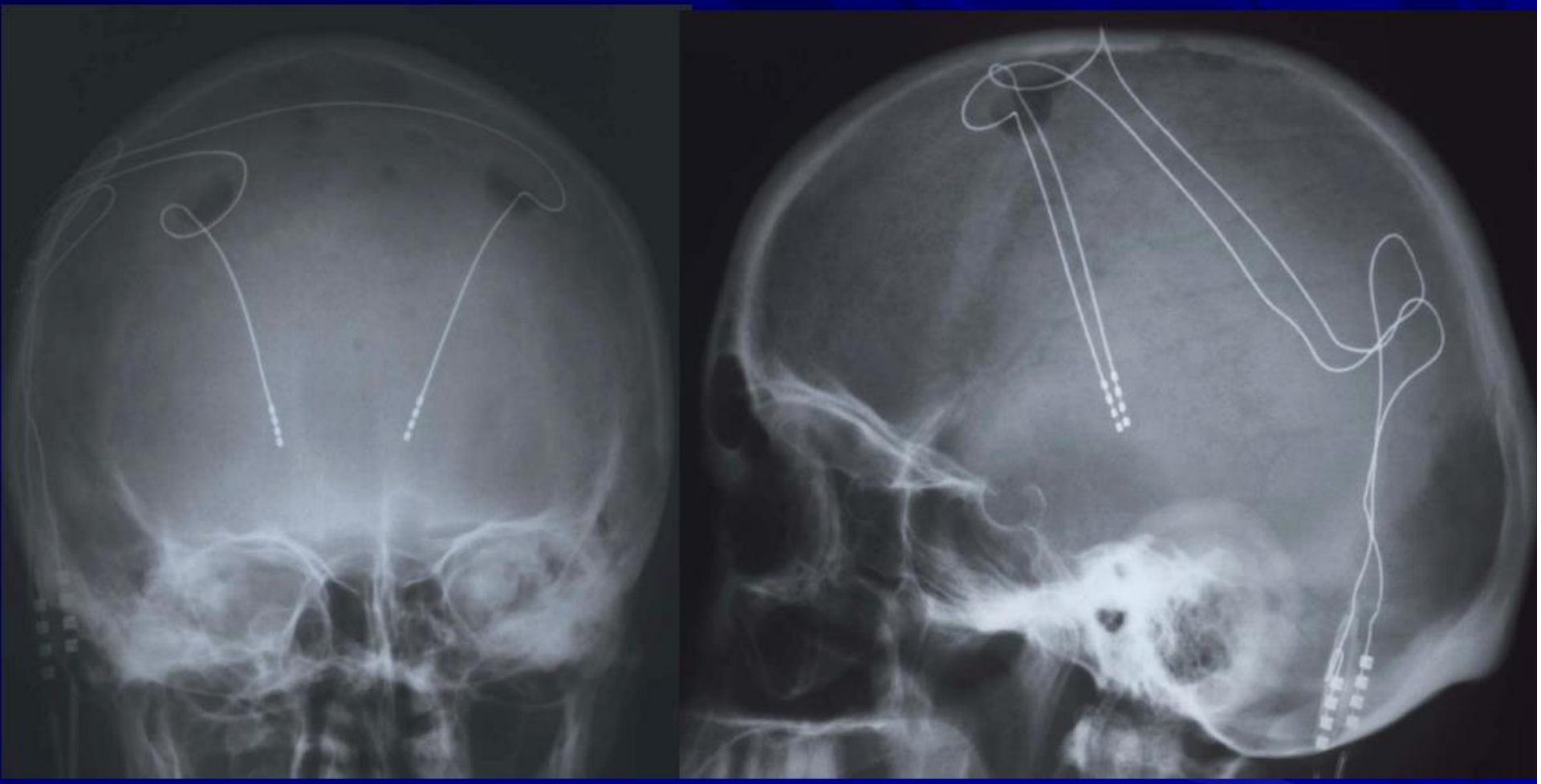
# Расположение электродов в бледном шаре



Анатомический препарат



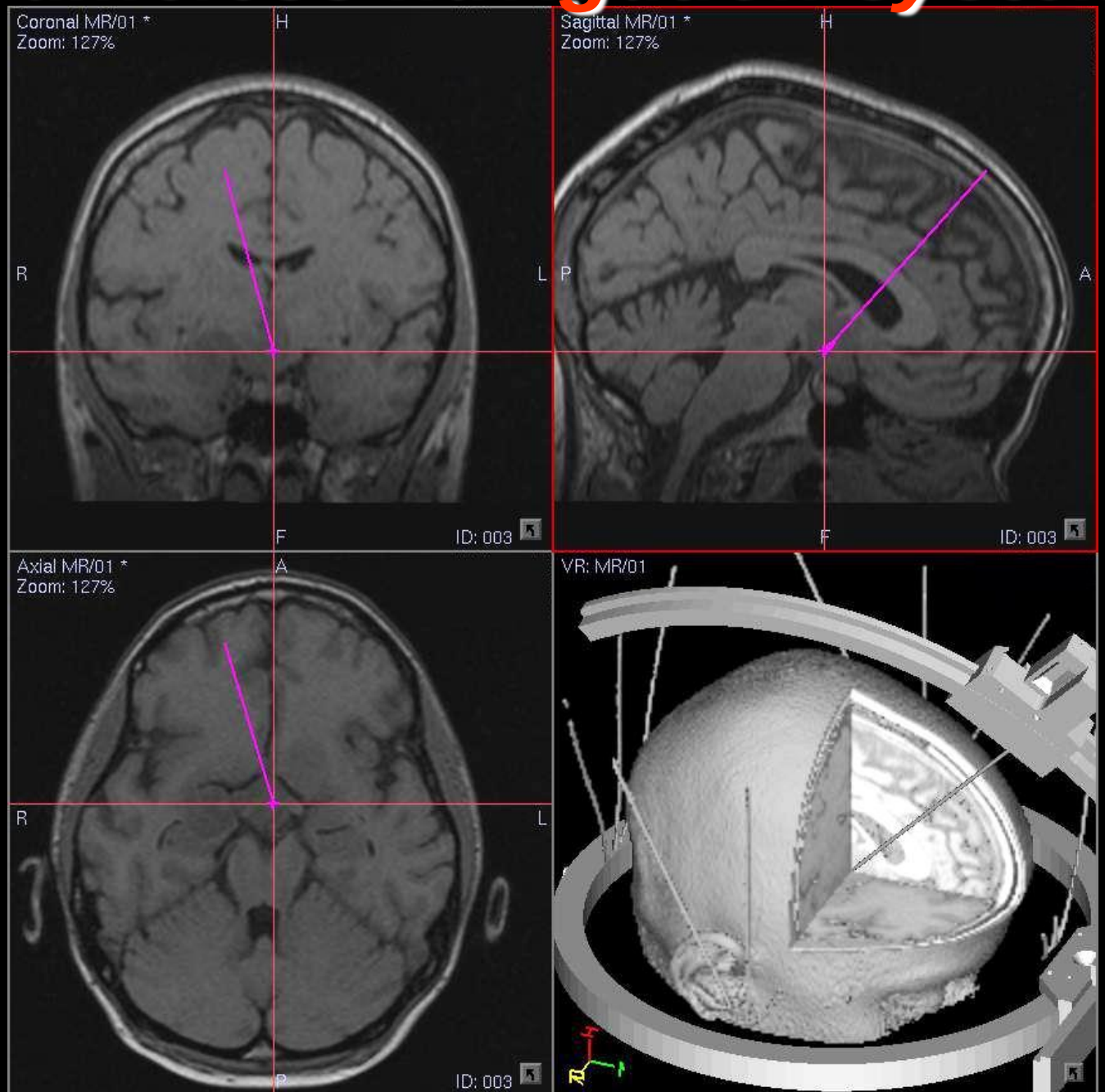

КТ - головного мозга, после операции



**Рентгенографическая картина расположения электродов в Vim таламуса с 2-х сторон. Прямая и боковая проекции**

# Frameless navigation system

# Frameless navigation system



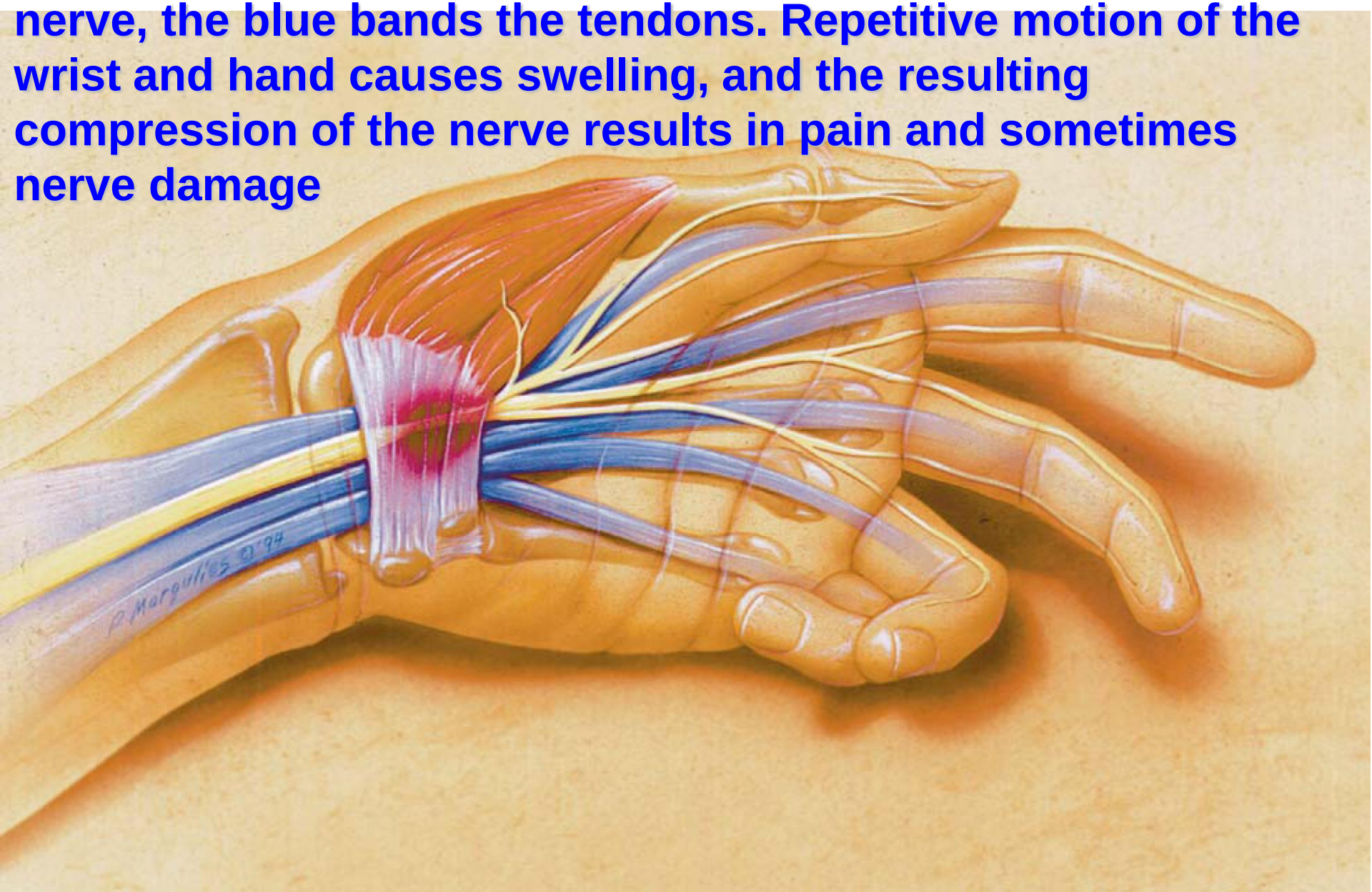
# *What is electrostimulation?*

- The impact of electricity on slaboimpulsnogo structure of the peripheral and central nervous system

- **Fundamental mechanisms of action of neurostimulation is still unknown**

# Pump of baklofen with microcatheters


Medical illustration of left wrist and hand showing carpel tunnel syndrome. The yellow lines represent the median nerve, the blue bands the tendons. Repetitive motion of the wrist and hand causes swelling, and the resulting compression of the nerve results in pain and sometimes nerve damage

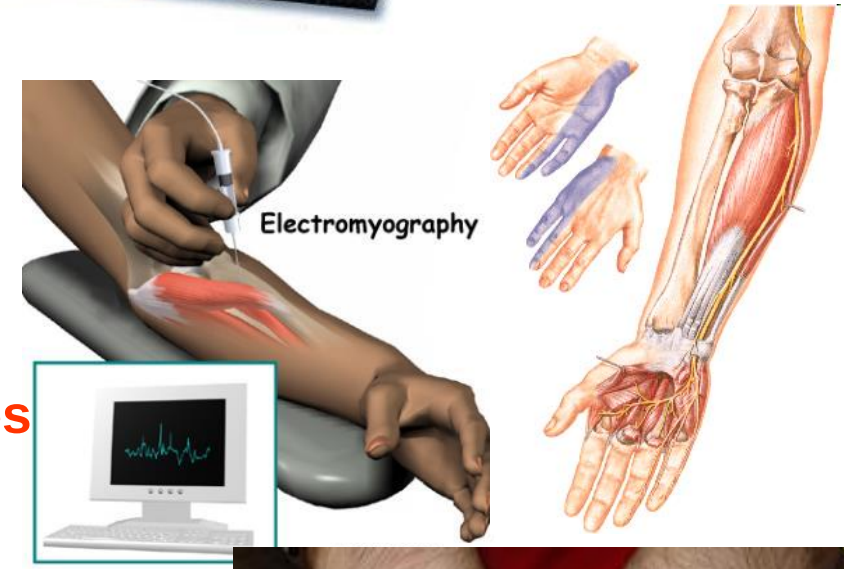


## Problems with the nerves

The nerve;
compression;
Fire damage to the nerves;
Tumors of the nerves;
Damage to the brachial plexus;
The defeat of the facial nerve


## Methods of diagnosis

Clinical examination;
Electromyography;
Magnetic resonance imaging;
X-rays

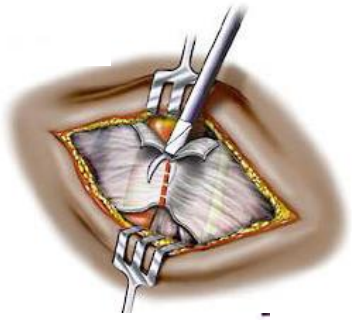



## Methods of treating injuries and diseases of the nerves

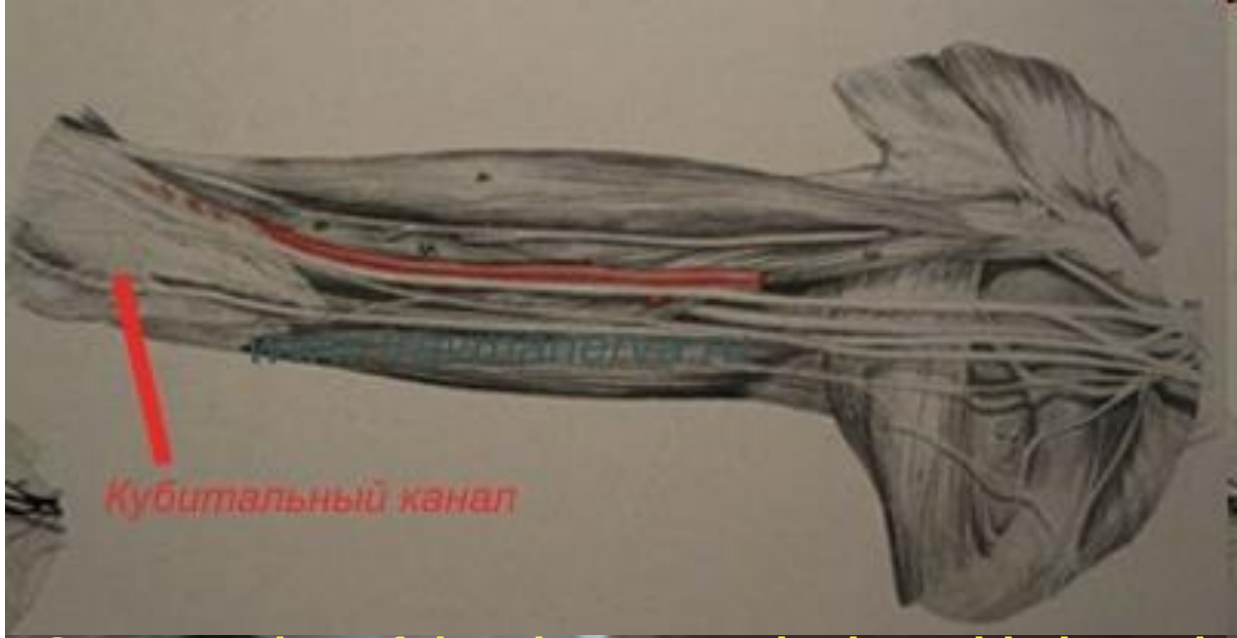
Suture of nerve;
Suture of nerve damage after a fire;
neurolysis;
Decompression, moving into a new bed;
reinnervation;
Orthopedic surgery in irreparable damage to the nerves;
removal of the tumor



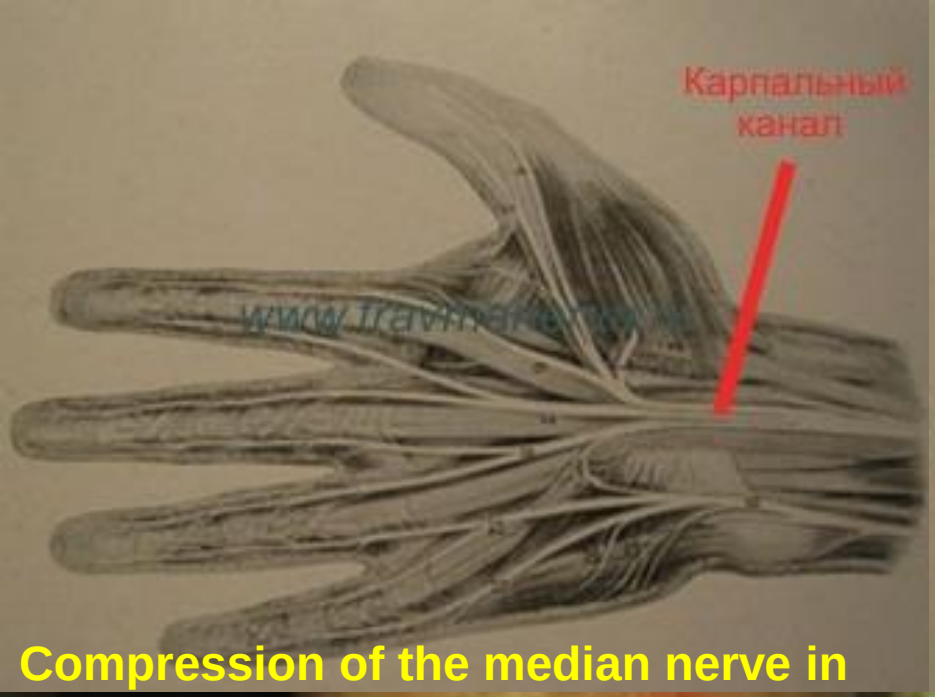

- **In the treatment of cubital syndrome;**
- **In the treatment of carpal syndrome;**
- **In the treatment of tarsal syndrome;**
- **In the treatment of the fibulyar syndrome**

