V.N.Karazin Kharkiv National University
Department of Neurosurgery

TRAUMATIC BRAIN INJURIES, VERTEBRO-SPINAL TRAUMA

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Epidemiology of head injury

- According to WHO, TBI is about 40% of all injuries, its amount increases annually by 2%.
- In Ukraine, received TBI each year about 200.000 people (2 per 1.000 inhabitants).
- In Russia every year 1.200.000 TBI (4 per 1000 inhabitants), including 160.000 children.
- The frequency of patients with TBI in the United States - 3 of 1.000 inhabitants, Australia - 5 per 1.000 residents in China - seven in 1.000.
- Patients with traumatic brain injury is 70% among the group of patients who are treated at the neurosurgical hospital: in Ukraine – 58.454 (69%), Russia – 84.647 (71%)

Classification of head injury

- A. By mechanism
- 1. Closed
- 2. Penetrating
- B. By severity
- 1. Glasgow Coma Scale score
- 2. Mild, moderate, severe

- C. By morphology
- 1. **Skull fractures**
- a. Vault
- (1) Linear or stellate
- (2) Depressed or nondepressed
- b. Basilar
- 2. **Intracranial lesions**
- a. Focal
- (1) Epidural
- (2) Subdural
- (3) Contusions and Intracerebral Hematomas
- b. Diffuse Injuries
- (1) Mild concussion
- (2) Classical concussion
- (3) Diffuse axonal injury

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Classification of head injury (Petit,1774)

- **Concussion of the brain** (commocio cerebri)
- **Bruising of the brain** (contusio cerebri)
- **Compression of the brain** (compressio cerebri)

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Glasgow Coma Scale

EYE OPENING		Eye score
Spontaneous	= 4	
To sound	= 3	___
To pain	= 2	
None	= 1	
BEST VERBAL RESPONSE		Verbal score
Oriented	= 5	
Not oriented (confused)	= 4	___
Inappropriate speech	= 3	
Incomprehensible sounds	= 2	
None	= 1	
BEST MOTOR RESPONSE		Motor Score
Obeys commands	= 6	
Localizes stimulus	= 5	___
Withdrawal from stimulus	= 4	
Abnormal flexion	= 3	
Abnormal extension	= 2	
Flaccid	= 1	
Patient's consciousness level		TOTAL POINTS = ___

Glasgow Coma Scale

G.Teasdale и B.Jennet (1974)

- Comatose Less than 8 points on the Glasgow Coma Scale
- Moderate head injury GCS total of 9 to 12 points
- Mild head injury A total point count of 13 to 15 on the Glasgow Coma Scale

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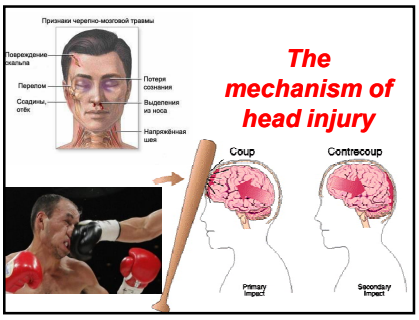
Closed Brain Injury Classification

Primary		Secondary
Diffuse	Focal	Compression-hematomas
Concussion	Contusion	Epidural hematoma
Diffuse Axonal Injury - DAI	Laceration	Acute subdural hematoma
		Chronic subdural hematoma
		Intracerebral hematoma
Conservative therapy		Surgical therapy



Diagnostic studies (TBI)

- **Physical examination.** *General:* Open wounds, fractures, bruises, bleeding or clear discharge from the nose or ear
- *Neurological:* Respiration, circulation, pupils, motor function, other focal signs.
- *Laboratory:* Blood test, coagulation, electrolytes, blood glucose, urea, creatinine, serum osmolality, blood alcohol, drug levels in urine, pregnancy testing if indicated
- *Essential radiological studies:* Head CT with brain and bone windows is mandatory in all cases unless the neurological examination is completely normal. A cervical spine series from C1 to C7 is needed to rule out associated cervical injury. Plain films of the skull are generally unnecessary if CT is performed
- *Additional studies, as indicated:* Cranial or spinal MRI or MR angiography, EEG, Doppler ultrasonography, evoked potentials
- *In multiorgan trauma:* Blood should be typed and cross-matched and several units should be kept ready for transfusion as needed. Physical examination and ancillary studies for any fractures, abdominal bleeding, pulmonary injury

BRAIN CONCUSSION

• **Clinical features:** - *retrograde and / or anterograde amnesia (20-25% of cases);*
- *uncounciosness from a few seconds to* ***15 minutes****;*
- *nausea, single vomiting, headache, dizziness;*
- *autonomic phenomenon: a sense of fever, tinnitus, sweating, fluctuations in blood pressure, tachy-, bradycardia, flushing, insomnia;*

• **Neurological status:** - *labile anizorefleksia, nystagmus;*
- *lightweight cladding symptoms disappear after* ***3-7 days****;*
- *the absence of bone lesions of the skull;*
- *analysis of the cerebrospinal fluid is normal;*

• **Current:** *improvement during the* ***7-10 days***

BRAIN CONTUSION MILD

• **Clinical features:** - *loss of consciousness from 15 minutes to 1 hour;*
- *headache, nausea, 2-3-fold vomiting, dizziness;*
- *retrograde amnesia;*
- *vital functions without marked changes;*
- *moderate brady-, tachycardia, fluctuations in blood pressure;*

• **Neurological status:** - *clonic nystagmus;*
- *light anisocoria;*
- *pyramidal insufficiency;*
- *meningeal symptoms;*
- *possible fractures of the cranial vault, subarachnoid hemorrhage;*

• **Current:** *regression of symptoms in* ***14-18 day***

BRAIN CONTUSION MEDIUM

• **Clinical features:** - *loss of consciousness from 1 to 6 h;*
- *pronounced retro-, concentration, and anterograde amnesia;*
- *severe headache, repeated vomiting;*
- *transient disturbances of vital functions: bradycardia (40-50 beats per minute), tachycardia (120 beats per minute);*
- *increased blood pressure (up to 180/100 mm Hg);*
- *tachypnea without breaking the rhythm of breathing;*
- *change the cycle sleep;*
- *waking in the form of sleepiness during the day, insomnia at night with episodes of agitation;*
- *low-grade fever;*

• **Neurological status:** - *can be observed shell marks;*
- *stem symptoms: nystagmus, dissociation of muscle tone and tendon reflexes*
- *bilateral pathological signs;*
- *a distinct focal symptoms, defined by the localization of injury: pupillary and oculomotor disturbances, paresis, aphasia, hyperesthesia;*
- *subarachnoid hemorrhage;*
- *otorrhoea, nazorrhoe;*