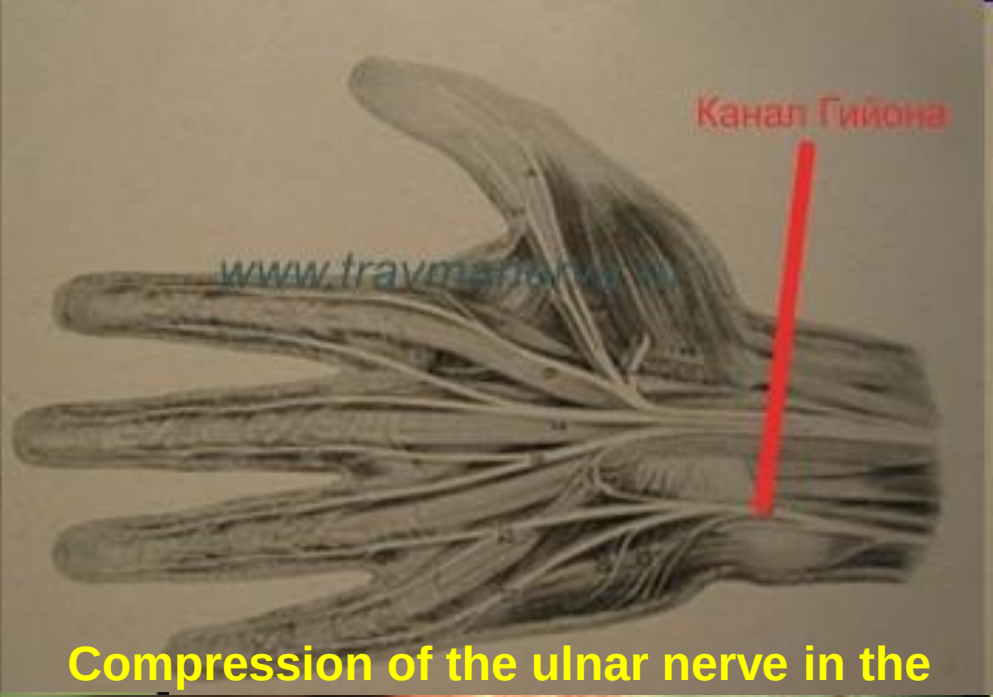





**Compression of the ulnar nerve in the cubital canal**



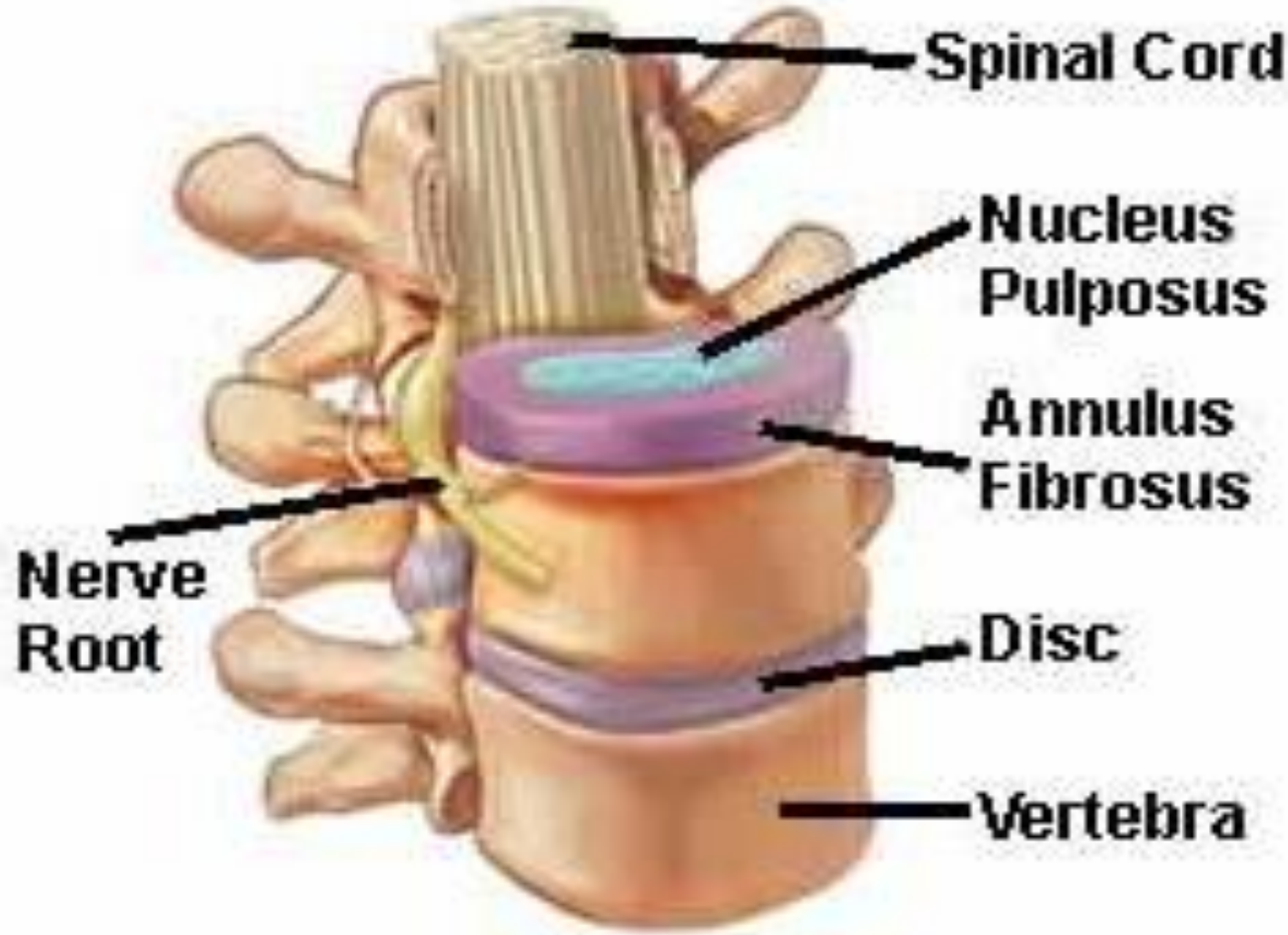

Compression of the median nerve in the carpal canal

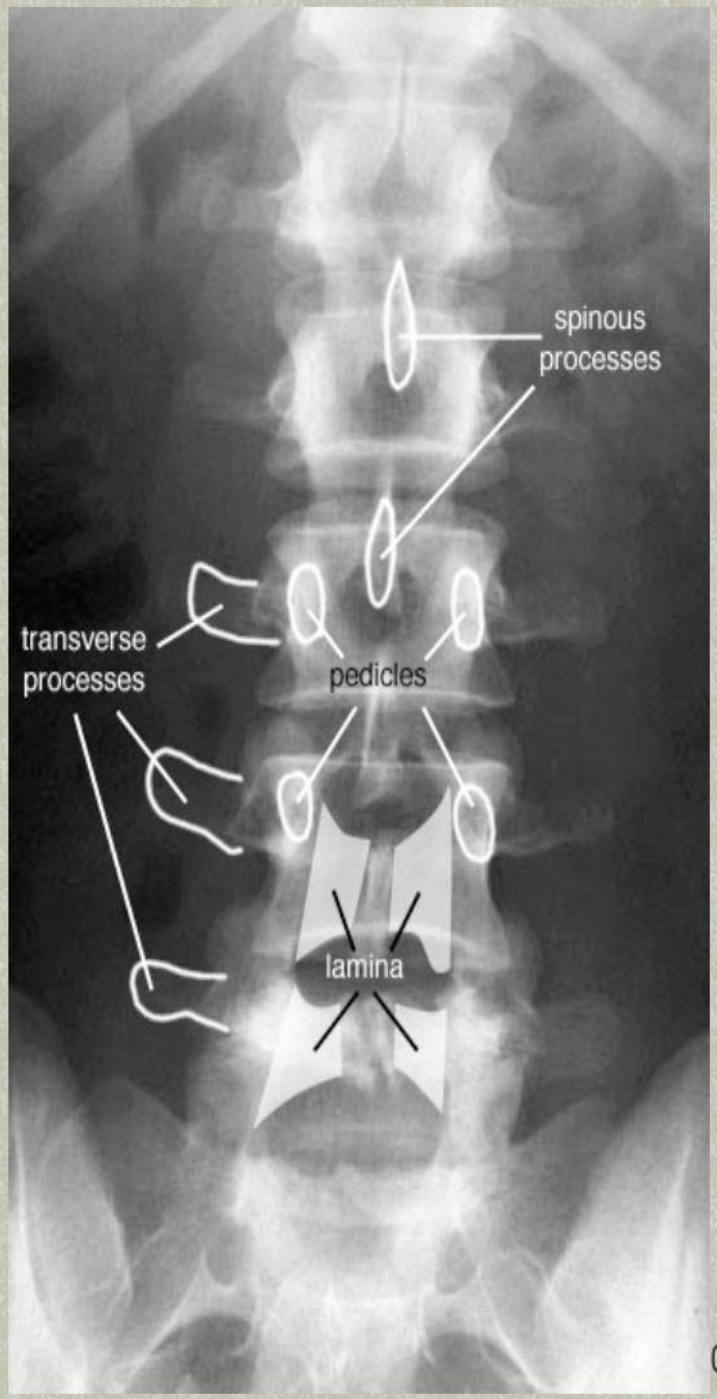


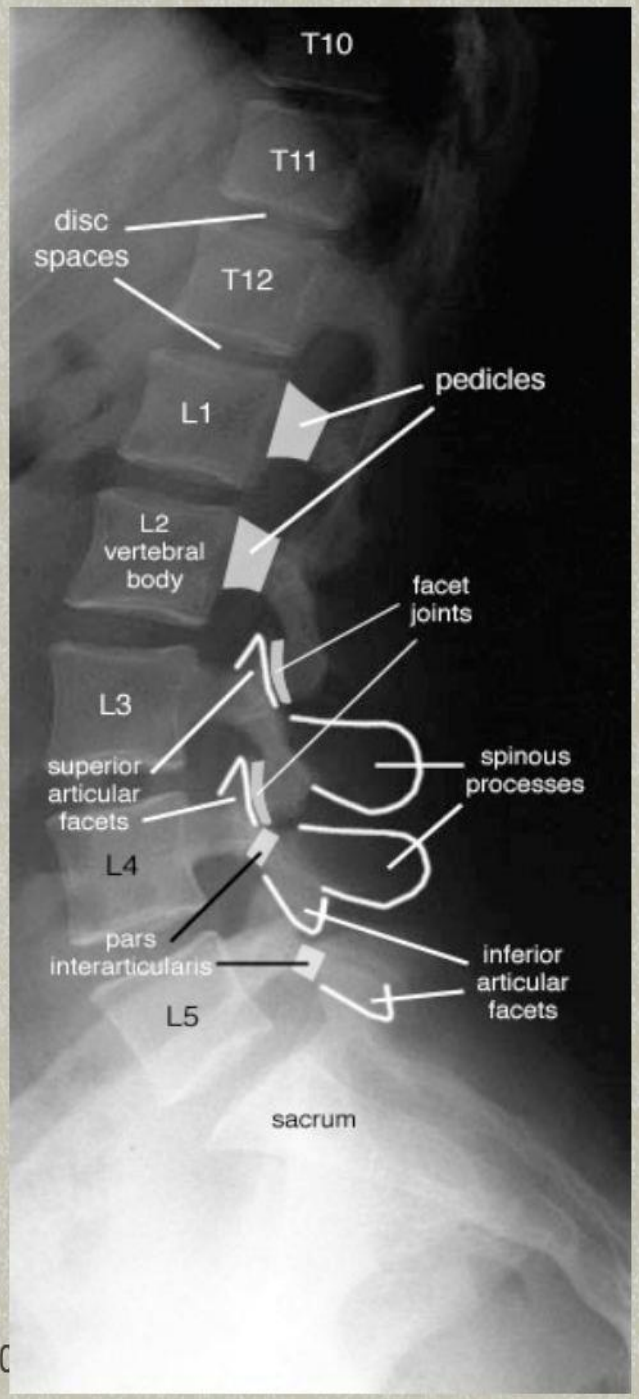

Compression of the ulnar nerve in the Guyon canal

# OSTEOCHONDROSIS OF THE SPINE

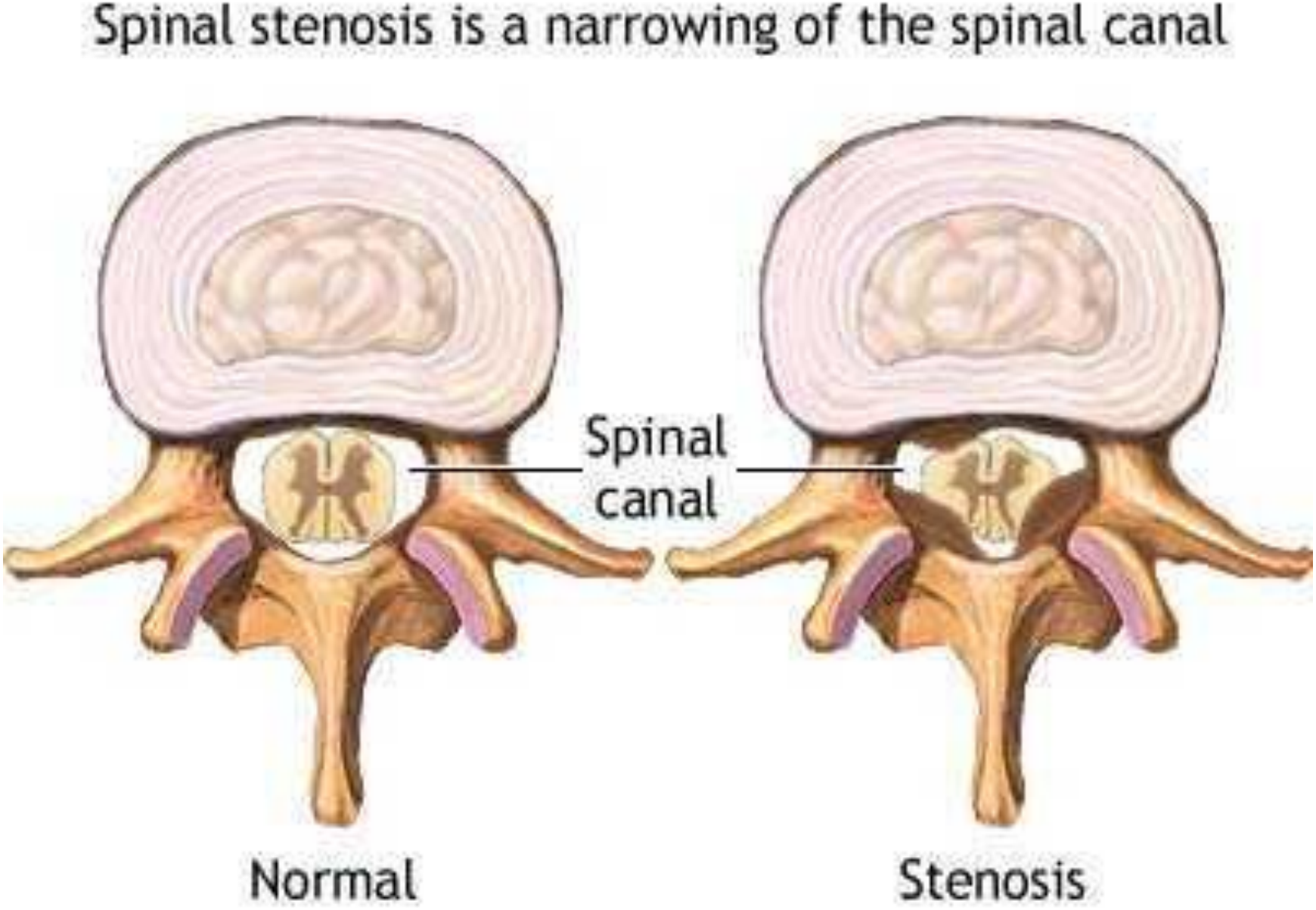
# The normal anatomy of the spine






# The main X-ray guidance




# Spinal stenosis

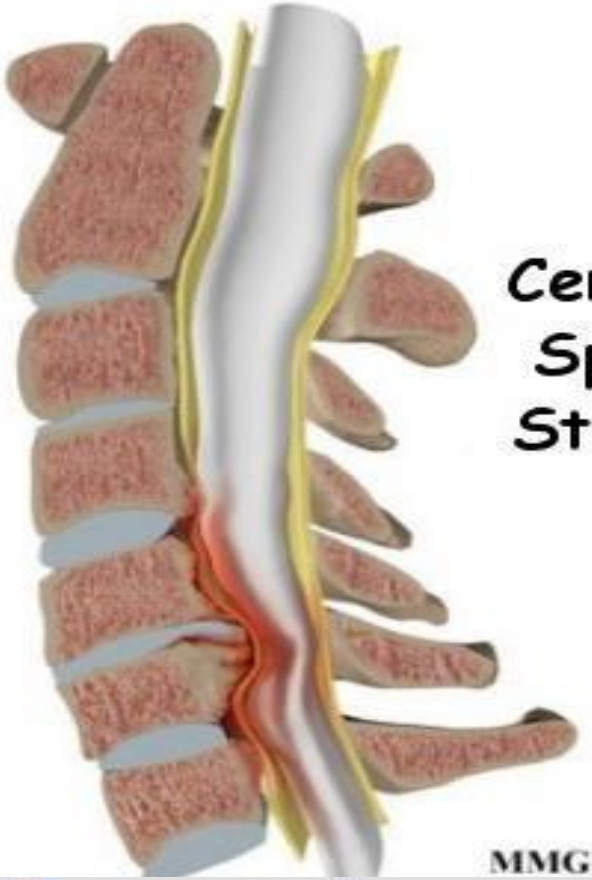
# OSTEOCHONDROSIS OF THE SPINE

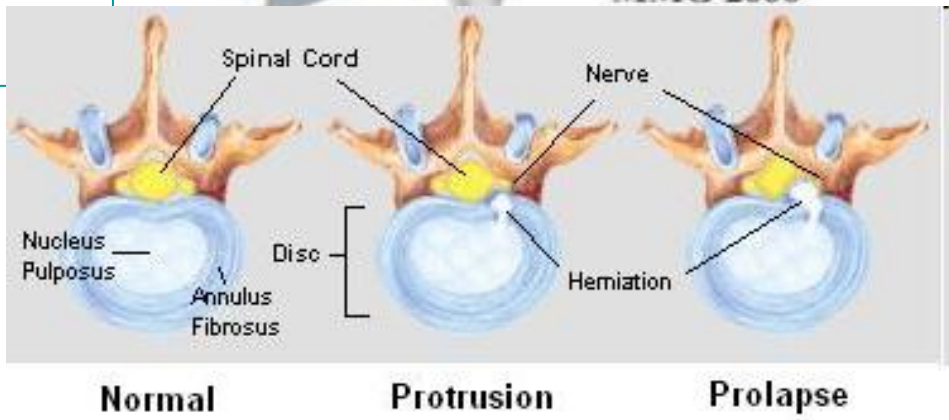
Healthy Cervical Spine

Central Stenosis

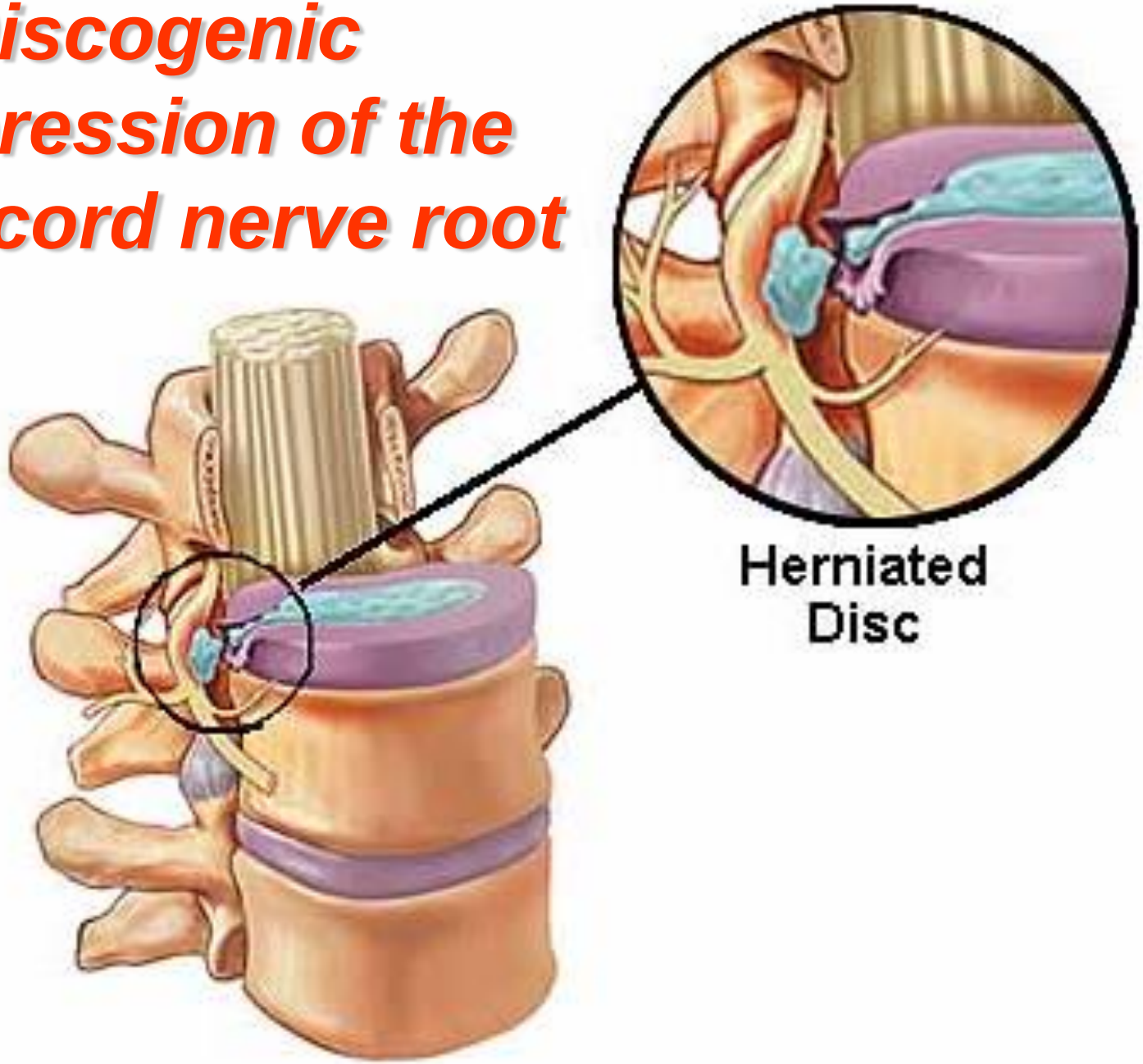
Foraminal Stenosis

Herniated Disk

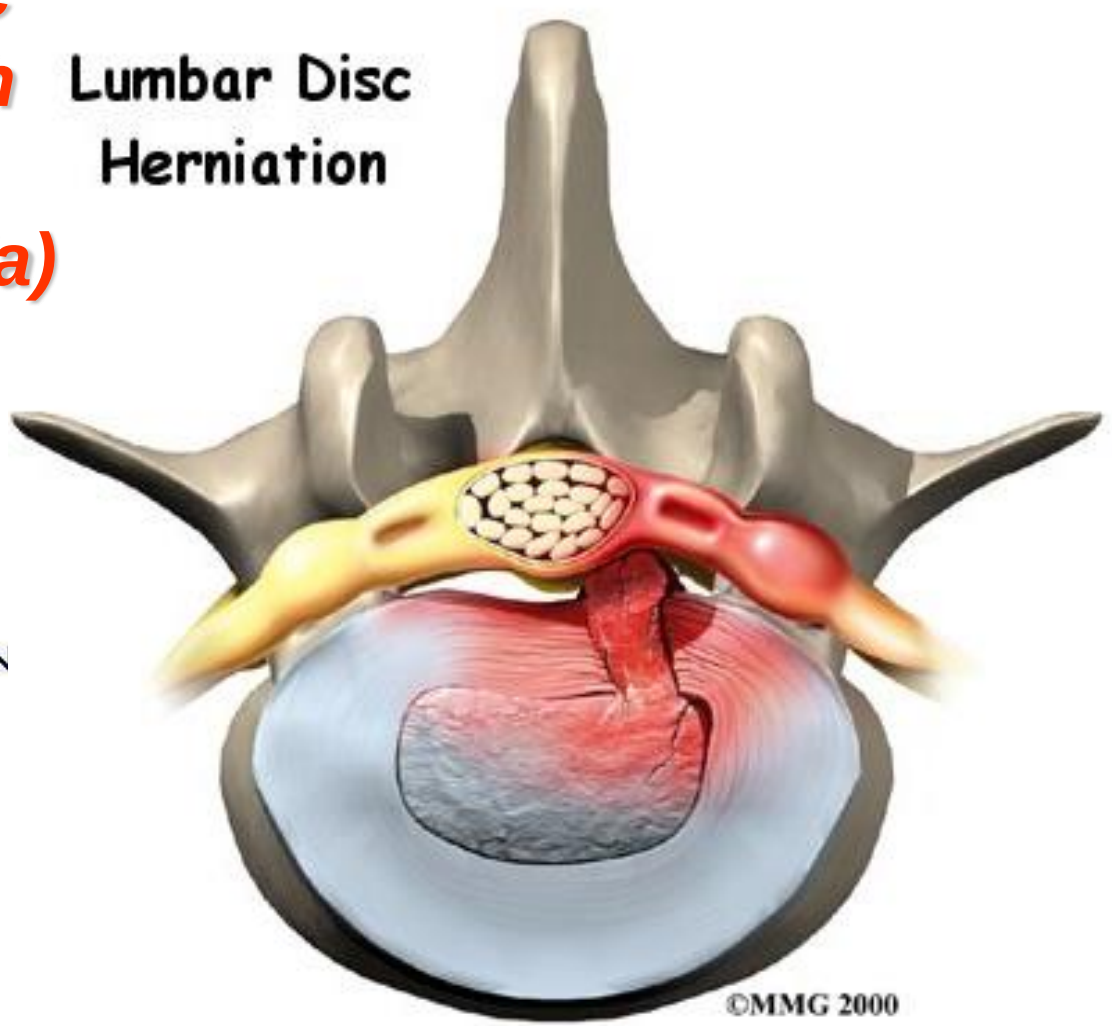


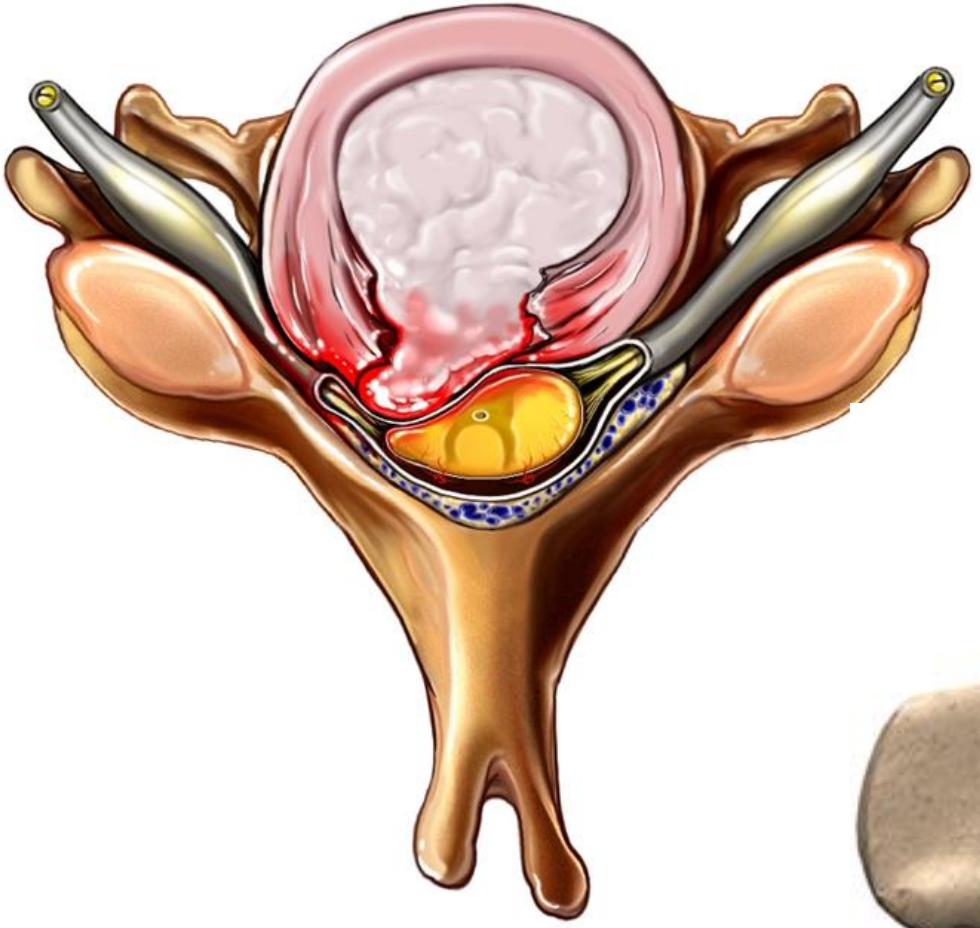



# *Discogenic compression of the spinal cord nerve root*

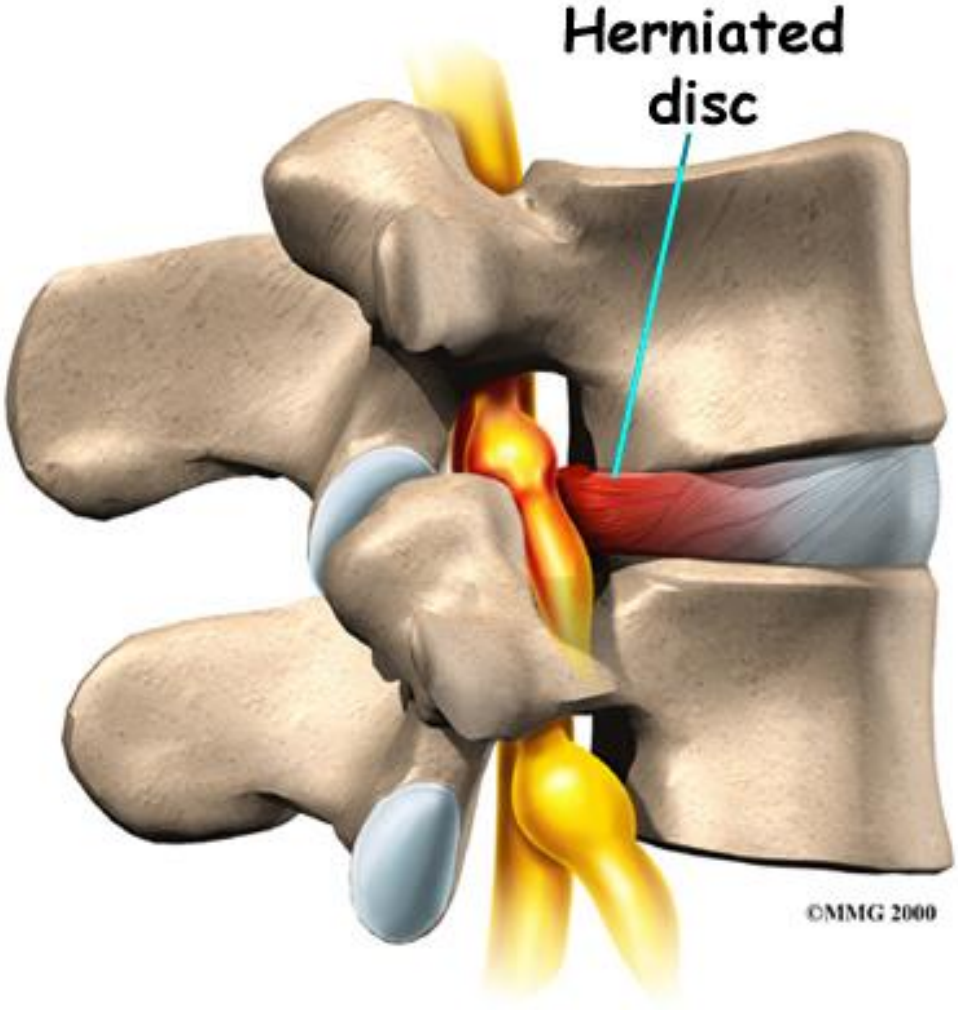


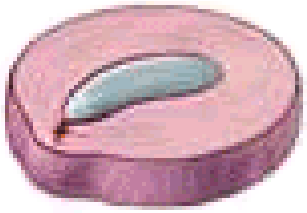
# Posterior-lateral disc herniation L4-L5 with compression of the spine (radikuloishemia)