• **Current:** *focal symptoms regress within* ***21-35 days***

BRAIN CONTUSION SEVERE

• **Clinical features:** - *loss of consciousness from 6 hours to a few weeks and months;*
- *often a motor (psychomotor) excitation;*
- *severe disorders of vital functions: bradycardia (less than 40 beats per minute) or tachycardia (120 beats per minute), often with arrhythmias;*
- *increase in blood pressure over 180/110 mm Hg;*
- *tachypnea (30-40 breaths per minute) or bradypnea (8-10 breaths per minute), often in violation of the respiratory rhythm;*
- *hyperthermia;*

• **Neurological status:** - *stem signs: floating eyeballs, paresis of gaze, a multiple tonic nystagmus;*
- *bilateral mydriasis or miosis;*
- *swallowing;*
- *changing the tone, decerebrate rigidity;*
- *inhibition or increase tendor reflexes, pathological signs, paresis, paralysis;*
- *reflexes of oral automatism;*
- *generalized or focal seizures (in 10-15% of cases);*
- *fractures of the skull base;*
- *subarachnoid hemorrhage;*
- *threatening hyperthermia;*
- *otorrhoea, nazorrhoe;*

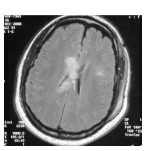
• **Current:** *symptoms regressed slowly over* ***2-4, sometimes 6 months***

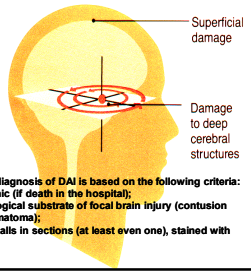
DIFFUSE AXONAL INJURY

Clinical picture:
- ***Prolonged coma itself after injury;***
- ***Hyperthermia;***
- ***Hyperhidrosis;***
- ***Hypersalivation;***
- ***Violation of breath;***
- ***Symmetrical or asymmetrical or decerebrate decortical rigidity;***
- ***Change in muscle tone (muscle hypotonia of the diffuse to gormetonia);***
- ***Change a coma transient or persistent apallic syndrome lasting several days months or years***

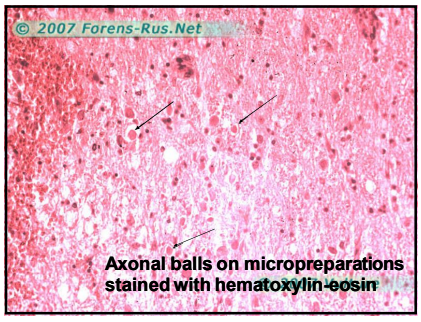
Neurological status:
- ***Paresis gaze upwards;***
- ***Reduction or absence of corneal reflex;***
- ***Bilateral or depression no oculocefalic reflex;***
- ***Meningeal syndrome;***
- ***Tetrasindroms pyramidal-extrapyramidal nature;***
- ***Pozo-tonic and noncoordinated defense reactions;***
- ***Facial synkineses;***
- ***Stiffness, bradykinesia;***
- ***Increased intracranial pressure;***
- ***Mental disorders***

DIFFUSE AXONAL INJURY (DAI)

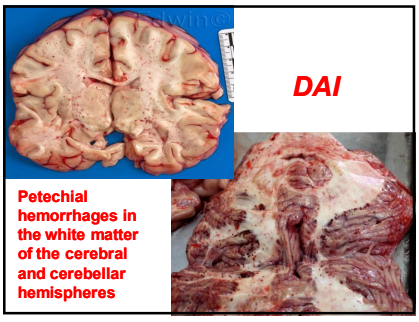




Clinical and morphological diagnosis of DAI is based on the following criteria:
1) **Corresponding to the clinic (if death in the hospital);**
2) **The absence of morphological substrate of focal brain injury (contusion lesions, intracerebral hematoma);**
3) **The presence of axonal balls in sections (at least even one), stained with hematoxylin and eosin**



Axonal balls on micropreparations stained with hematoxylin-eosin



DAI

Petechial hemorrhages in the white matter of the cerebral and cerebellar hemispheres

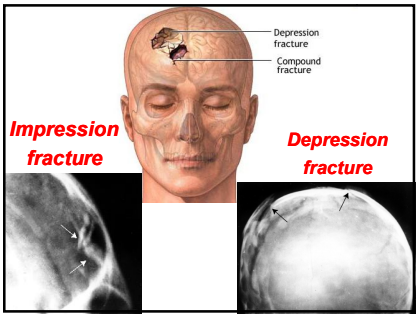
Types of brain compression

- Depressed fracture
- Epidural hematoma
- Subdural hematoma
- Intracerebral hematoma
- Subdural hydroma
- Foreign body
- Intense pneumocefaliya

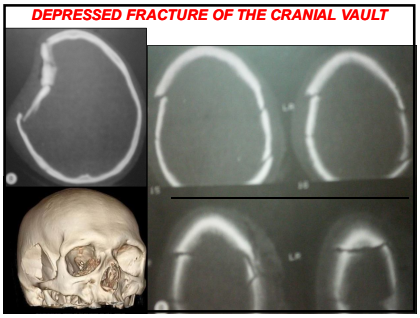
THE RATE OF COMPRESSION OF THE BRAIN

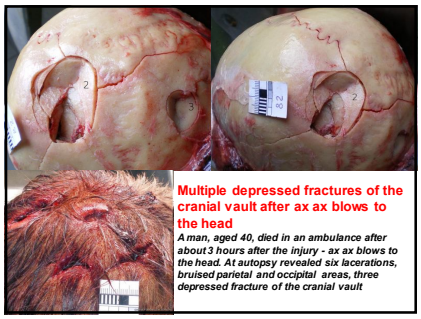
In the rate of compression of the brain are distinguished:

- **Acute compression** - threatening clinical manifestation within days after injury;
- **Subacute compression** - there are signs of compression for 2-14 days after injury;
- **Chronic compression** - threatening clinical symptoms after 15 days and more after TBI



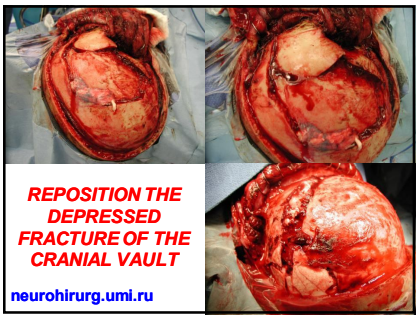
DEPRESSED FRACTURE OF THE CRANIAL VAULT





Multiple depressed fractures of the cranial vault after ax ax blows to the head

A man, aged 40, died in an ambulance after about 3 hours after the injury - ax ax blows to the head. At autopsy revealed six lacerations, bruised parietal and occipital areas, three depressed fracture of the cranial vault



REPOSITION THE DEPRESSED FRACTURE OF THE CRANIAL VAULT

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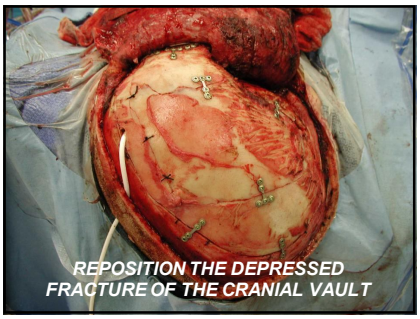