# Posterior-lateral disc herniation in the thoracic spine with compression and spinal cord (mieloradikuloishemia)

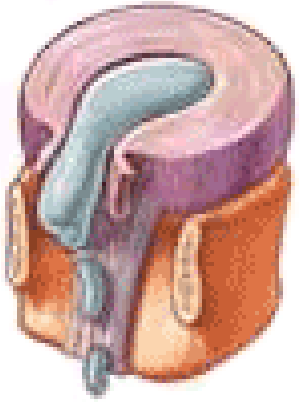




Начальная дегенерация диска

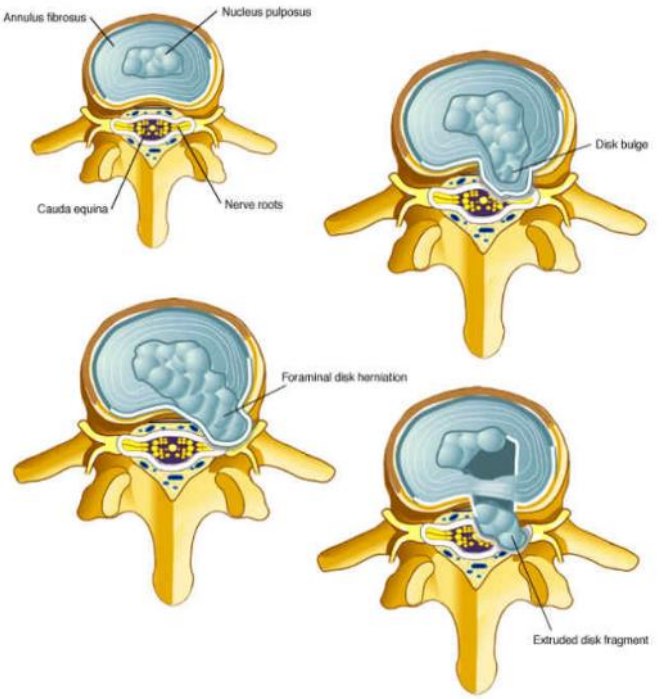
Пролапс

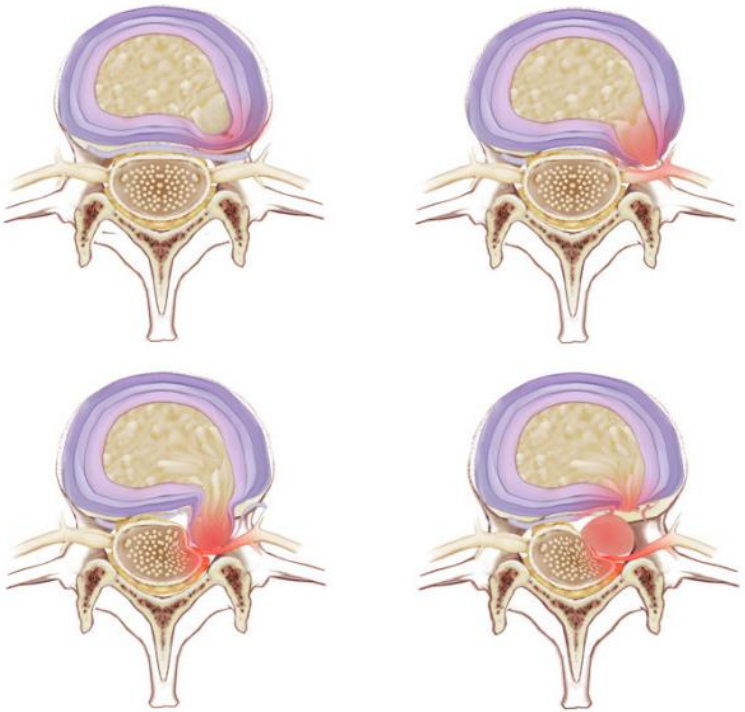
Формирование грыжи диска



Секвестрания

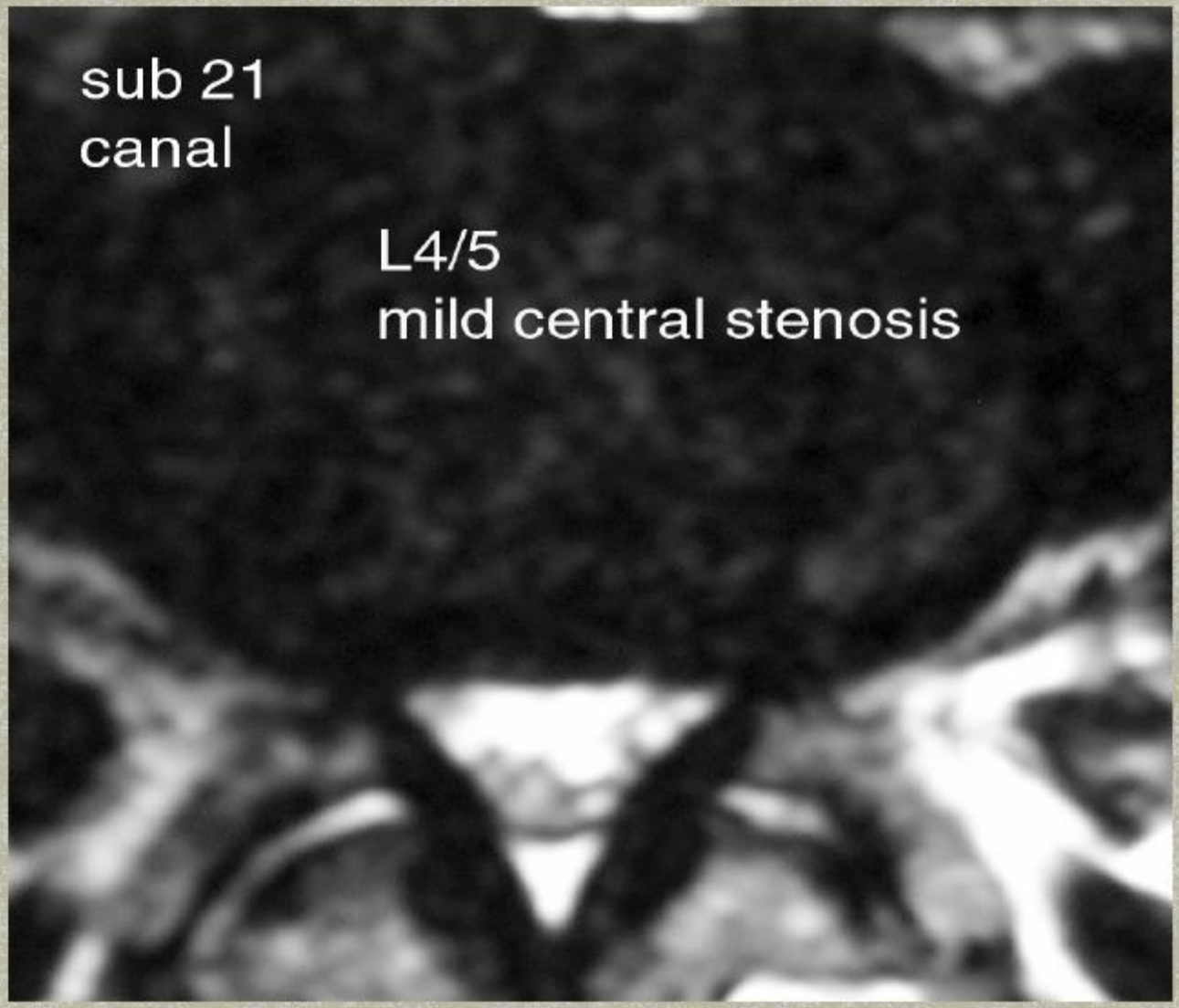
# Stages of formation of hernias

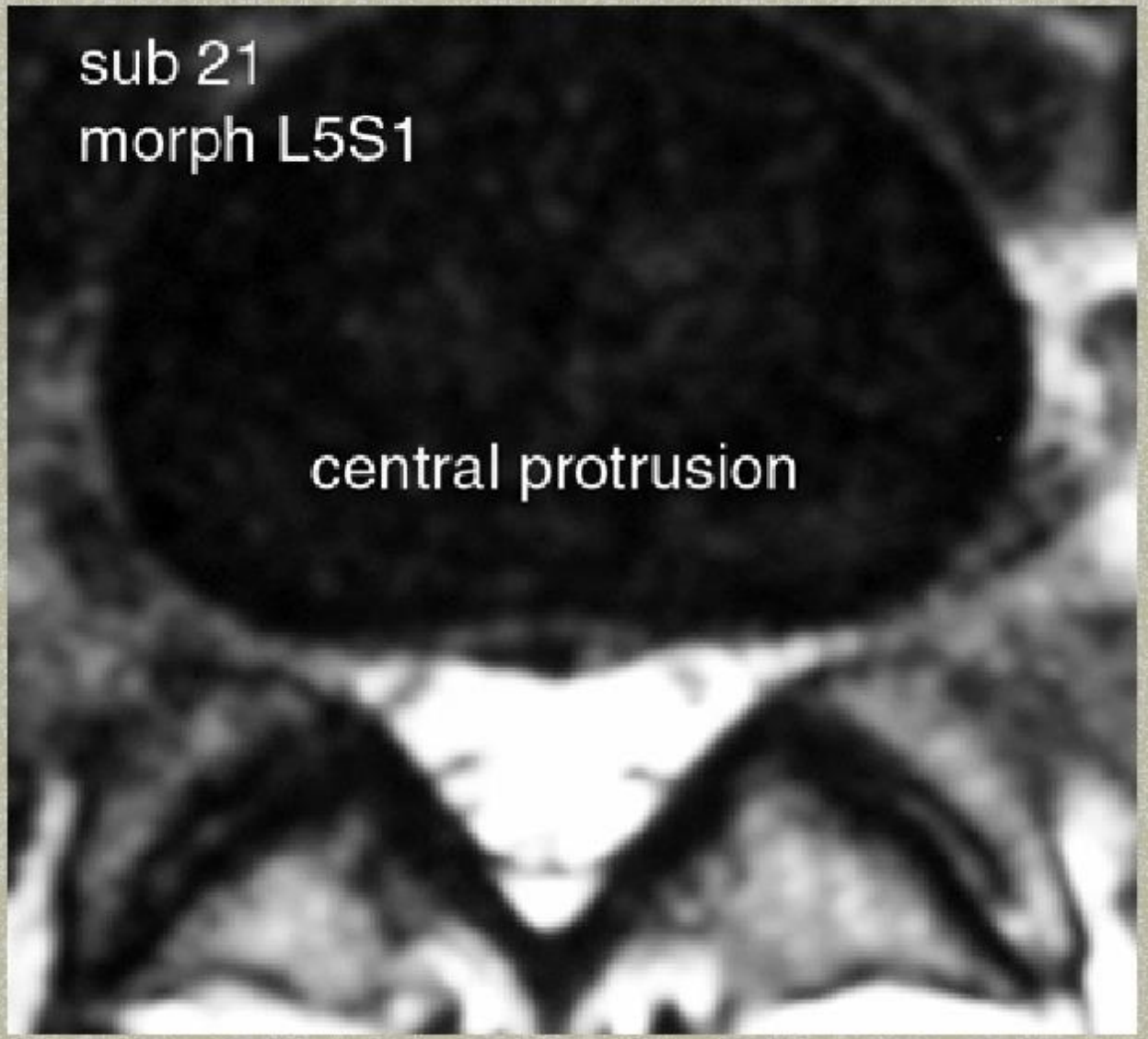



# MRI of the spine. Herniated disc L5-S1, L3-L4

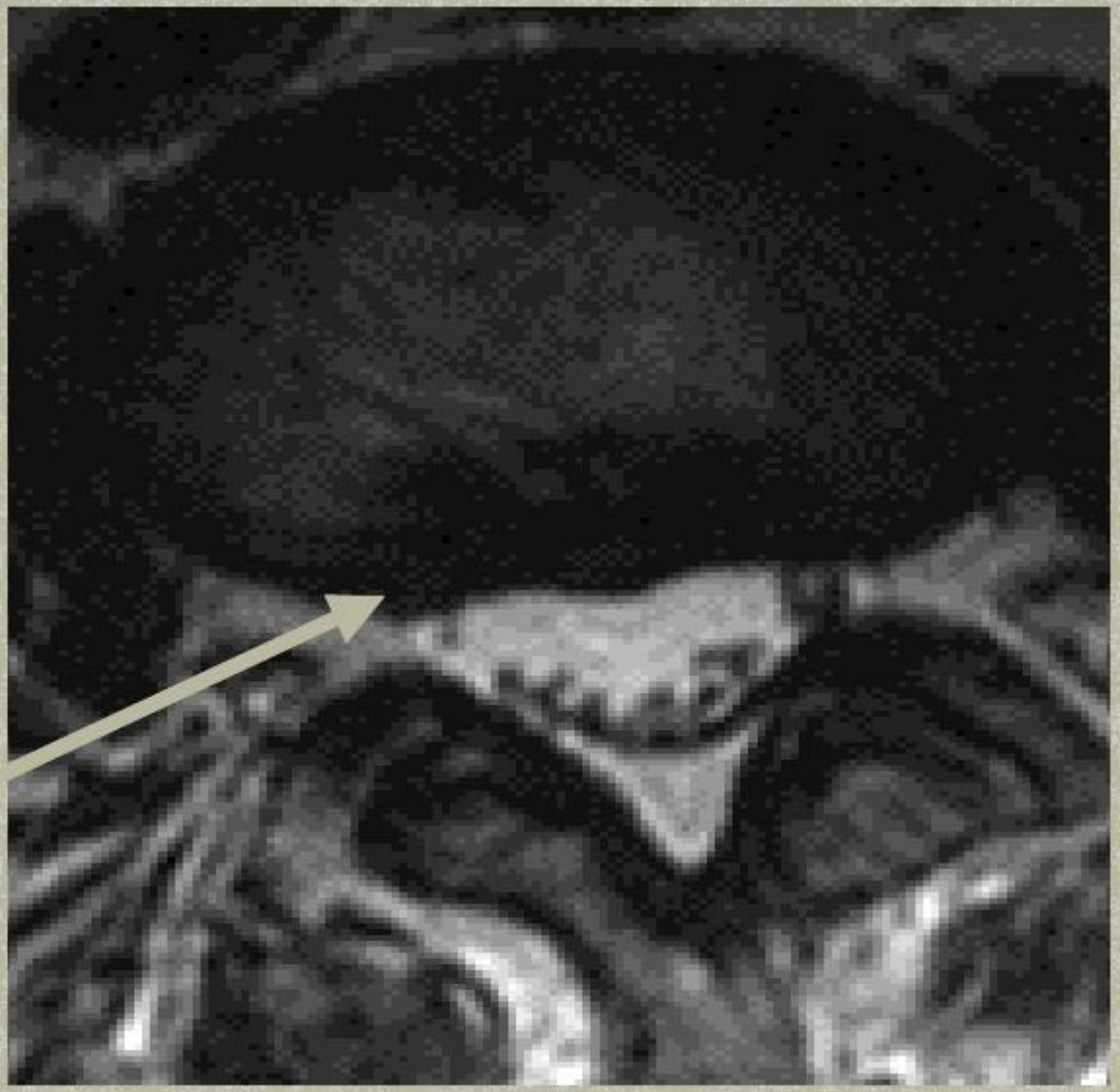

# The circular protrusion



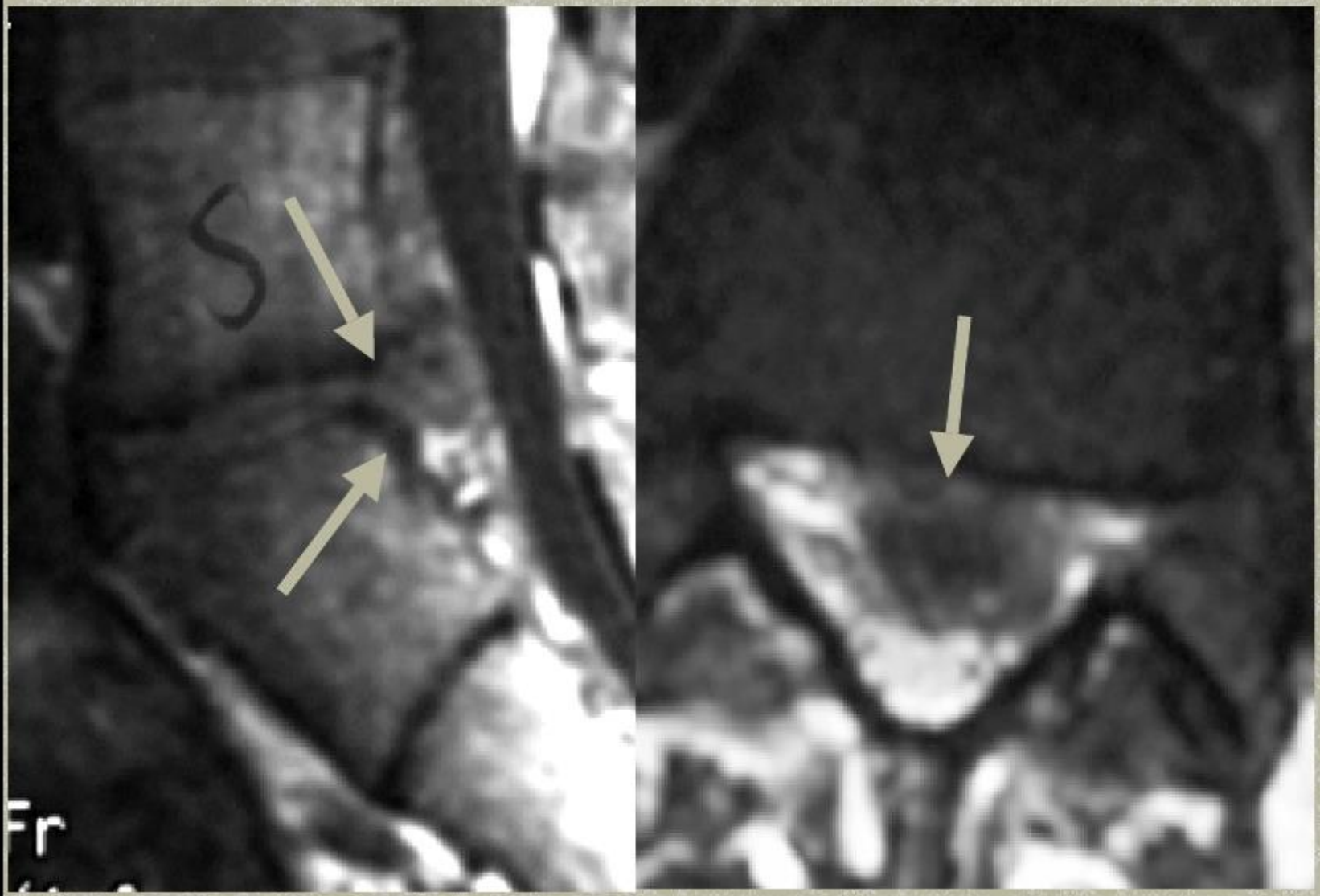
# The central protrusion



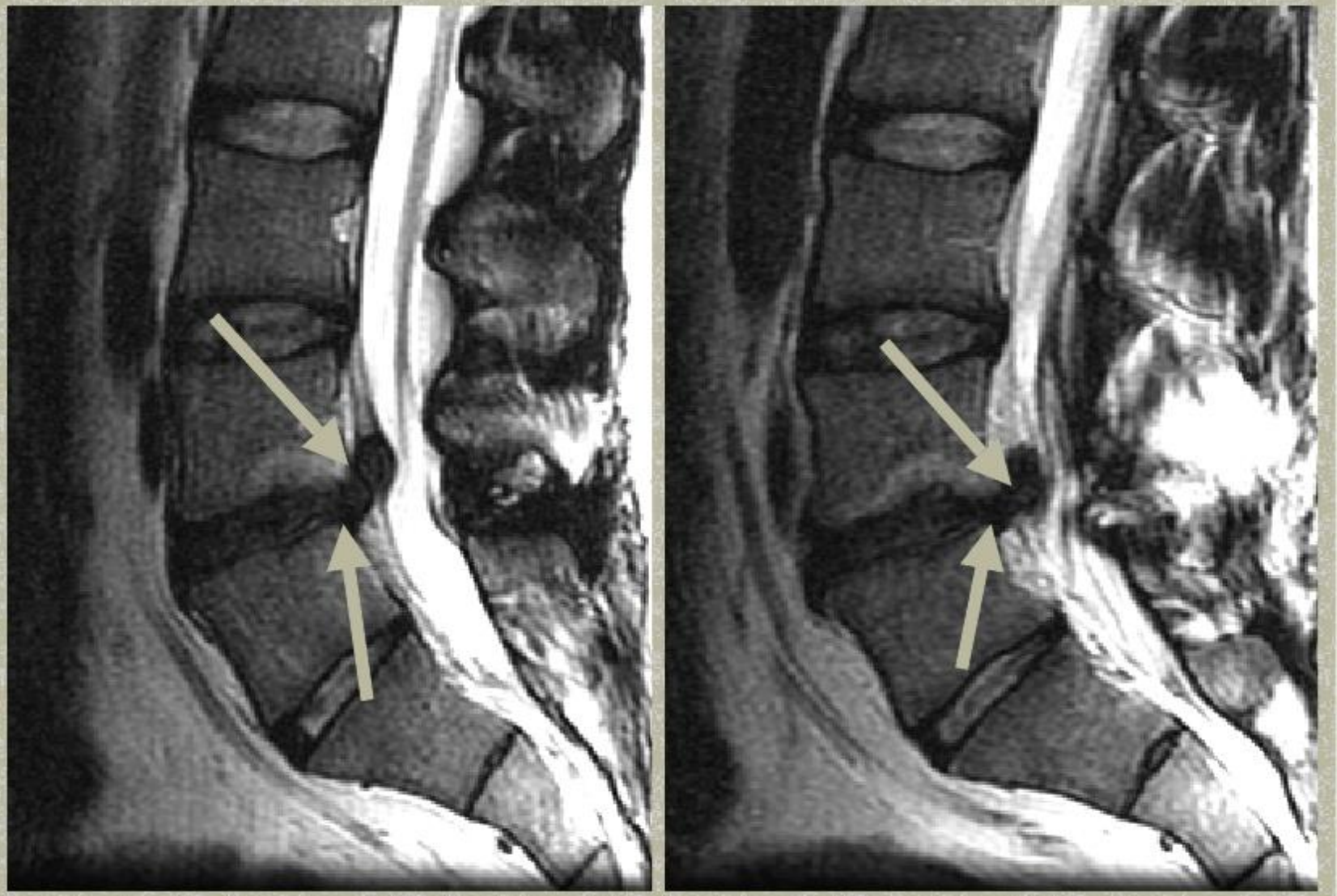
# The lateral protrusion



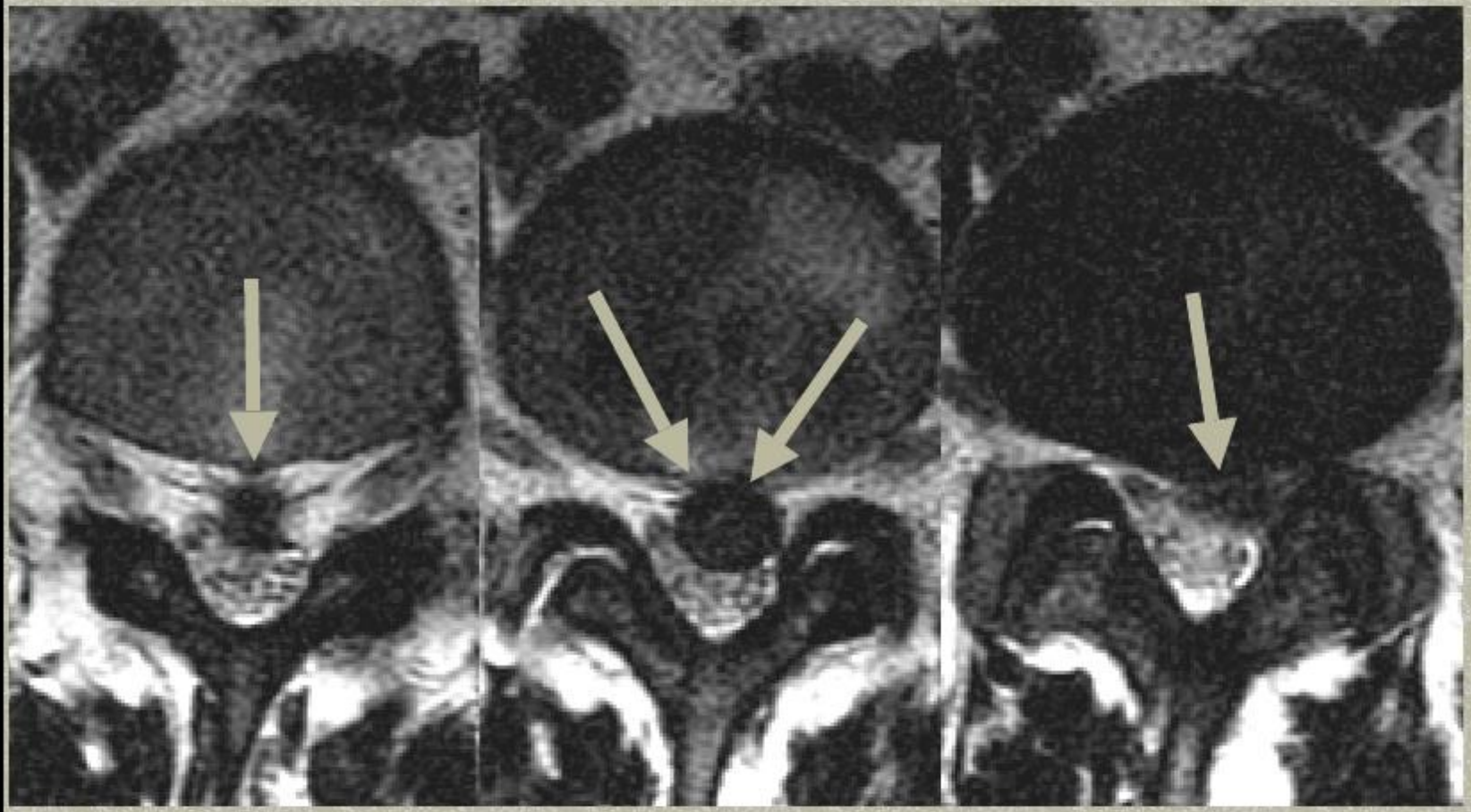
# Disc prolapse



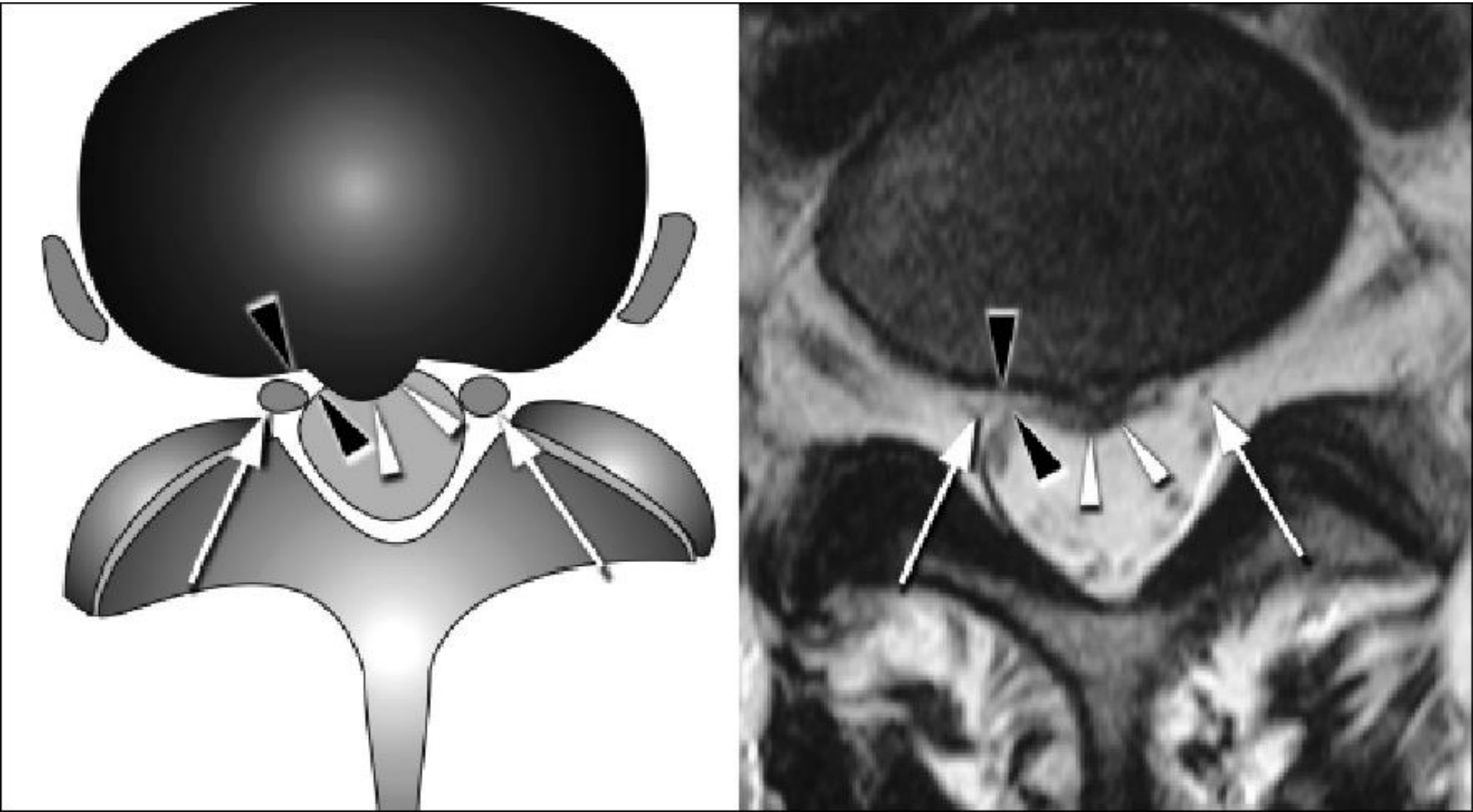