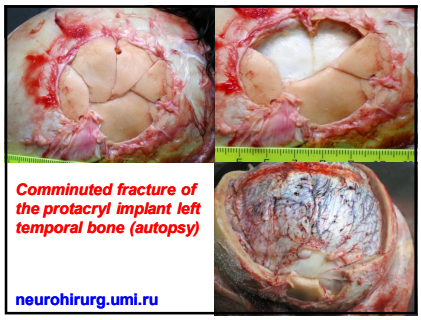

Comminuted fracture of the protacryl implant left temporal bone (autopsy)

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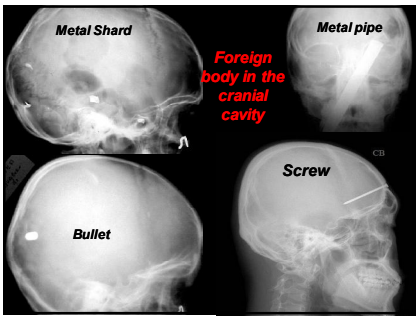
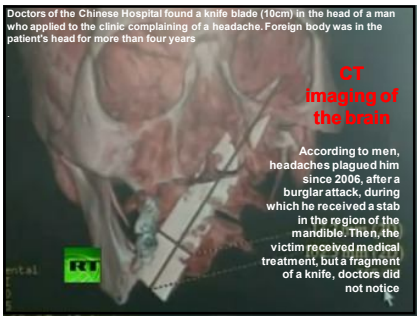
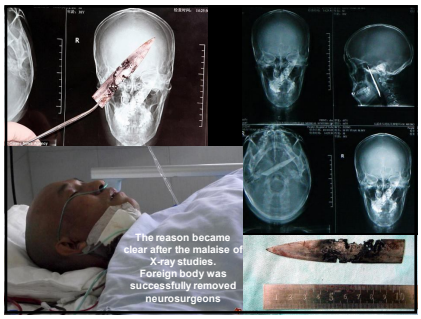
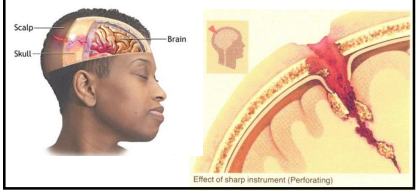




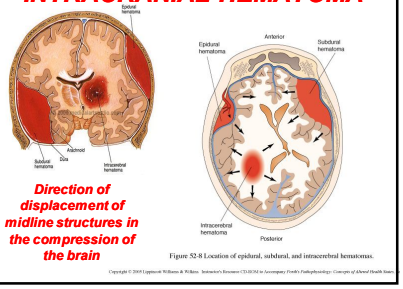


Clinical forms of intracranial hematomas

Acute hematoma – up to 3 days;
Subacute hematoma – up to 2 weeks;
Chronic hematoma – more than 2 weeks



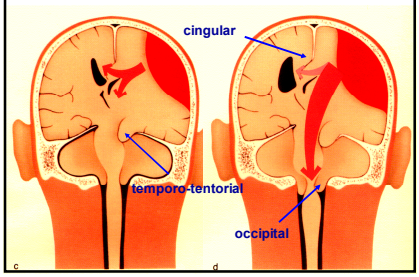
INTRACRANIAL HEMATOMA

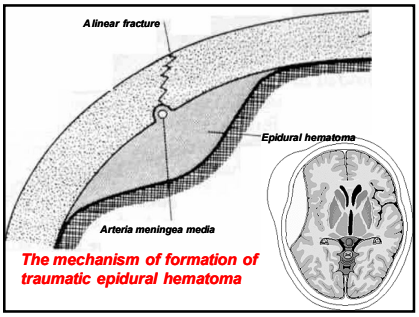


Direction of displacement of midline structures in the compression of the brain

Figure 52-8 Location of epidural, subdural, and intracerebral hematomas.

THE MECHANISM AND TYPE OF HERNIATION

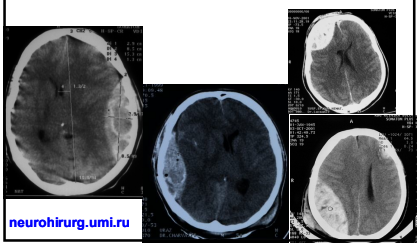




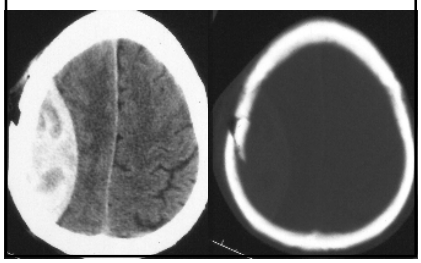
The mechanism of formation of traumatic epidural hematoma

Epidural hematoma – CT and MR findings

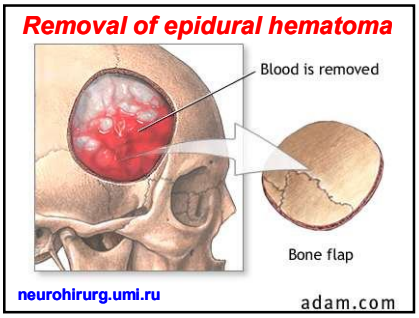
Lens-like shape – clot separates dura from bone

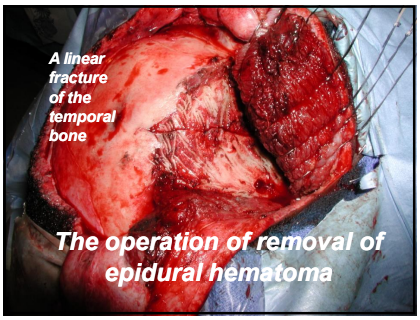


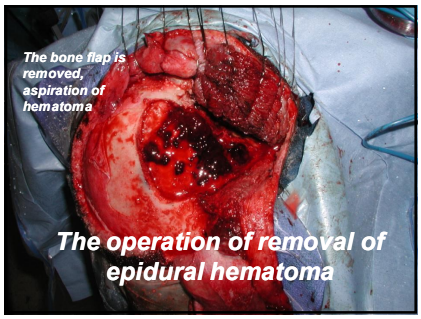
Epidural hematoma, depressed fracture

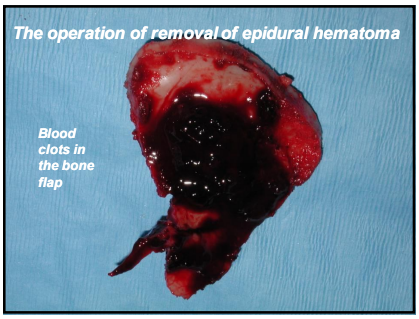


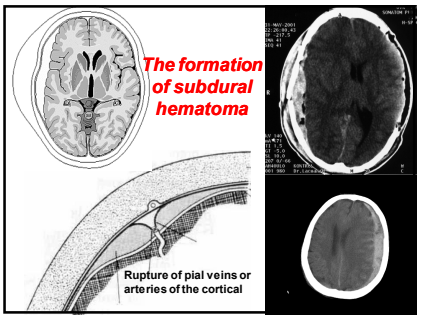
Removal of epidural hematoma

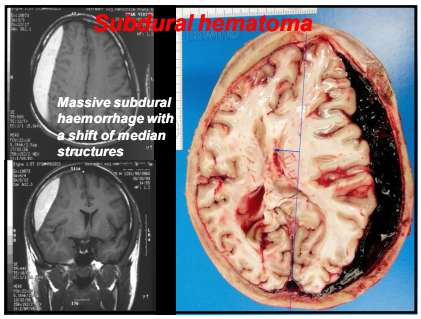


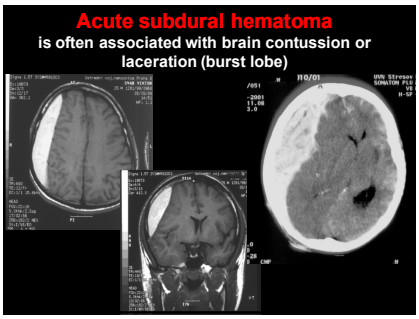


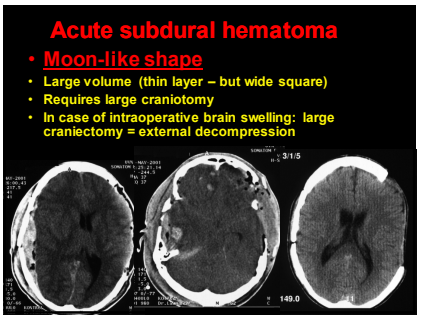

The bone flap is removed, aspiration of hematoma
The operation of removal of epidural hematoma

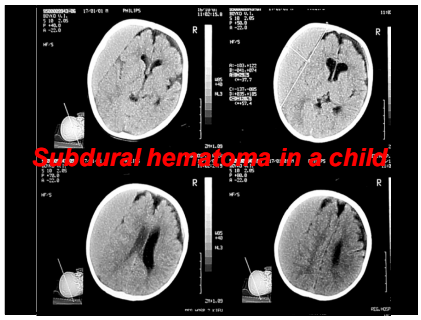

The operation of removal of epidural hematoma
Blood clots in the bone flap

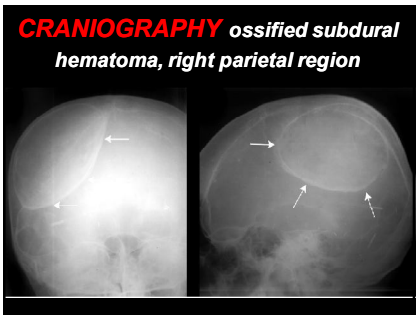

The formation of subdural hematoma
Rupture of pial veins or arteries of the cortical

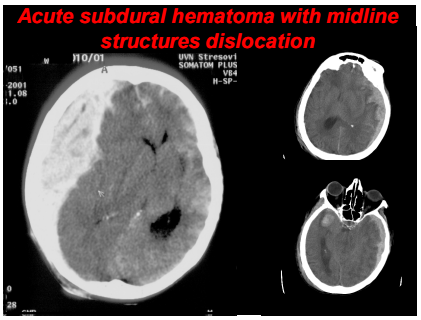

Subdural hematoma
Massive subdural haemorrhage with a shift of median structures

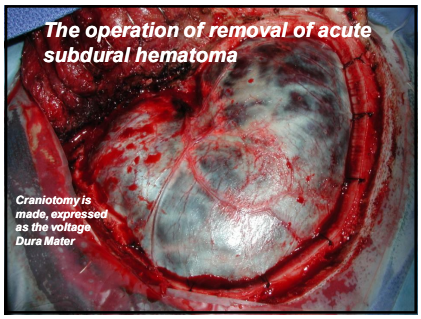

Acute subdural hematoma
is often associated with brain contusion or laceration (burst lobe)

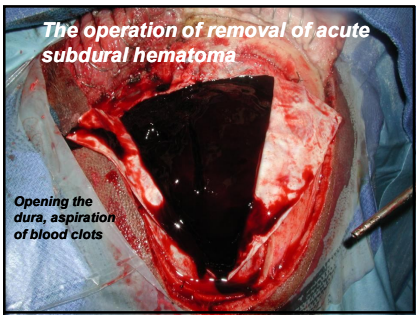

Acute subdural hematoma
Moon-like shape
Large volume (thin layer – but wide square)
Requires large craniotomy
In case of intraoperative brain swelling: large craniectomy = external decompression

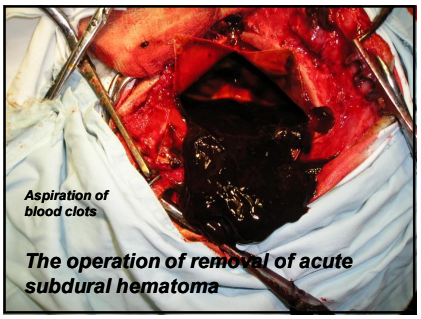

Subdural hematoma in a child

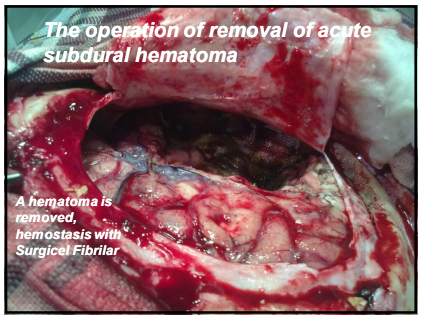

CRANIOGRAPHY ossified subdural hematoma, right parietal region

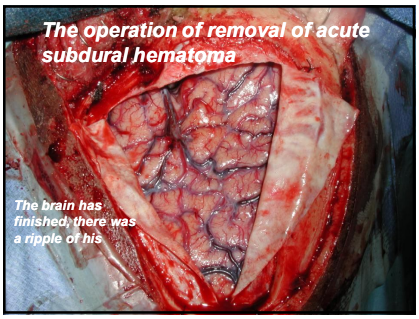

Acute subdural hematoma with midline structures dislocation

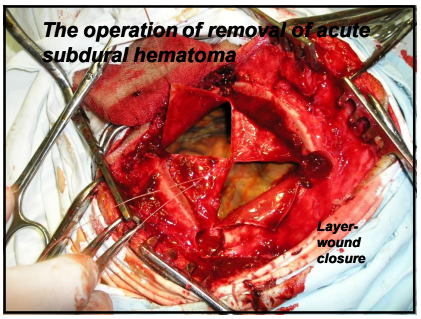

The operation of removal of acute subdural hematoma
Craniotomy is made, expressed as the voltage Dura Mater