# Herniation of sequestered



# Herniation of sequestered

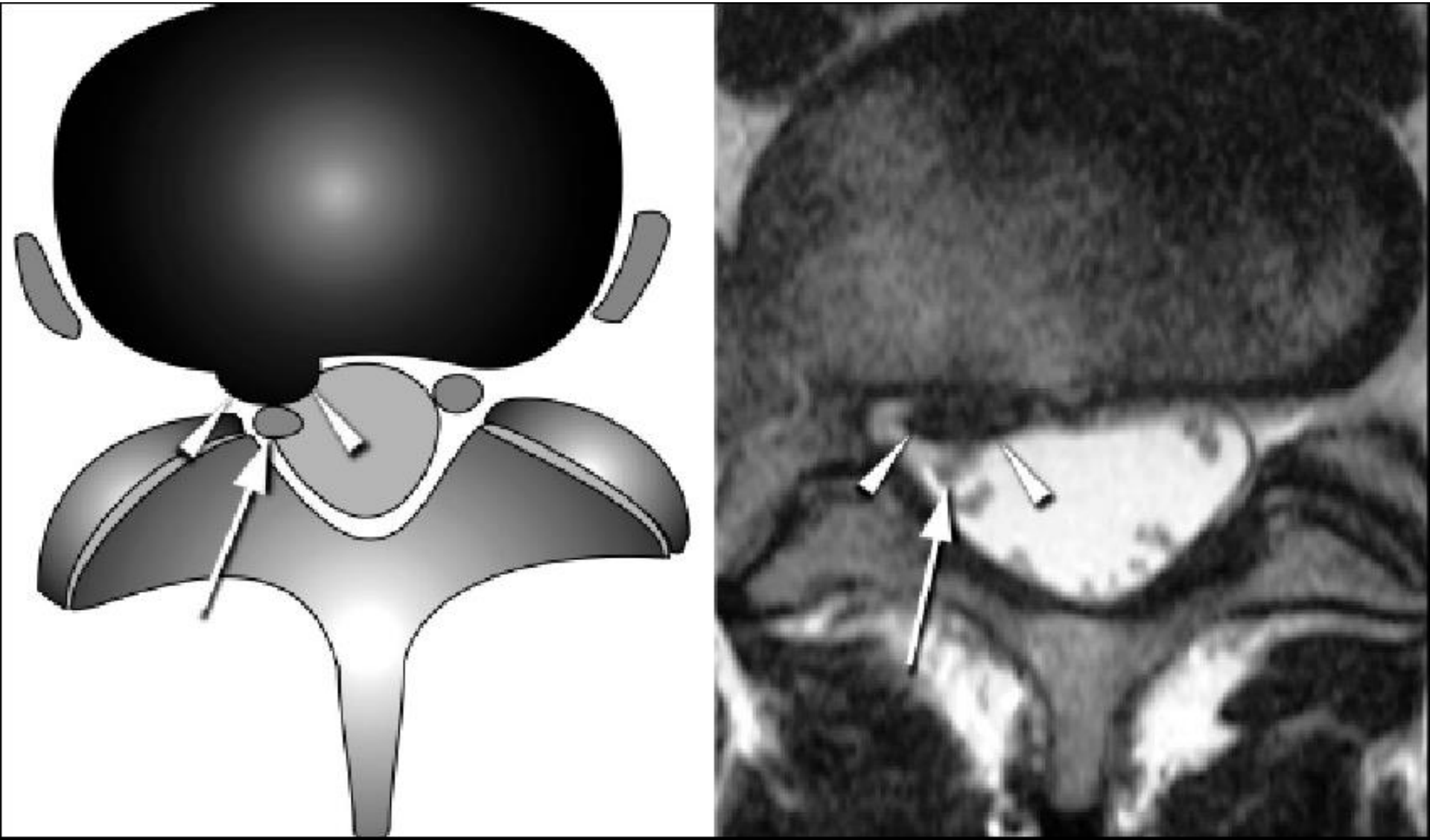


# Intact nerve root, with a central disc protrusion

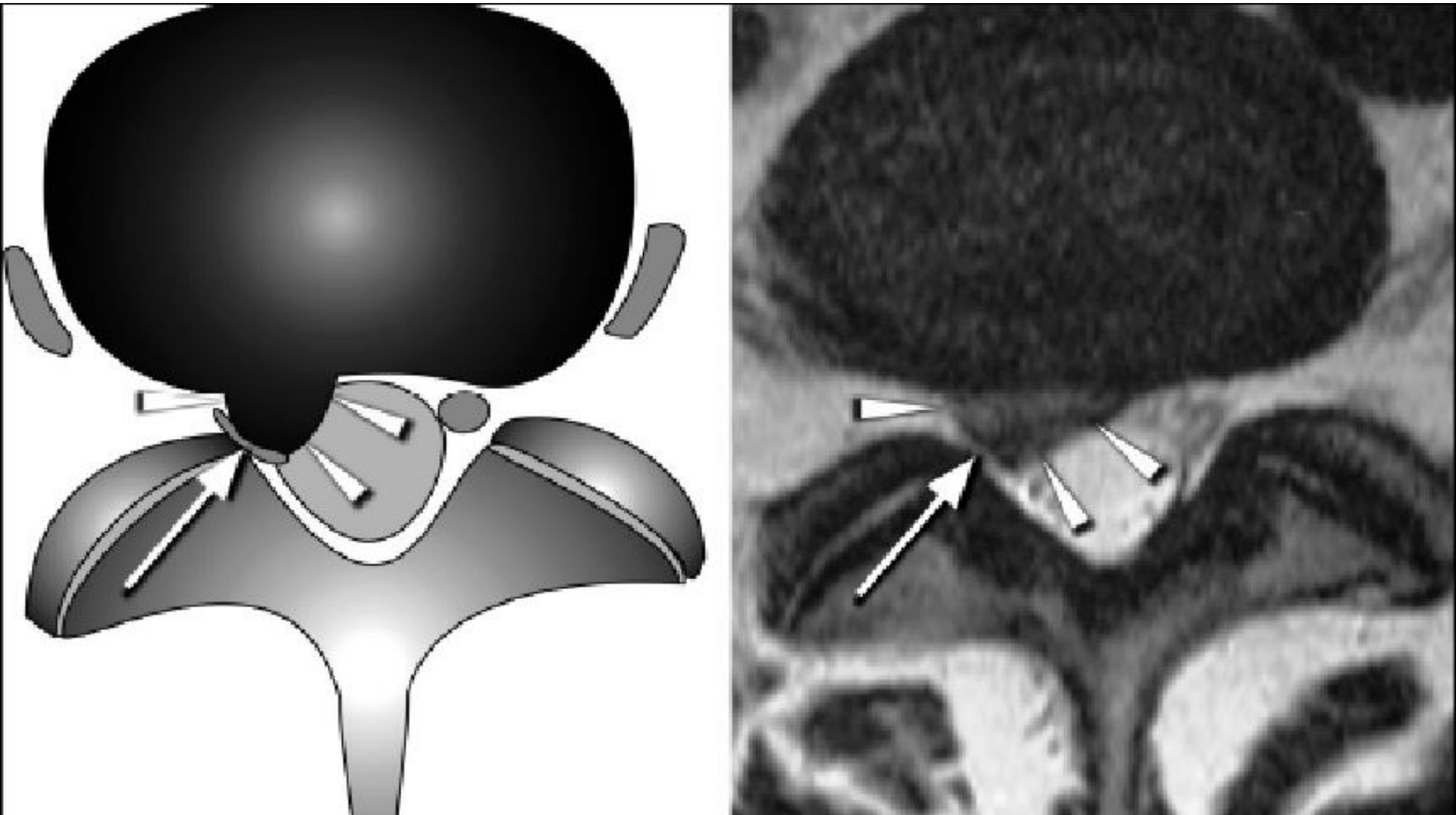


# Nerve root irritation

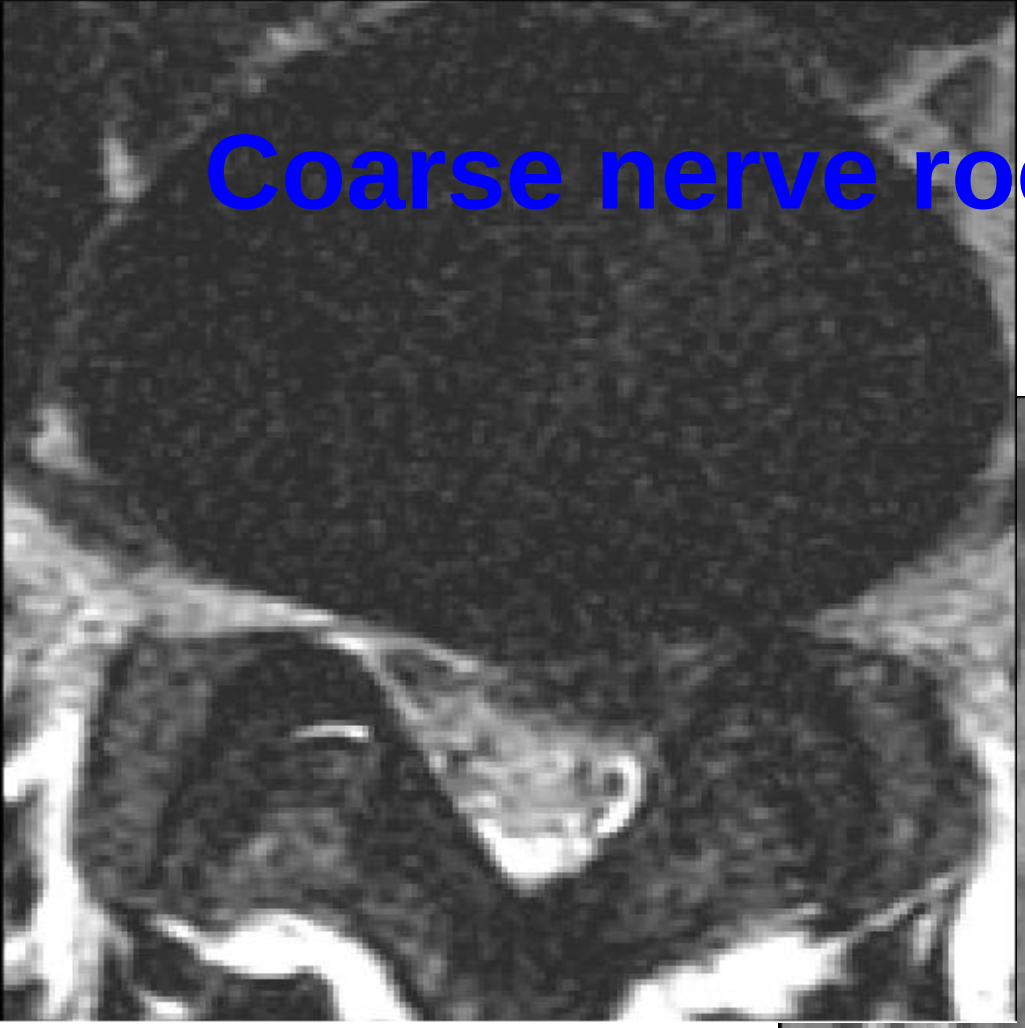
# Displacement of nerve root

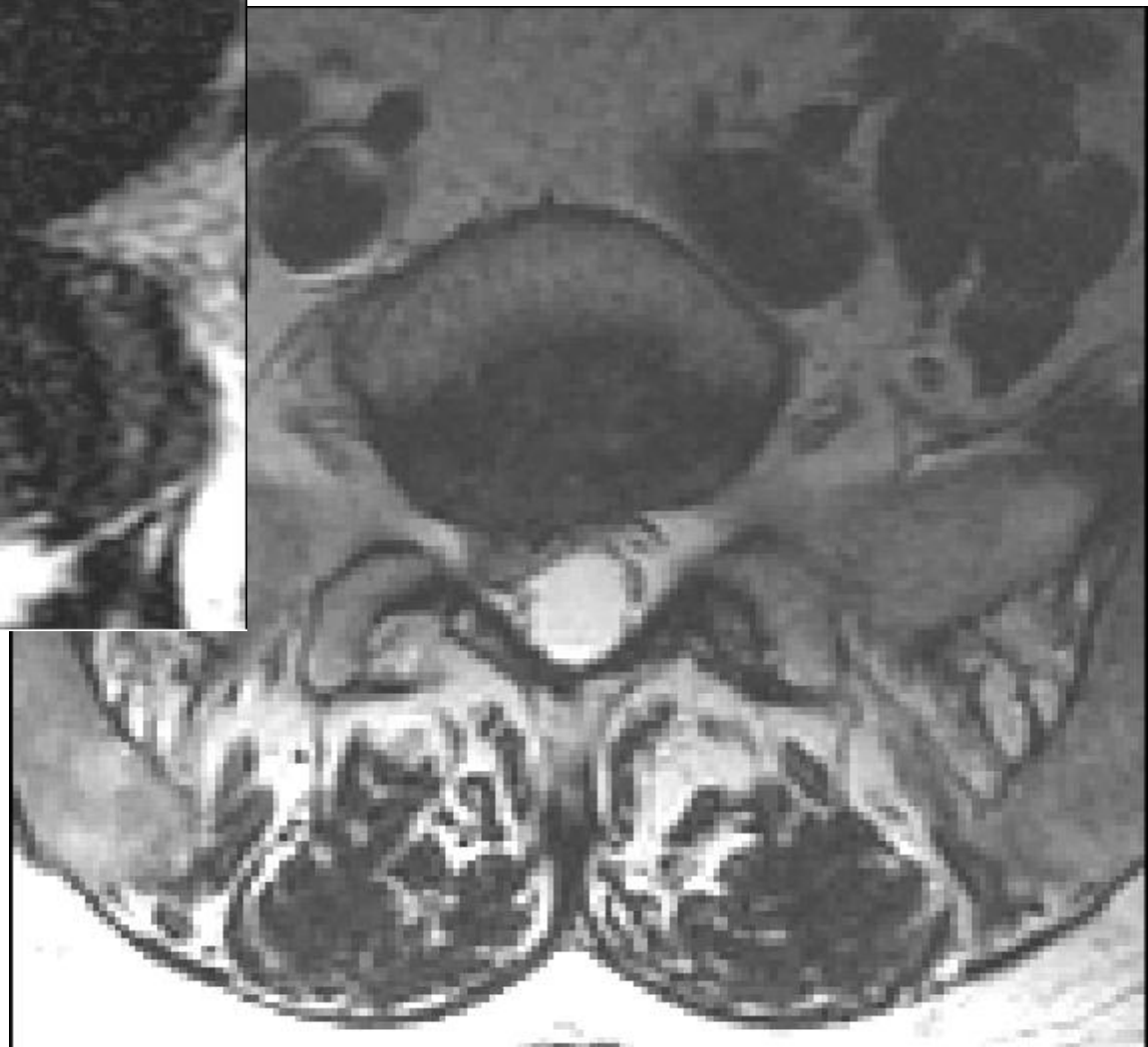


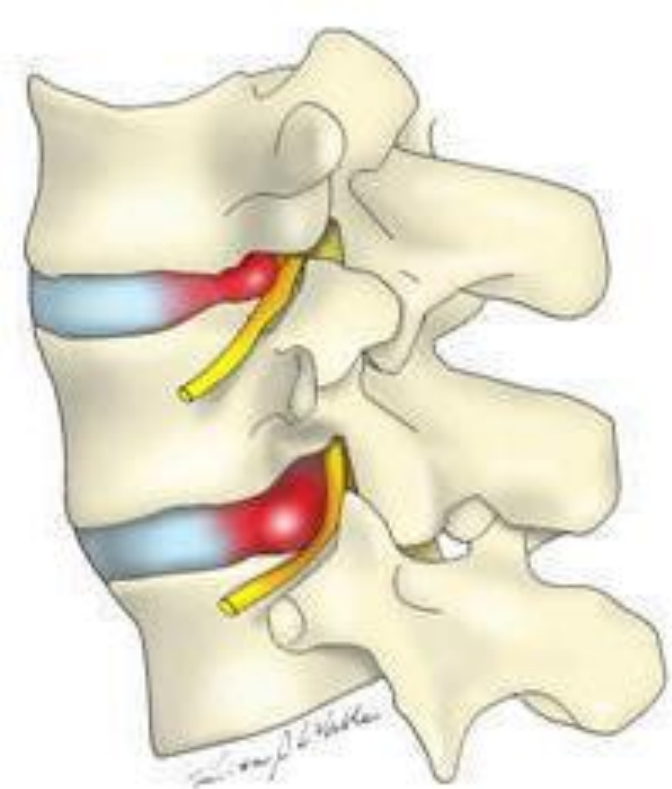
# Nerve root compression

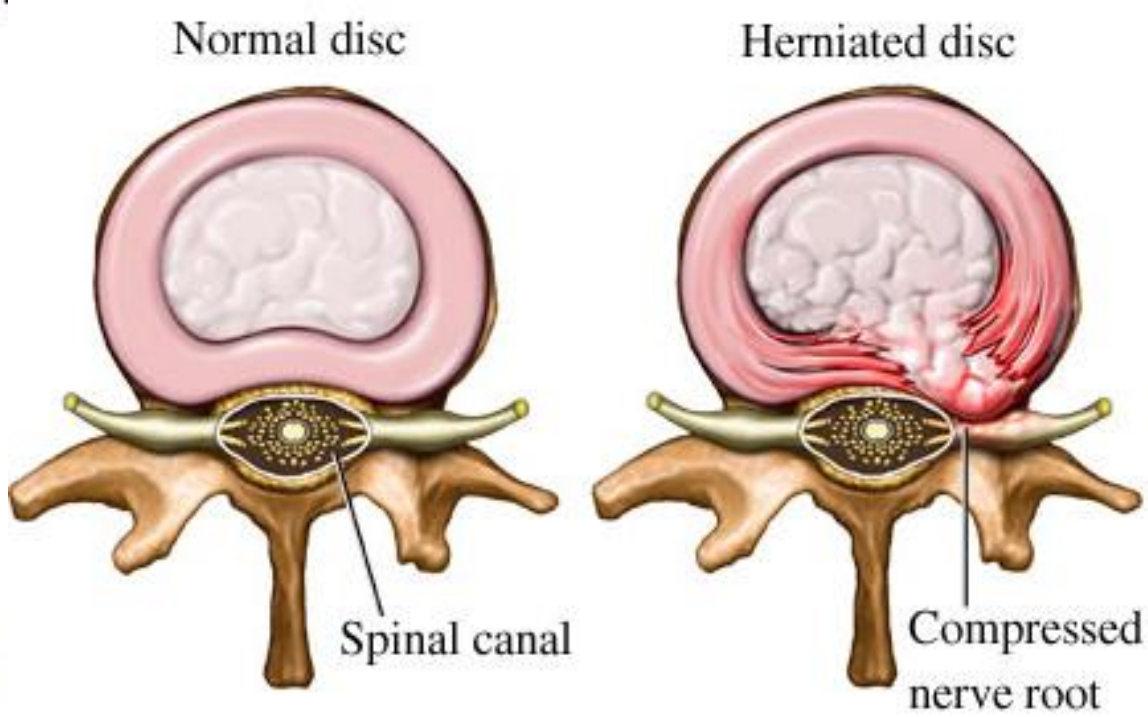


# Coarse nerve root compression

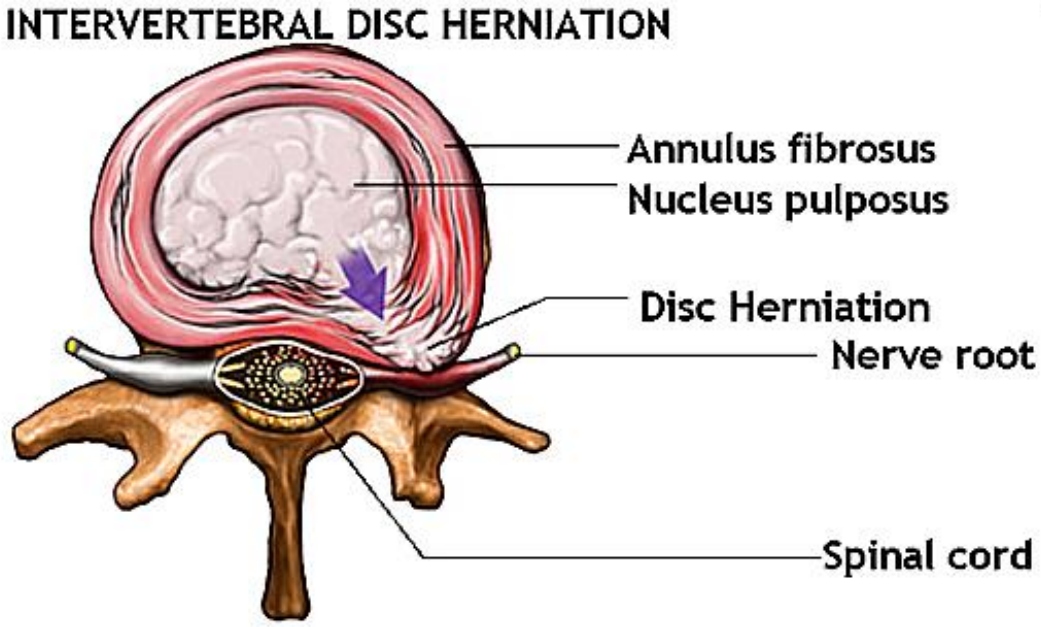


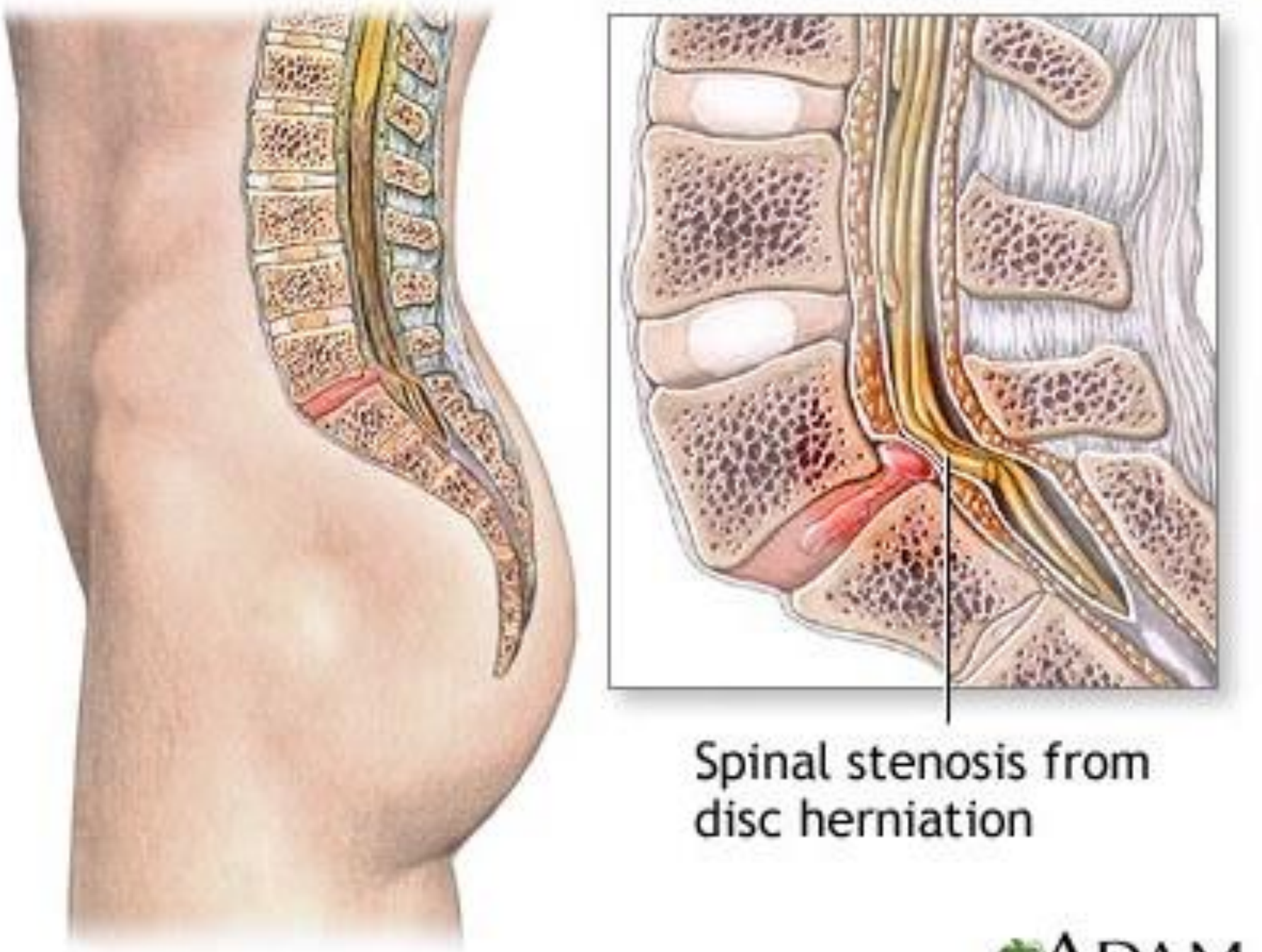






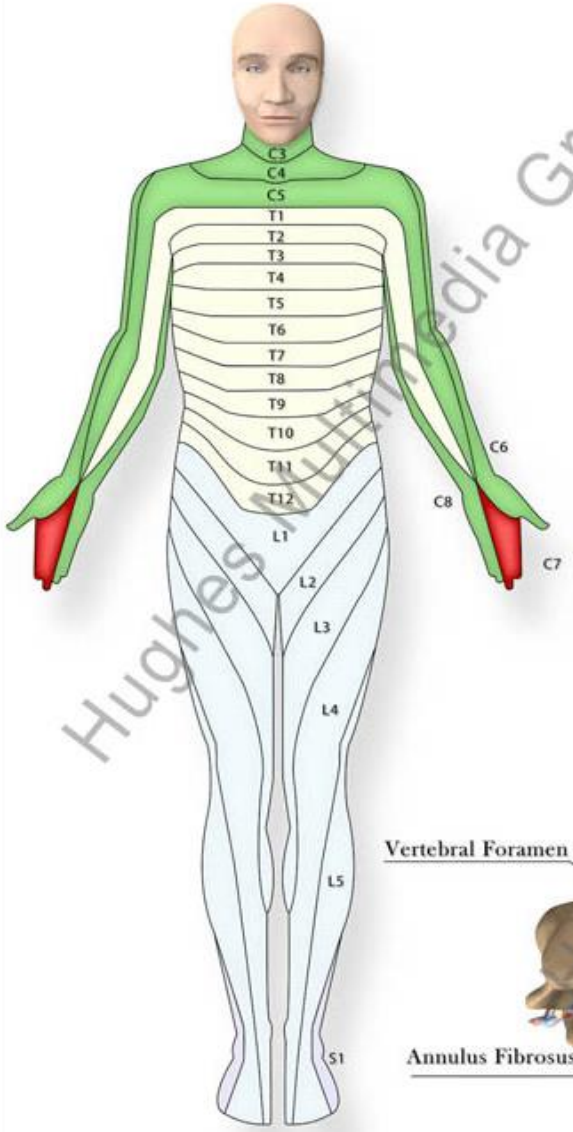

Top views of vertebrae



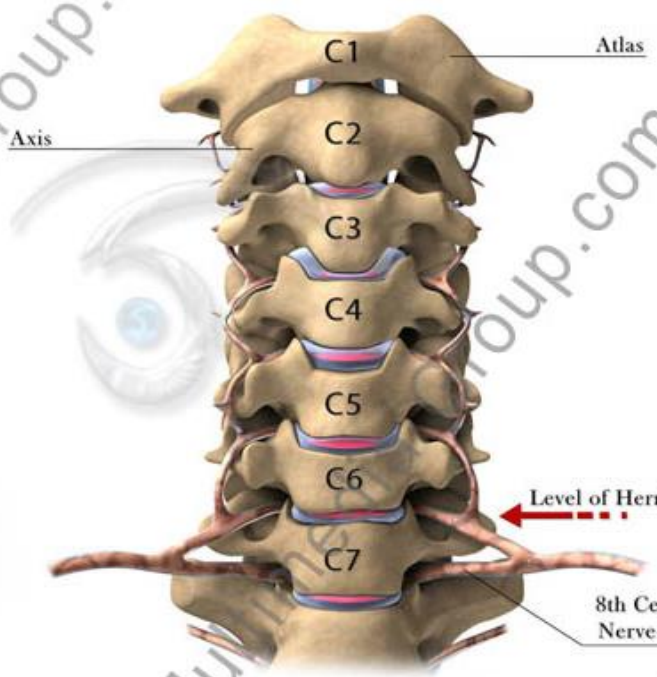


Spinal stenosis from
disc herniation
A.D.A.M.

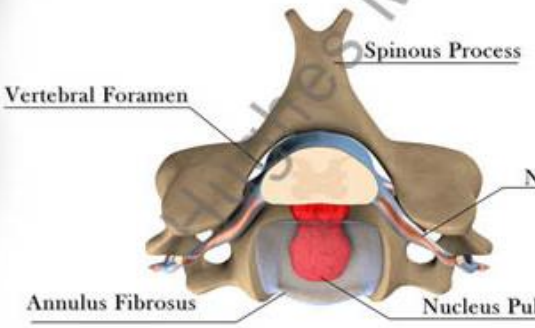
# The Cervical Spine & Dermatome Regions

## C6-C7 Central Disc Herniation & Affected Region

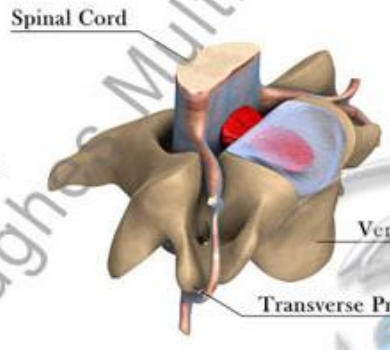