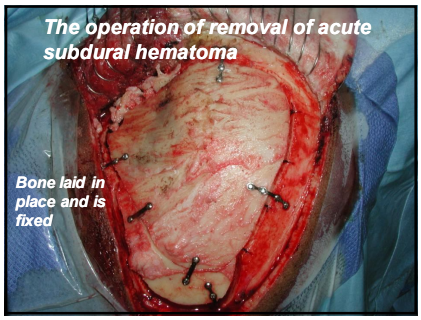

The operation of removal of acute subdural hematoma
Opening the dura, aspiration of blood clots


Aspiration of blood clots
The operation of removal of acute subdural hematoma

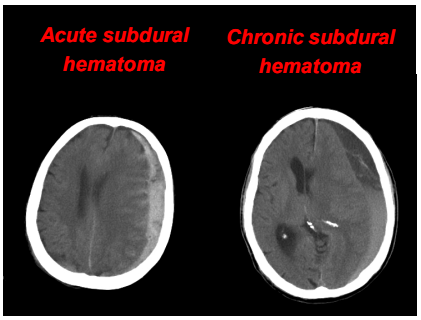

The operation of removal of acute subdural hematoma
A hematoma is removed, hemostasis with Surgicel Fibrilar

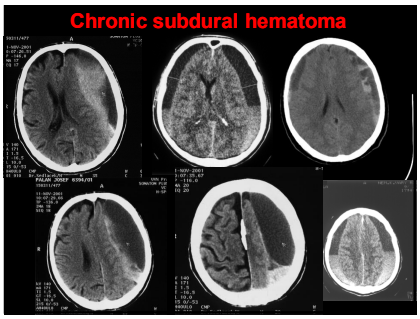

The operation of removal of acute subdural hematoma
The brain has finished, there was a ripple of his

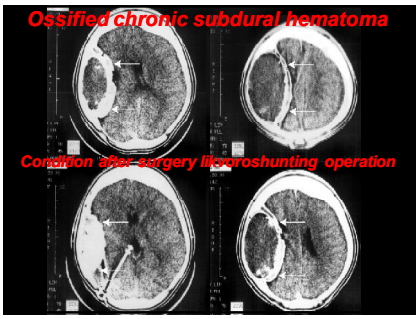

The operation of removal of acute subdural hematoma
Layer-wound closure

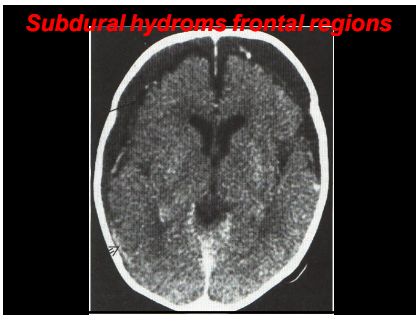

The operation of removal of acute subdural hematoma
Bone laid in place and is fixed

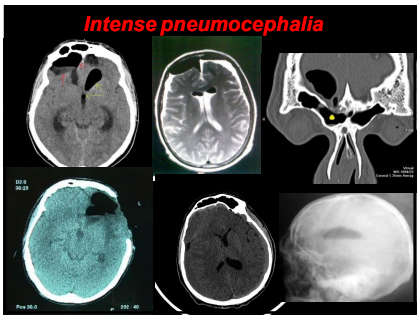

The operation of removal of acute subdural hematoma
Wound sutured and drained


Acute subdural hematoma
Chronic subdural hematoma

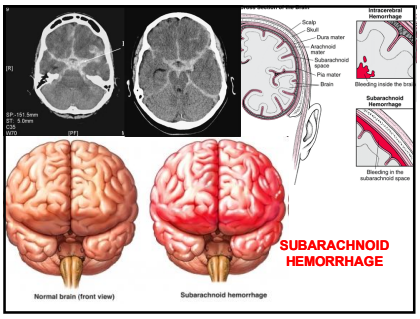

Chronic subdural hematoma

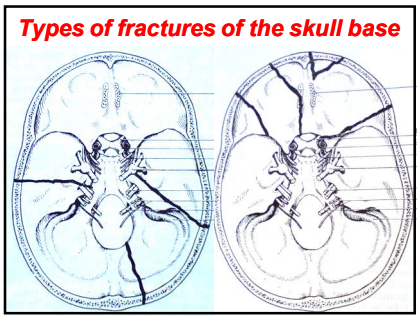

Ossified chronic subdural hematoma
Condition after surgery liquoroshunting operation

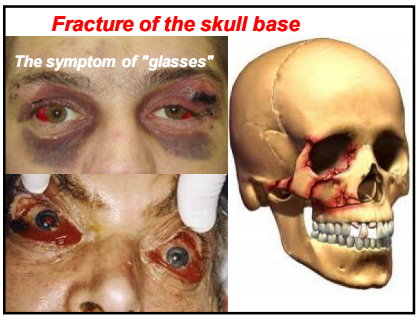

Subdural hydroms frontal regions

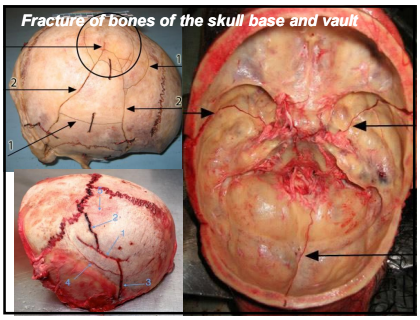

Intense pneumocephalia

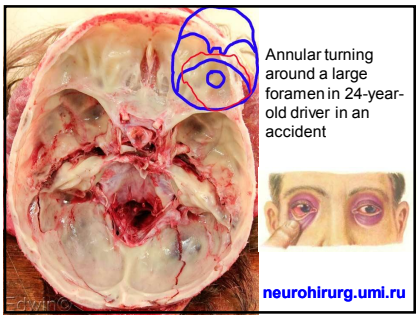

SUBARACHNOID
HEMORRHAGE


SUBARACHNOID
HEMORRHAGE
Normal brain (front view)
Subarachnoid hemorrhage


Types of fractures of the skull base


Fracture of the skull base
The symptom of "glasses"


Fracture of bones of the skull base and vault


Annular turning around a large foramen in 24-year-old driver in an accident
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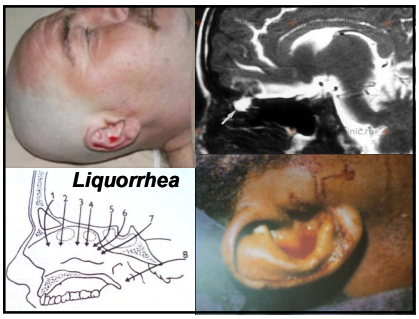
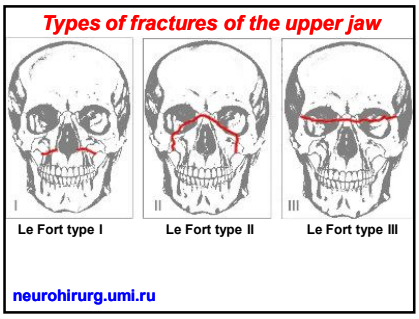