Anterior



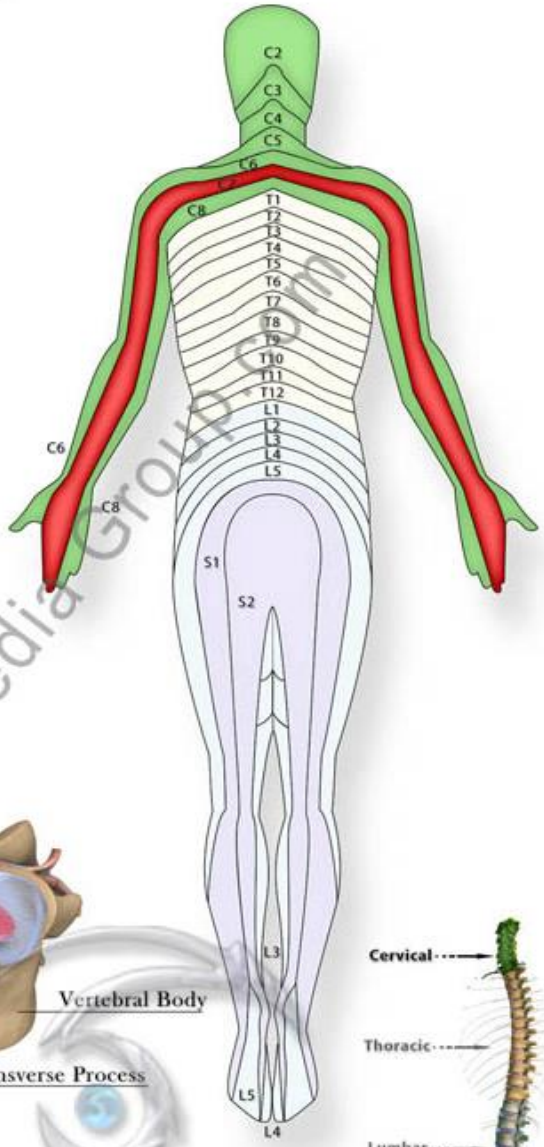




Superior View




3/4 View

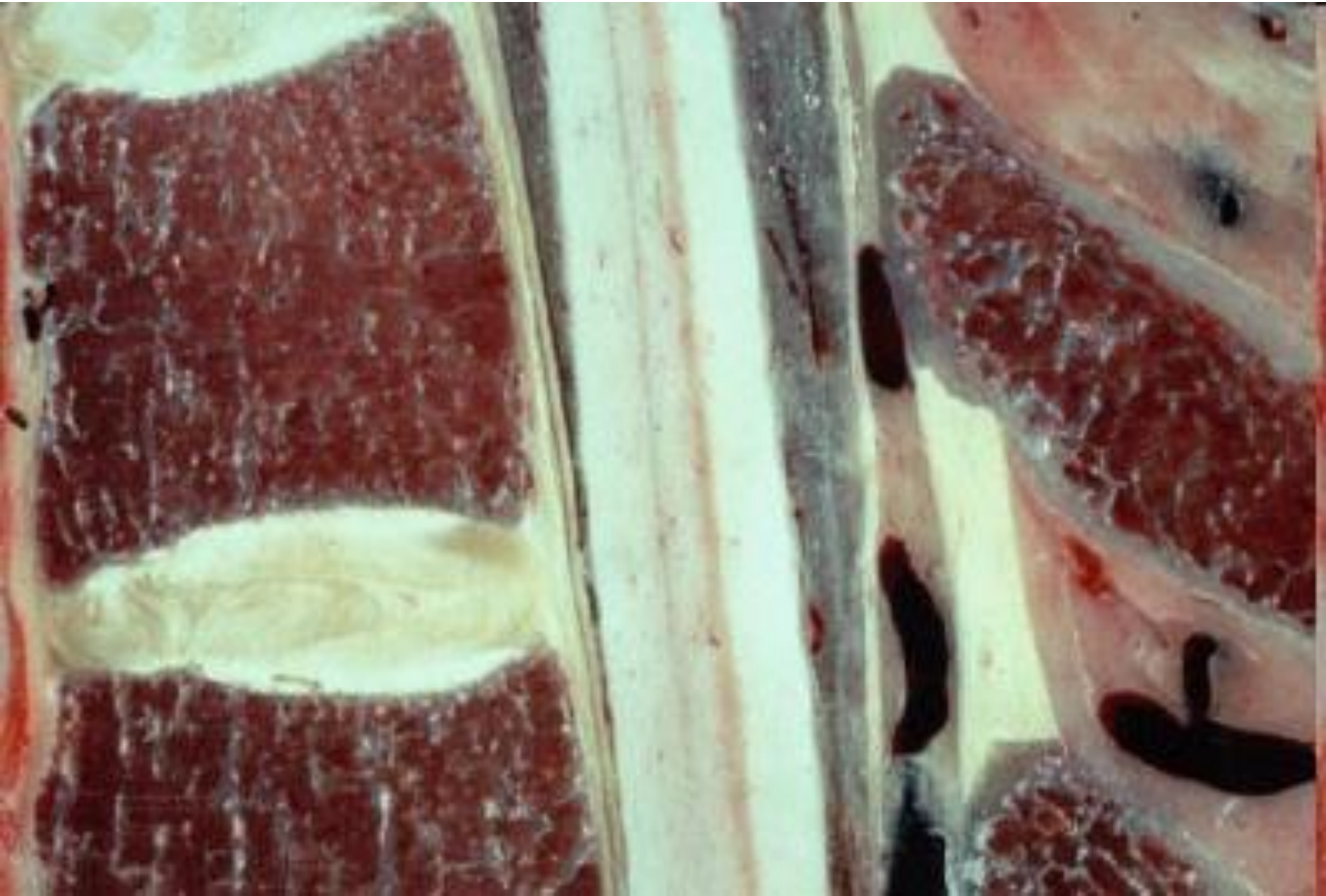
Typical Cervical Vertebra Depicting Central Disc Herniation




Posterior

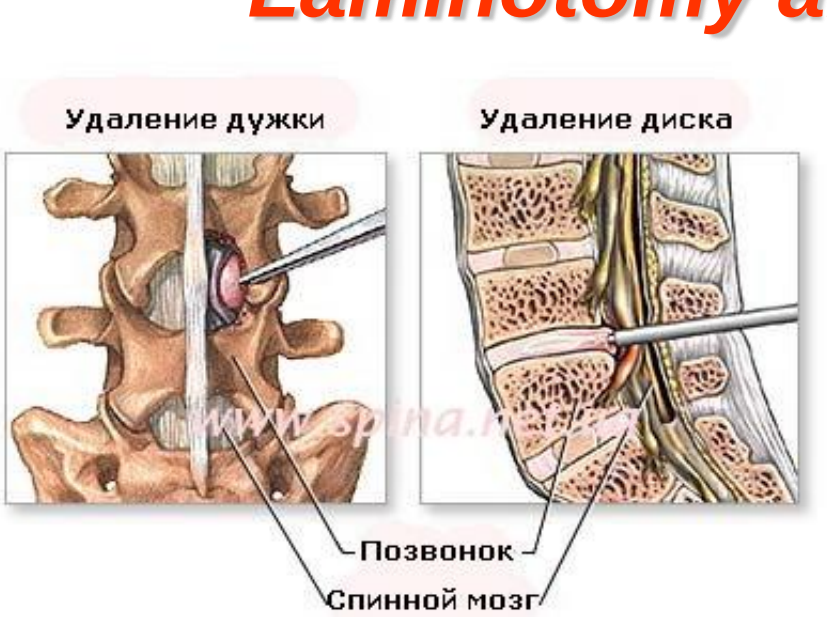
The Intervertebral discs are rendered transparent to visualize the Nucleus Pulposus.

# The normal vertebral canal

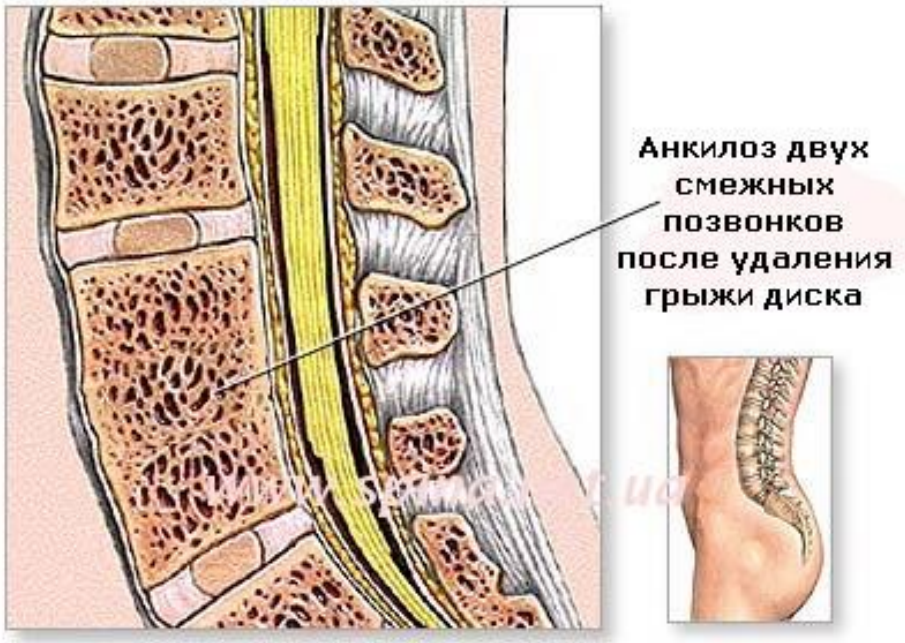


# *Sequestered herniated disc in the cervical spine with gross spinal cord compression*

# Laminotomy and discectomy



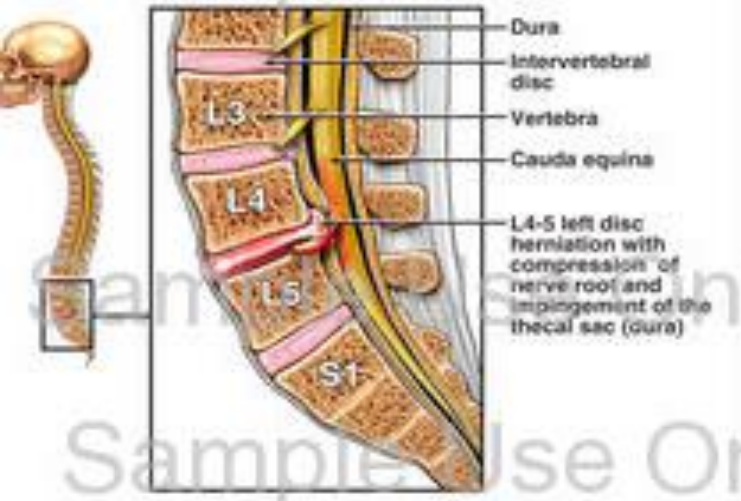




# L4-5 Disc Herniation with Laminotomy and Discectomy (Diskectomy)



## Pre-operative Condition




Sagittal view of the lumbosacral spine


Superior view

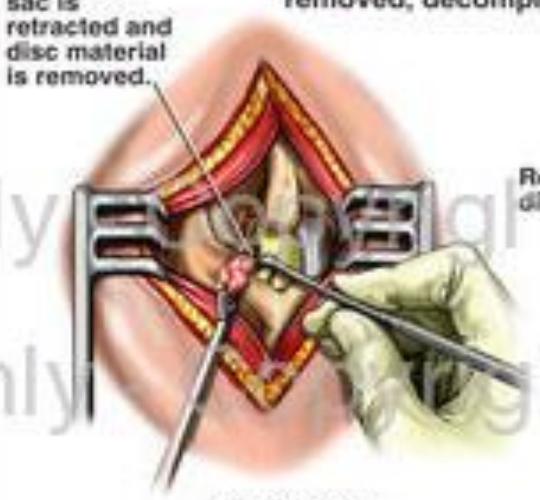
**A.** An incision is made over the L4-5 disc space.