Liquorrhea


Types of fractures of the upper jaw
Le Fort type I
Le Fort type II
Le Fort type III
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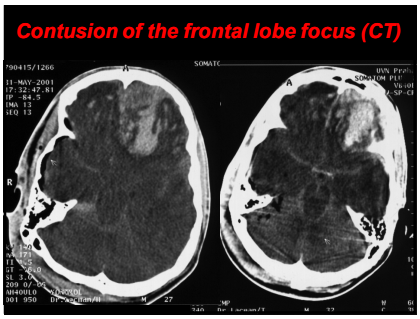
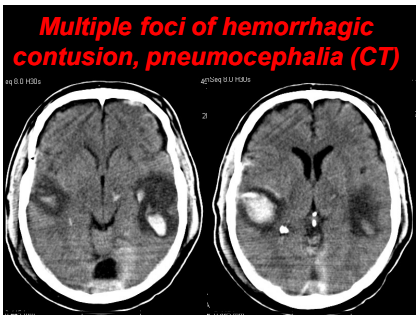
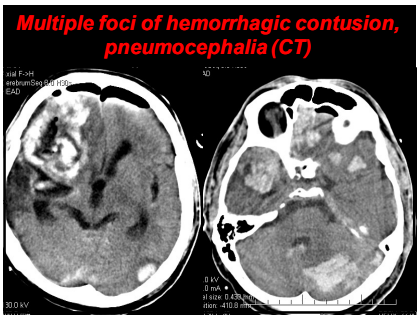
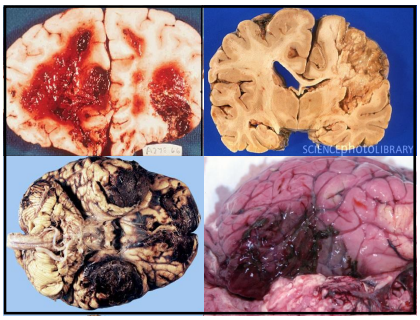
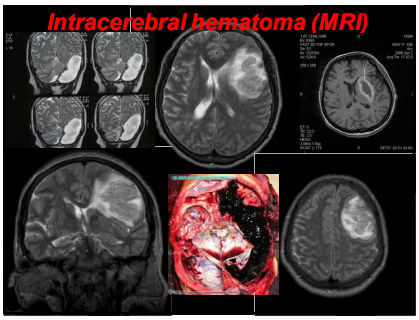
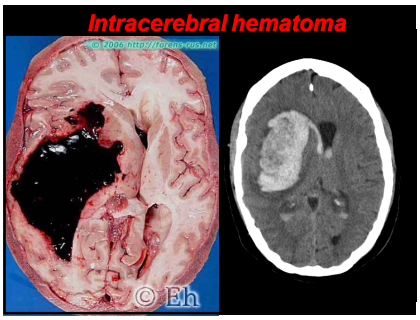

Contusion of the frontal lobe focus (CT)

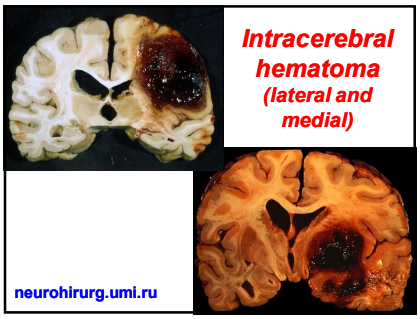

Multiple foci of hemorrhagic contusion, pneumocephalia (CT)


Multiple foci of hemorrhagic contusion, pneumocephalia (CT)




Intracerebral hematoma (MRI)


Intracerebral hematoma


Intracerebral hematoma
(lateral and medial)
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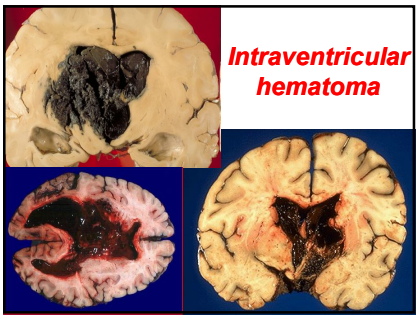
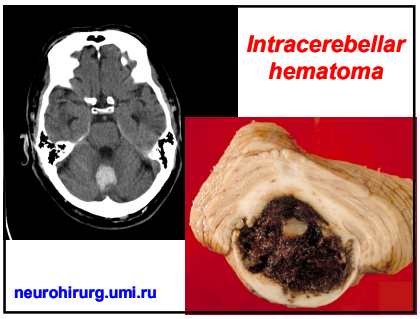

Intraventricular hematoma


Intracerebellar hematoma
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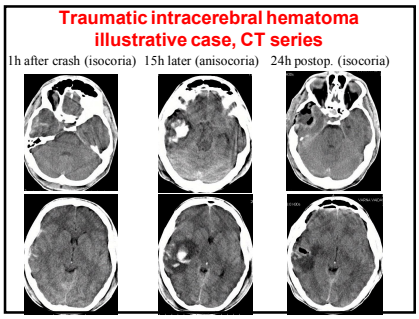
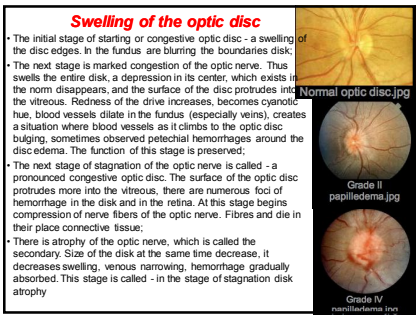
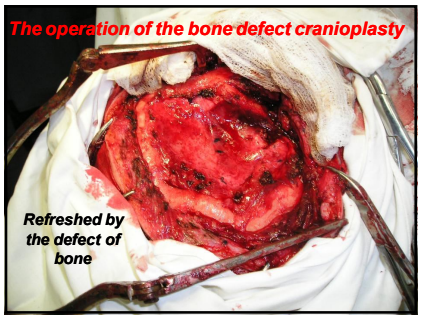

Traumatic intracerebral hematoma
illustrative case, CT series
1h after crash (isocoria)
15h later (anisocoria)
24h postop. (isocoria)

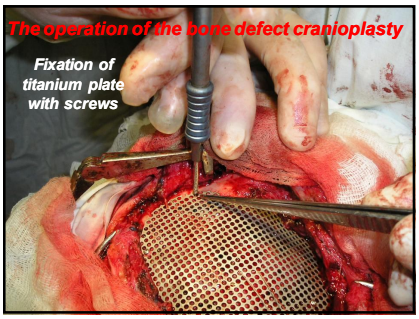

Swelling of the optic disc
• The initial stage of starting or congestive optic disc - a swelling of the disc edges. In the fundus are blurring the boundaries disk;
• The next stage is marked congestion of the optic nerve. Thus swells the entire disk, a depression in its center, which exists in the norm disappears, and the surface of the disc protrudes into the vitreous. Redness of the drive increases, becomes cyanotic hue, blood vessels dilate in the fundus (especially veins), creates a situation where blood vessels as it climbs to the optic disc bulging, sometimes observed petechial hemorrhages around the disc edema. The function of this stage is preserved;
• The next stage of stagnation of the optic nerve is called - a pronounced congestive optic disc. The surface of the optic disc protrudes more into the vitreous, there are numerous foci of hemorrhage in the disk and in the retina. At this stage begins compression of nerve fibers of the optic nerve. Fibres and die in their place connective tissue;
• There is atrophy of the optic nerve, which is called the secondary. Size of the disk at the same time decrease, it decreases swelling, venous narrowing, hemorrhage gradually absorbed. This stage is called - in the stage of stagnation disk atrophy
Normal optic disc.jpg
Grade II papilledema.jpg
Grade IV papilledema.jpg