Posterior view

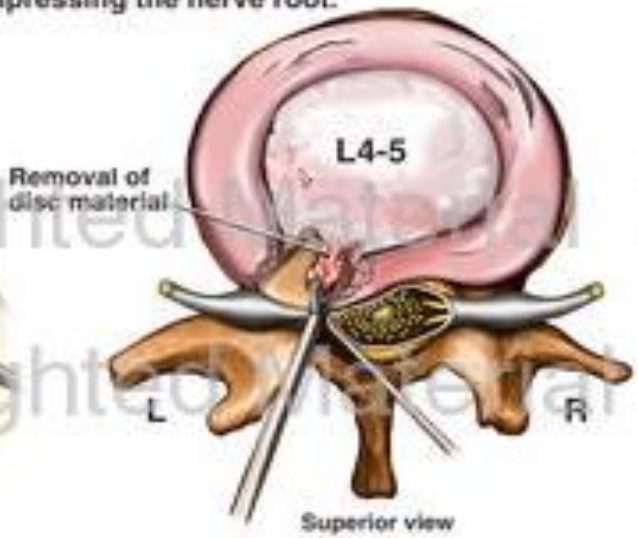
**B.** A laminotomy is performed to expose the herniated disc and the nerve root.

Posterior view

**C.** The herniated disc and extruded fragments are removed, decompressing the nerve root.

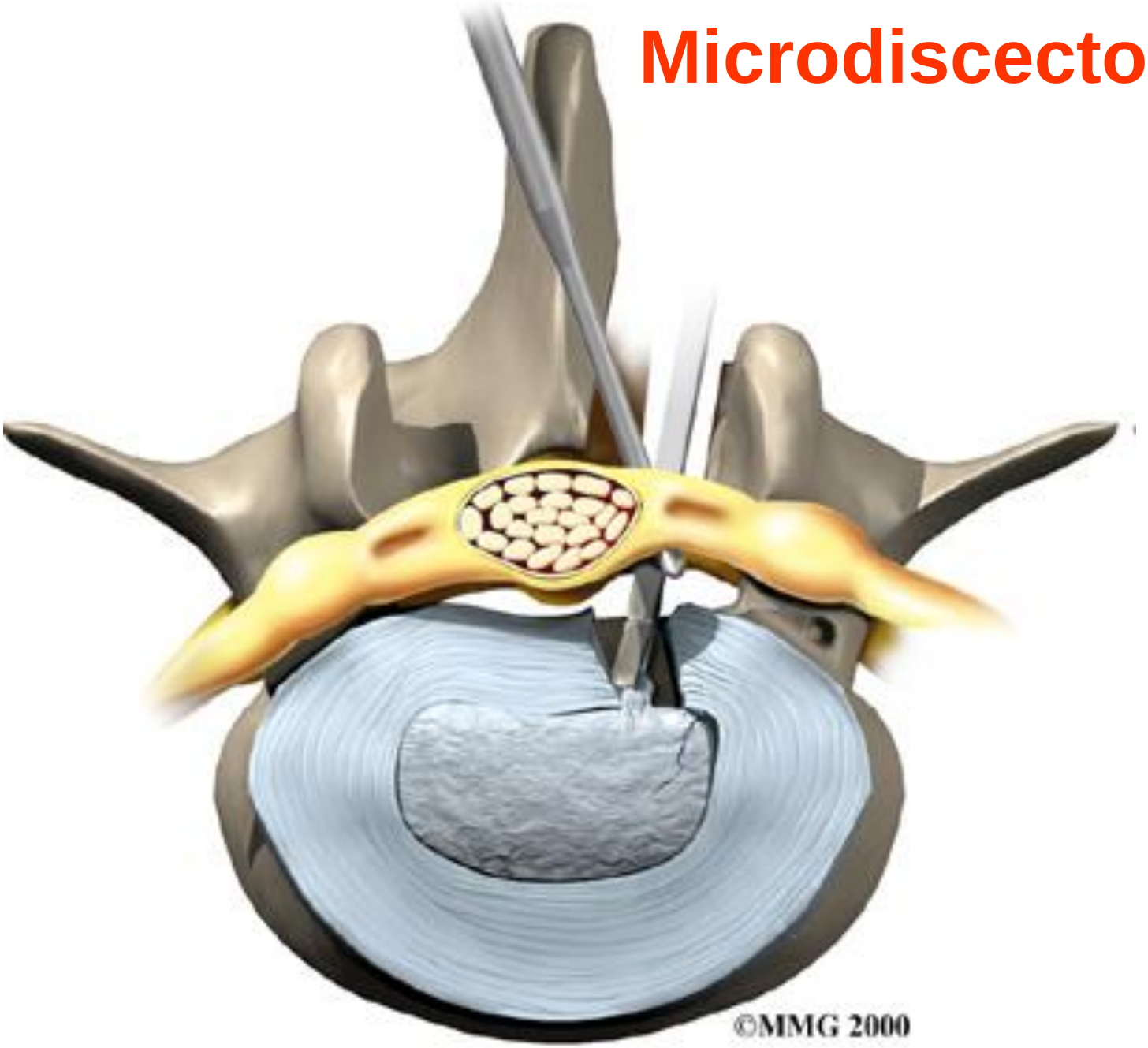



Posterior view




Superior view

# Microdiscectomy

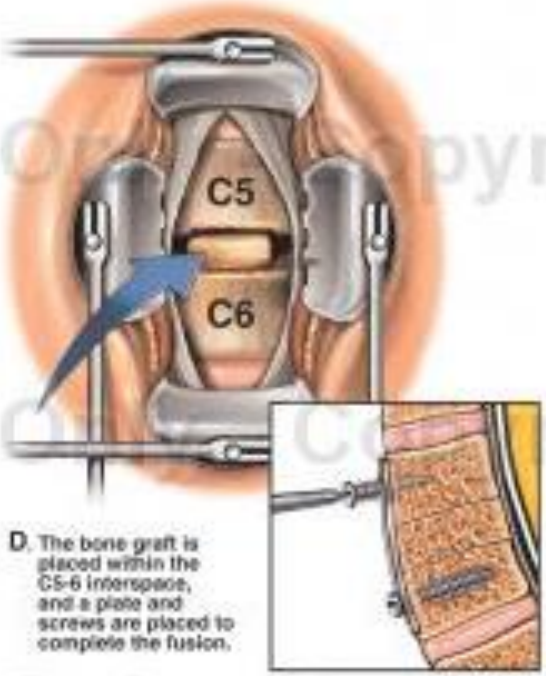


# C5-6 Disc Herniation with Anterior Cervical Fusion

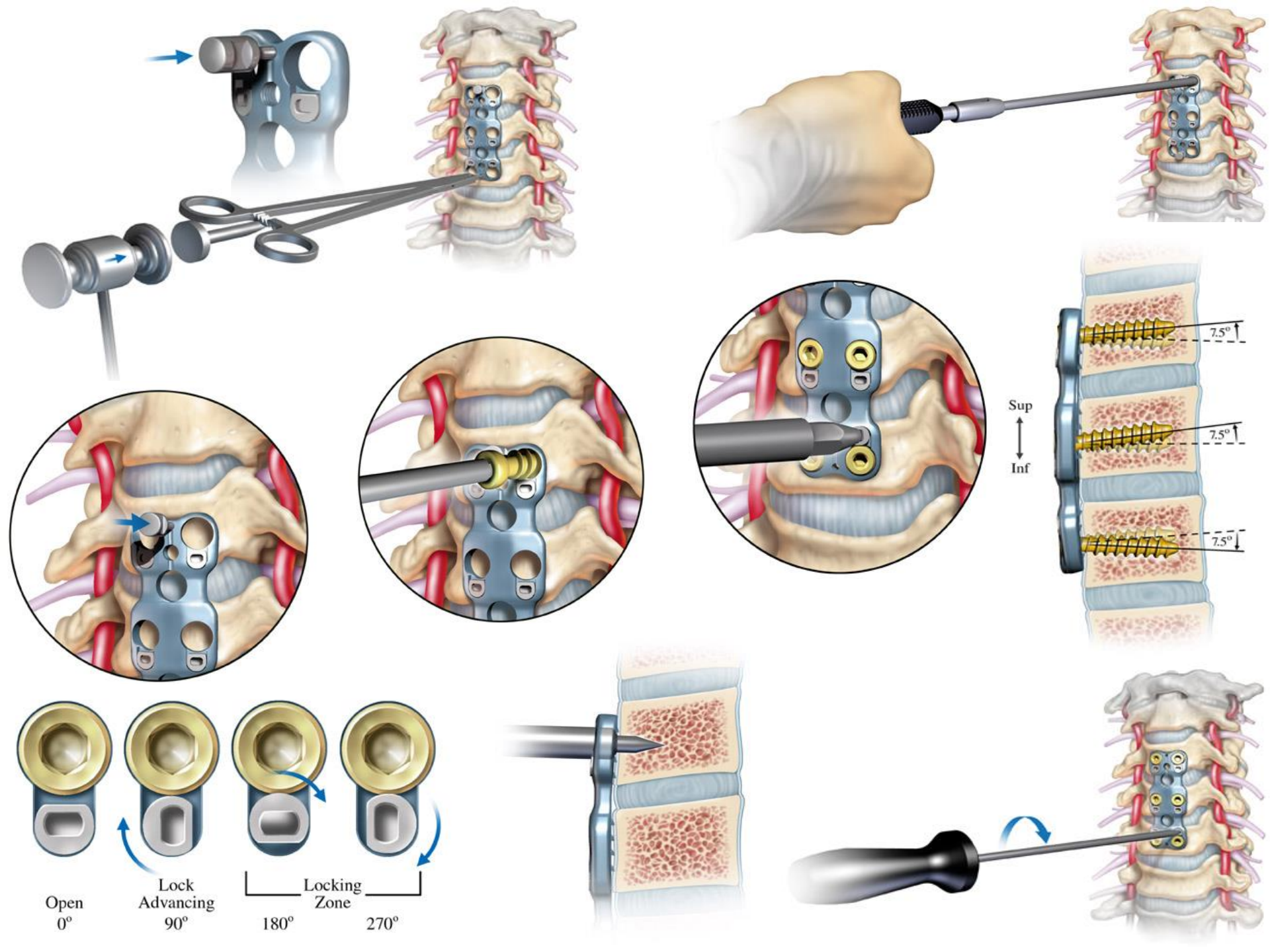
A. An incision is created to expose the C5-6 intervertebral disc space.


B. The bulging disc material is removed from C5-6.


C. The endplates are drilled to prepare for the bone graft.




D. The bone graft is placed within the C5-6 interspace, and a plate and screws are placed to complete the fusion.


Sup
Inf
7.5°
7.5°
7.5°
Open
0°
Lock
Advancing
90°
Locking
Zone
180°
270°

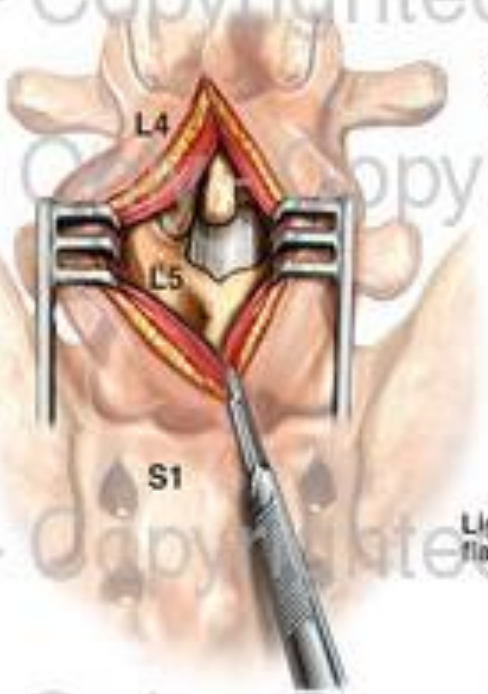
# L4-5 Microdiscectomy Procedure



A. A midline incision is made into the low back in the L5-S1 region.

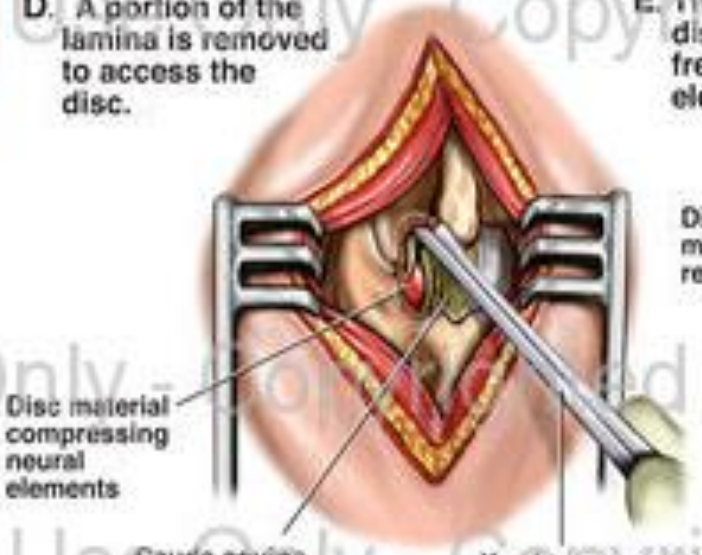
Posterior View

B. Dissection is carried down actually exposing the L4-5 vertebral interspace.

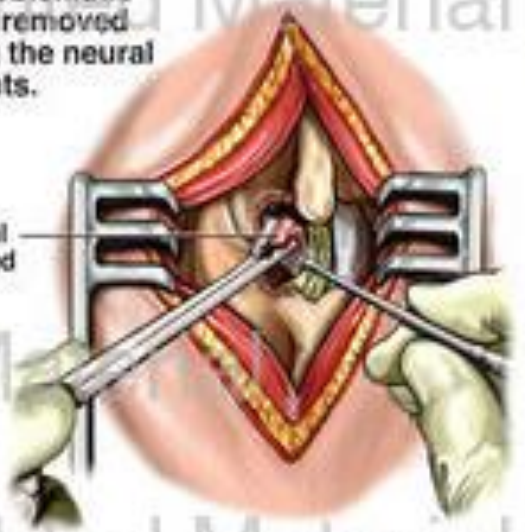



C. The ligamentum flavum is removed.


D. A portion of the lamina is removed to access the disc.

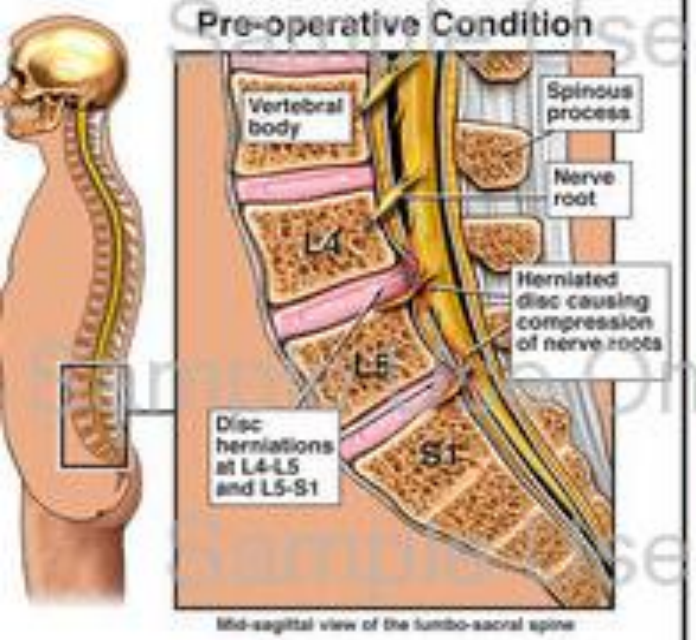



E. The problematic disc is removed freeing the neural elements.

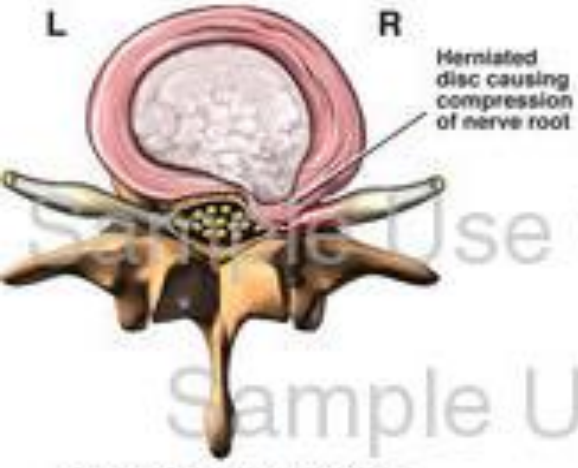


# L4-5, L5-S1 Spinal Injuries with Subsequent Surgical Fusions

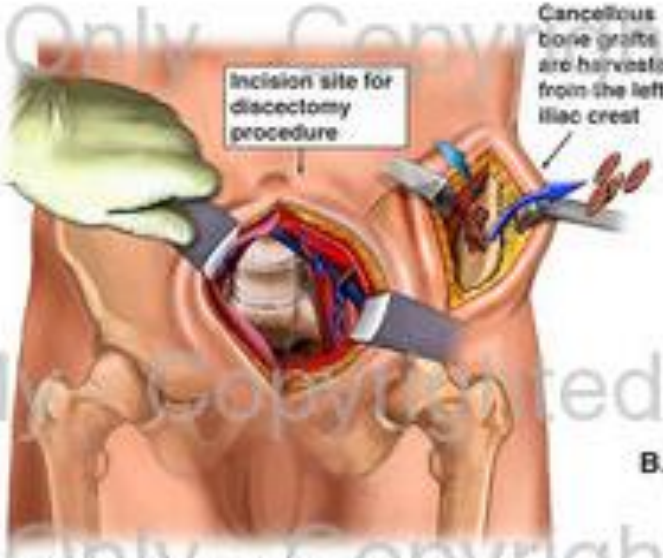




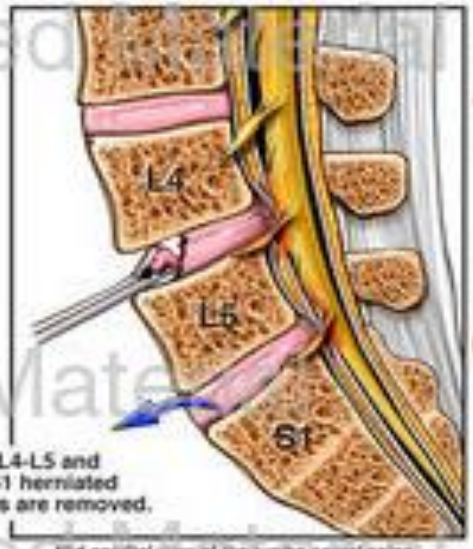
Mid-sagittal view of the lumbo-sacral spine



Superior cut-away view of herniated disc



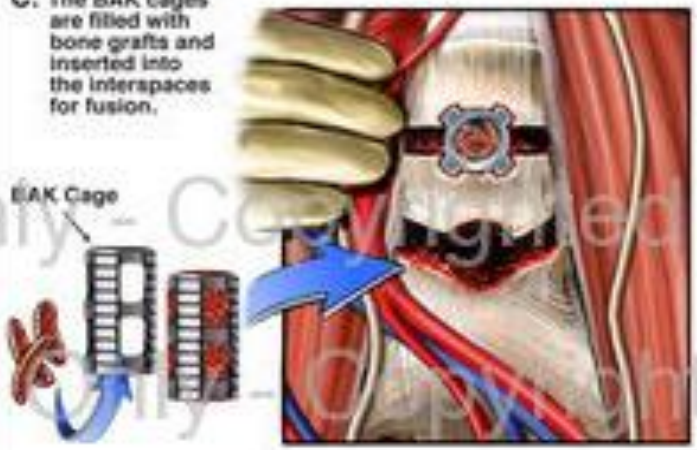
A. Anterior incisions are made exposing the interspaces and the iliac crest.



B. The L4-L5 and L5-S1 herniated discs are removed.

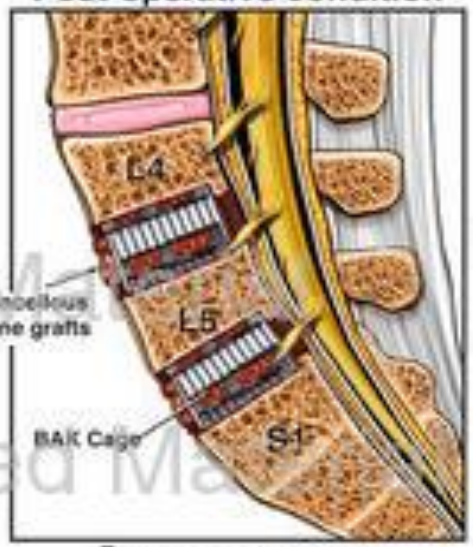
Mid-sagittal view of the lumbo-sacral spine

C. The BAK cages are filled with bone grafts and inserted into the interspaces for fusion.

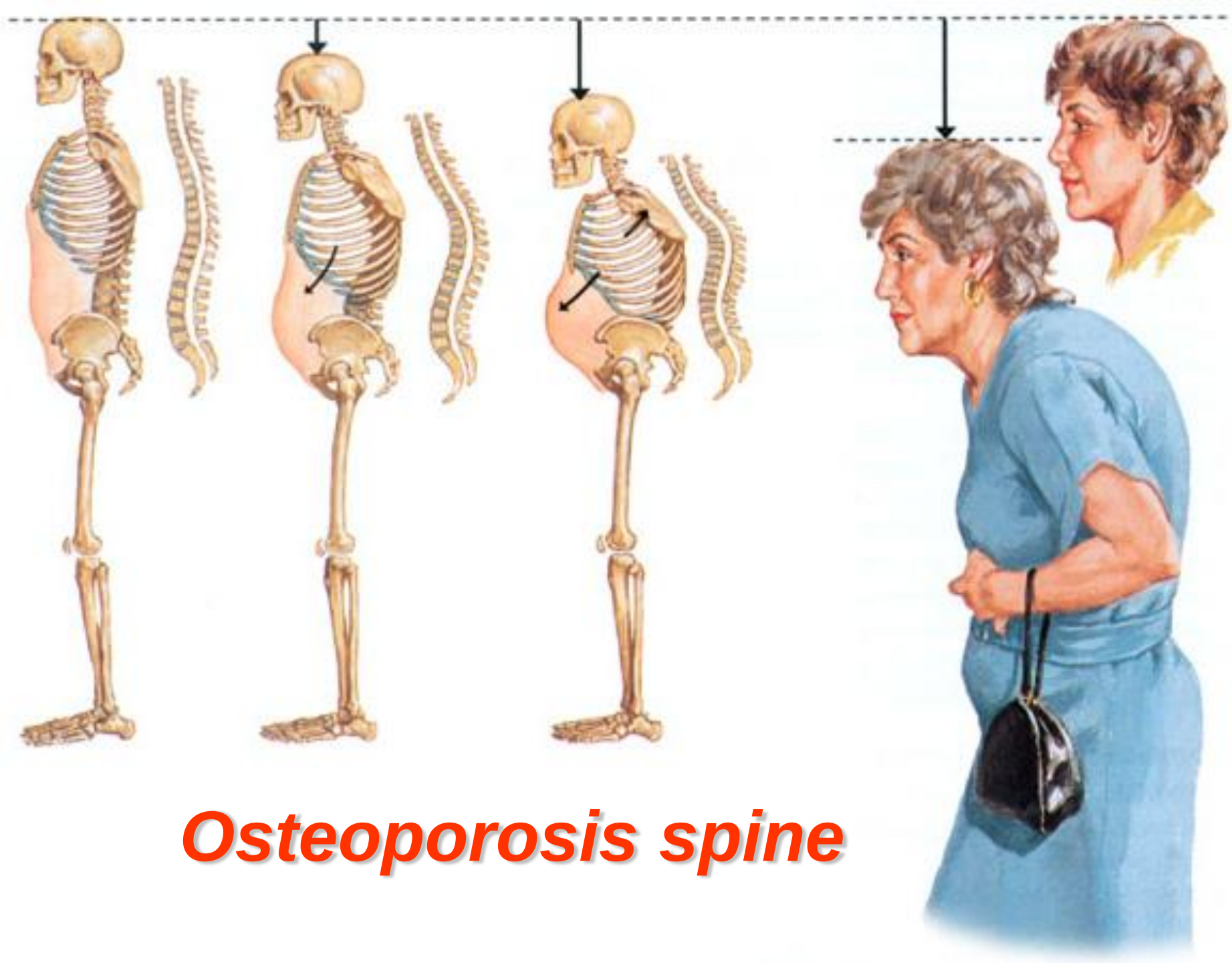


Anterior view

Post-operative condition

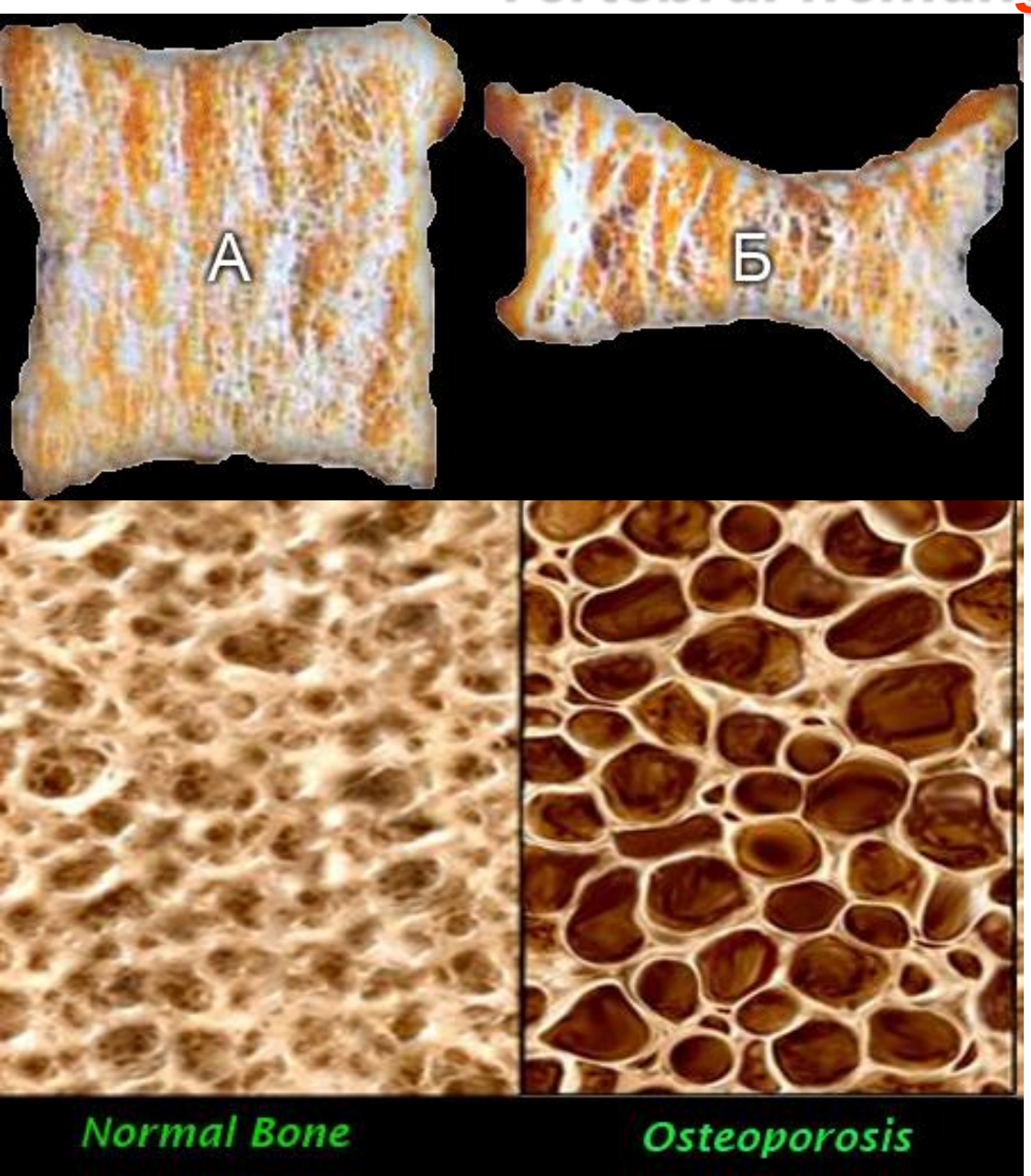


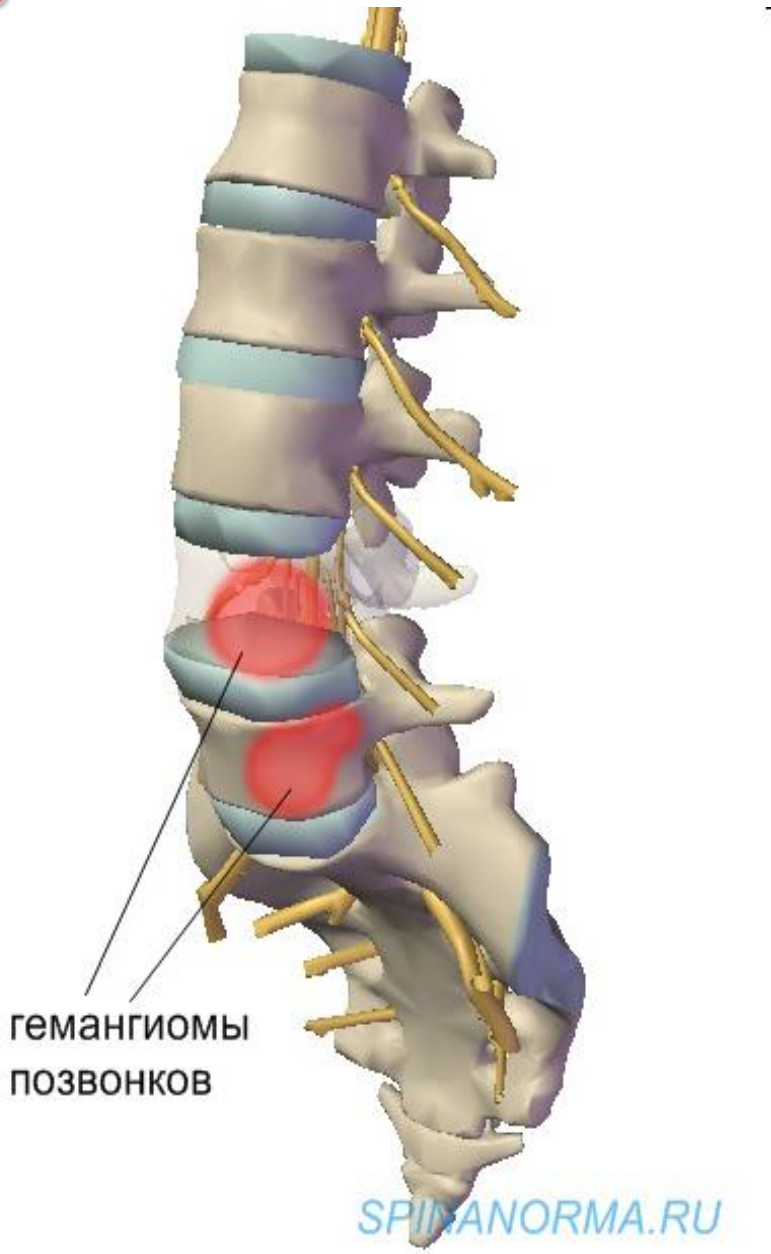
D. The fusion is complete.



# Osteoporosis spine

# Compression fractures in osteoporosis and vertebral hemangiomas



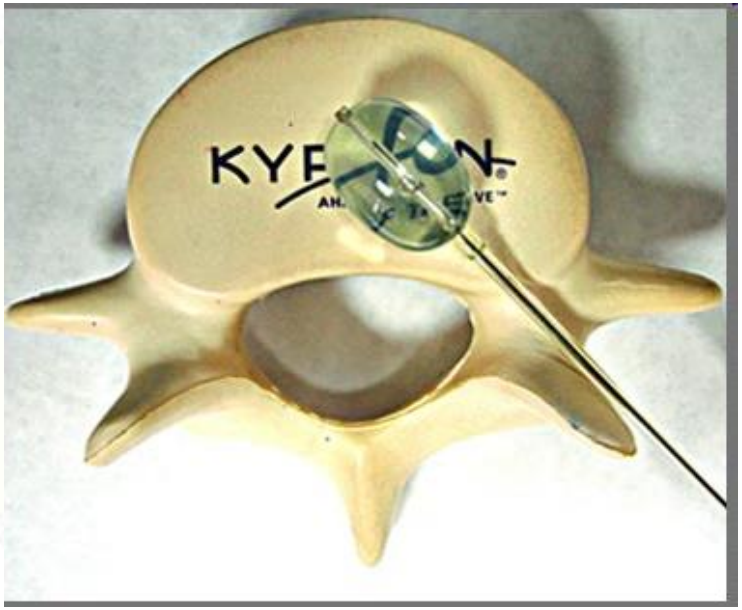



# KYPHOPLASTY SURGERY

**The modern method of treating abnormal (osteoporotic, gemangiomnyh, metastatic), fractures of the spine through its hardening acrylic cement**

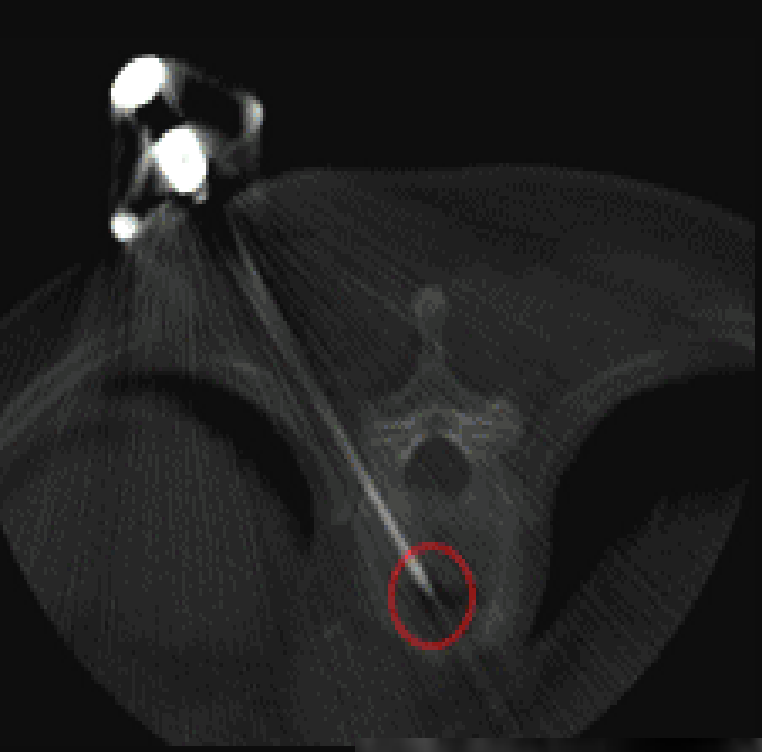


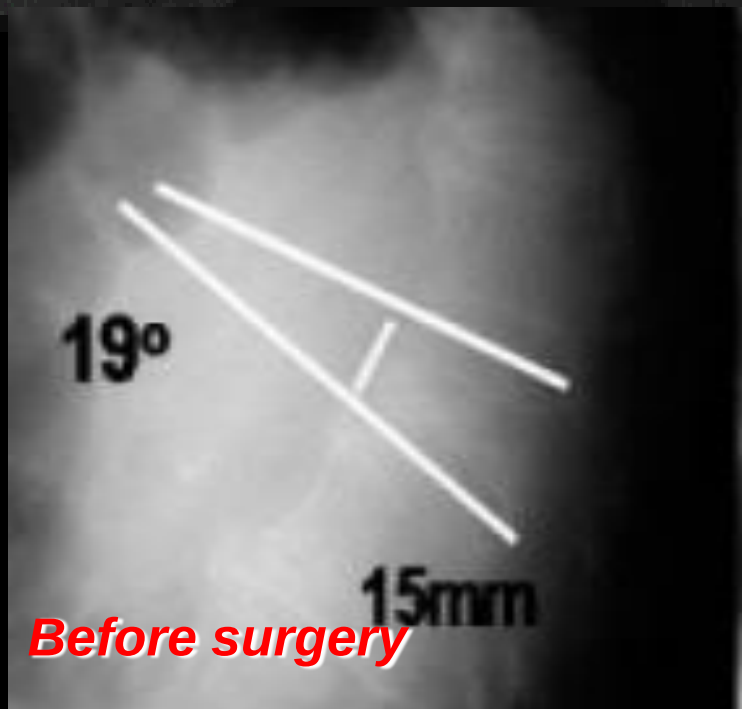


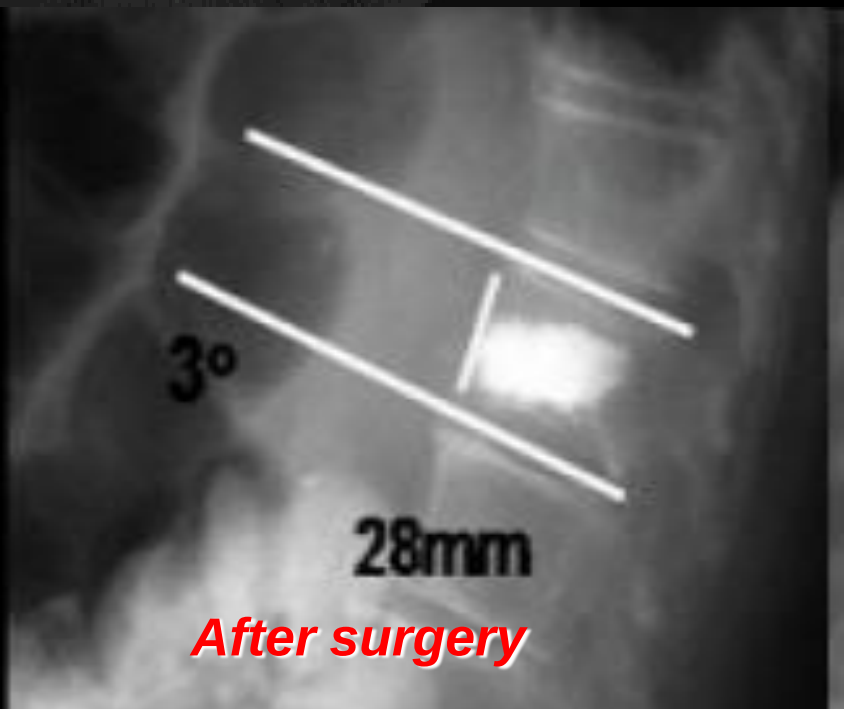

# *Stages of kyphoplasty surgery*

# Kyphoplasty for CT



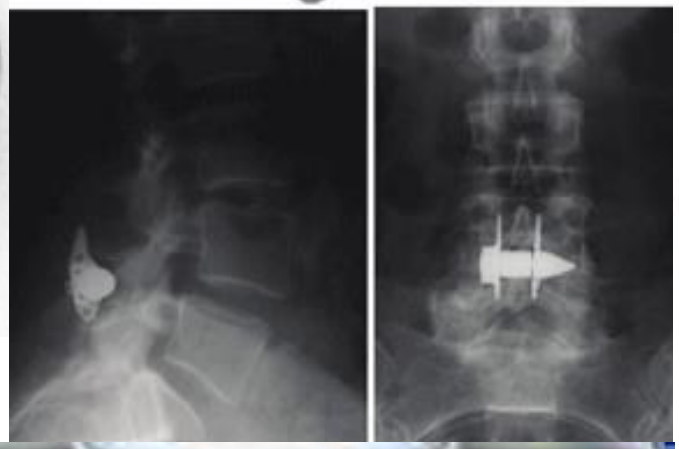


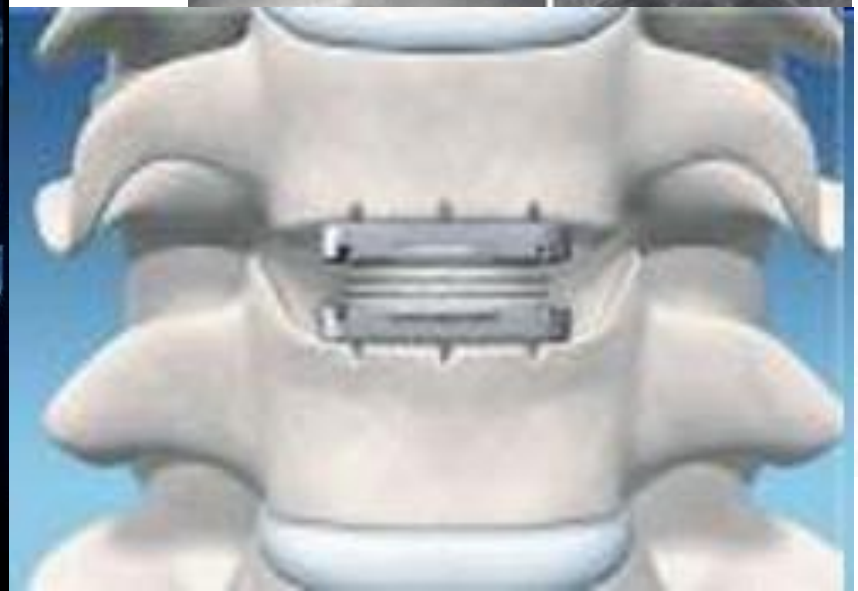

Before surgery




After surgery




# Spinal cervical arthroplasty

# Spinal cervical arthroplasty

# Spinal lumbar arthroplasty

# Dosed spinal skeletal traction

# Underwater spinal skeletal traction

# Methods of external fixation of the cervical spine

Wearing a neck brace (bus Schantz) in the treatment of pain in the neck and osteochondrosis of the cervical spine and cervical spine injury

Wearing a neck brace (Philadelphia collar) for the treatment of the stretched ligaments and joints injured neck

# *Methods of external fixation of thoracic and lumbar spine*

Alternative semi-rigid lumbosacral corset in the treatment of herniated disc and protrusion at the level of the lumbar spine

Wearing the extensor (ecstention) corset in the treatment of vertebral compression fractures


THANK YOU!!!