The patient with postoperative bone defect
Condition after surgery resection of depressive fracture of the frontal and temporal bones


The patient with postoperative bone defect


The operation of the bone defect cranioplasty
The surgical field


The operation of the bone defect cranioplasty
Refreshed by the defect of bone


The operation of the bone defect cranioplasty
Fixation of titanium plate with screws


The operation of the bone defect cranioplasty
Postoperative wound is sutured to the drains of the two glove


The first day after surgery, cranioplasty
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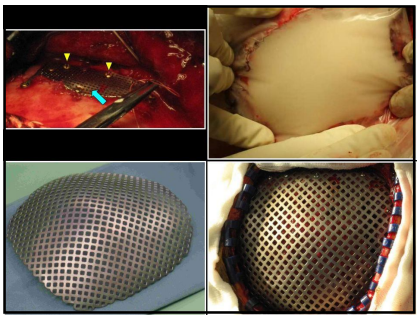
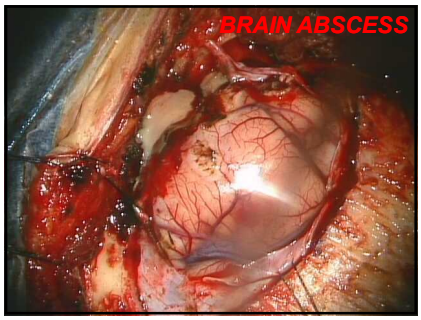
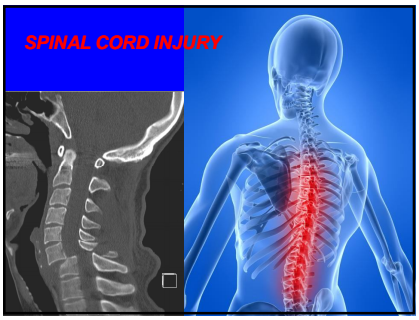
The seventh day after surgery, cranioplasty




BRAIN ABSCESS

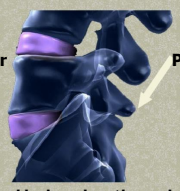

SPINAL CORD INJURY


•In the United States annually register 8000-10000 new cases complicated by spinal cord injury
•In Russia there are about 250,000 patients with consequences of spinal cord injury
•In Ukraine, recorded from 2000 to 3000 cases of spinal cord injuries each year

BIOMECHANICS

80% Anterior

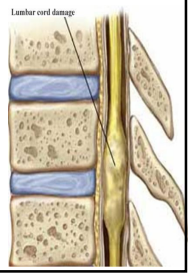
20% Posterior



Load balancing the spine

Spinal Cord Trauma

- Acute stage (spinal shock)
- Rehabilitation stage
- Chronic stage — late sequelae



Spinal Trauma

- Cervical spine distortion (whiplash injury)
- Vertebral fracture
- Trauma to nerve roots and brachial plexus
- Nerve root lesions
- Spinal Cord Trauma

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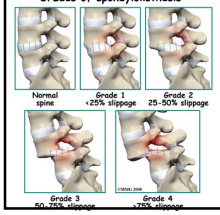
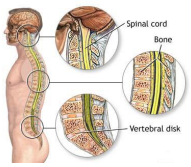
Spinal Trauma

- Damage to the spine without spinal cord injury
- Spinal injury with spinal cord injury
- Spinal cord injury without spinal injury

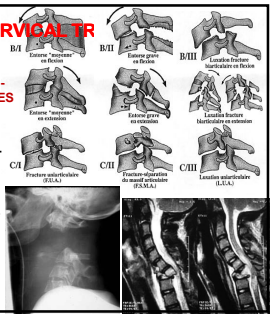
Grades of spondylolisthesis





CERVICAL TR

- FLEXION-EXTENSION-DISTRACTION INJURIES
  - Moderate sprain
  - Severe sprain
  - Bilateral fracture-dislocations
- ROTATION INJURIES
  - Unifacet fractures
  - Fracture separation of the articular pillar
  - Unilateral dislocation



Complicated by a spinal injury - a spinal cord injury in which not only damaged the supporting structure of the vertebra, and spinal cord and its roots. Complicated by a spinal injury occurs in 3-6% of cases among all patients with trauma of the musculoskeletal system. The most commonly affects the C5 and C6 vertebrae. In 90-95% of cases developing anterior spinal cord compression

Clinical forms of traumatic lesions spinal cord

I.Concussion of the spinal cord. Reversible functional changes that regress within 1-7 days;

II.Spinal cord contusion. Persistent neurologic manifestations that do not regress, or partially regressed;

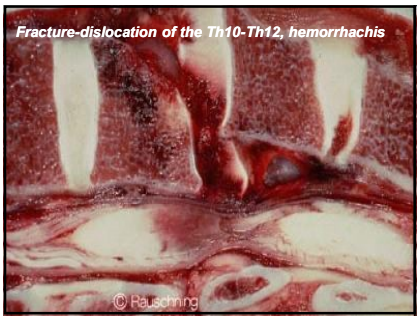
III.Hemorrhachis;

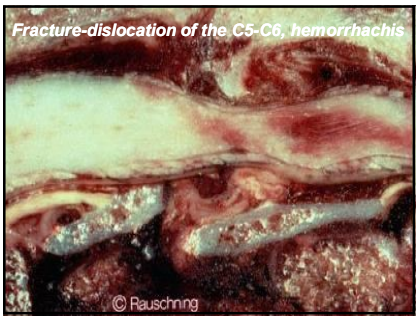
IV.The anatomical spinal cord injury (tears, tears, crushing);

V.Compression of the spinal cord (bony structures, ligaments and discs, hematomas, foreign bodies, edema, swelling of the spinal cord);

VI.The tension of the spinal cord at the displaced vertebrae;

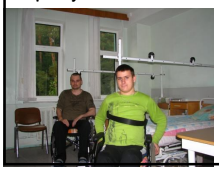
VII.Damage to the roots of the spinal cord

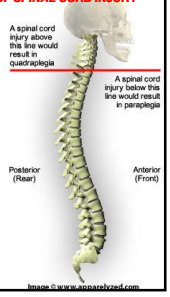




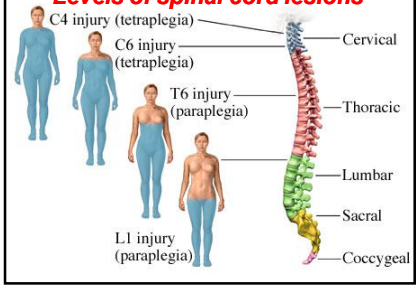
THE MAIN CLINICAL MANIFESTATIONS OF SPINAL CORD INJURY

- Spinal shock;
- The syndrome of spinal cord injury with a diameter corresponding wires and segmental symptoms;
- Syndrome of vegetative-trophic disorders;
- Violation of the pelvic organs;
- Liquorodynamic violation



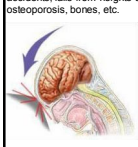


Levels of spinal cord lesions

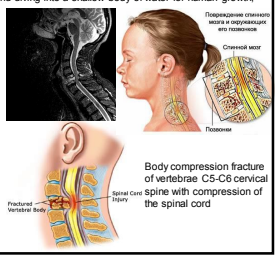


Compression fracture of spine

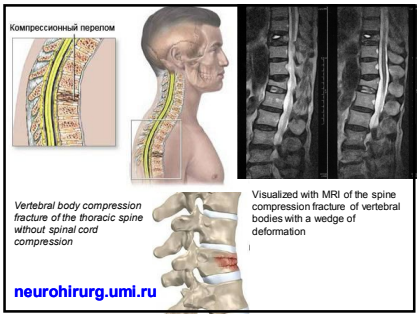
This pathology is quite common in modern man, and caused primarily by automobile accidents, falls from heights and diving into a shallow body of water for human growth, osteoporosis, bones, etc.



The mechanism of formation of vertebral compression fractures with concomitant whiplash tension of the muscles and ligaments of the cervical spine



Body compression fracture of vertebrae C5-C6 cervical spine with compression of the spinal cord



Vertebral body compression fracture of the thoracic spine without spinal cord compression

Visualized with MRI of the spine compression fracture of vertebral bodies with a wedge of deformation

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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

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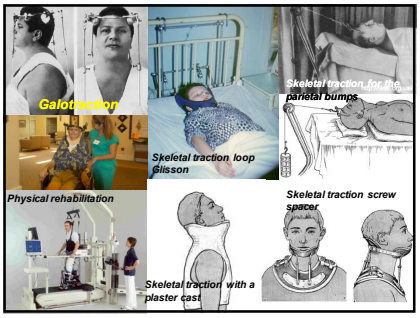
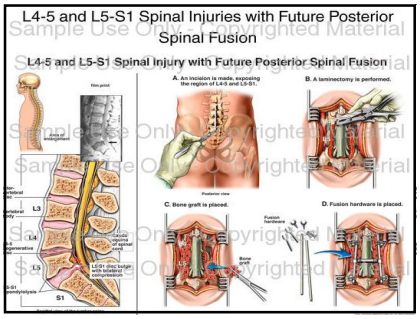
Methods of external fixation of thoracic and lumbar spine

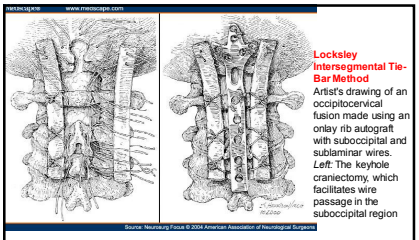
Alternative semi-rigid lumbosacral corset in the treatment of herniated disc and protrusion at the level of the lumbar spine

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



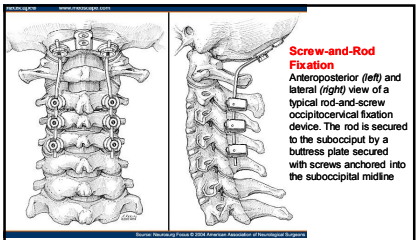
L4-5 and L5-S1 Spinal Injuries with Future Posterior Spinal Fusion





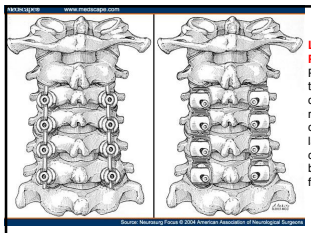
Locksley Intersegmental Tie-Bar Method
Artist's drawing of an occipitocervical fusion made using an onlay rib autograft with suboccipital and subliminar wires. *Left:* The keyhole craniectomy, which facilitates wire passage in the suboccipital region

This technique is used with numerous other suboccipitocervical wiring techniques as well. *Right:* The completed Locksley intersegmental tie-bar method, in which bilateral rib struts and a middle position posterior spinous/suboccipital plate are used to provide three-point fixation of the occipitocervical junction



Screw-and-Rod Fixation
Anteroposterior *(left)* and lateral *(right)* view of a typical rod-and-screw occipitocervical fixation device. The rod is secured to the suboccput by a buttress plate secured with screws anchored into the suboccipital midline

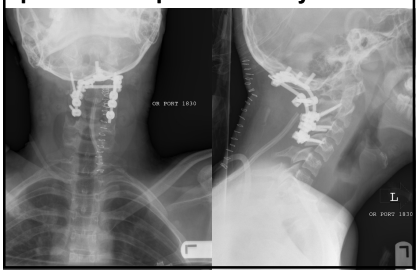
The rod is secured to C2-4 with lateral mass screws. In this example the posterior arch of C-1 has not been included in the fixation. The rod can be contoured to allow optimization of the occipitocervical angle as well as that of the cervical lordosis



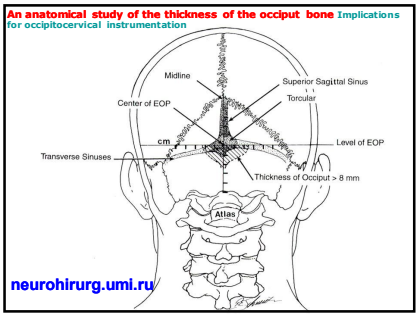
Lateral Mass Plates and Screws
Posterior views of the cervical spine demonstrating a rod-and-screw construct *(left)* and a lateral mass plate construct *(right)*, both of which extend from C-3 to C-6

Polyaxial head screw and-rod constructs allow for limitless positioning options of the lateral mass screws. The lateral mass plate demonstrated is one method by which variable screw positions can be selected with screws placed through an underlying elongated hole

Imagings of patients with established posterior occipital-cervical system



An anatomical study of the thickness of the occiput bone Implications for occipitocervical instrumentation



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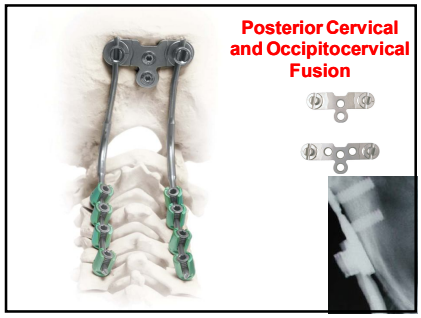
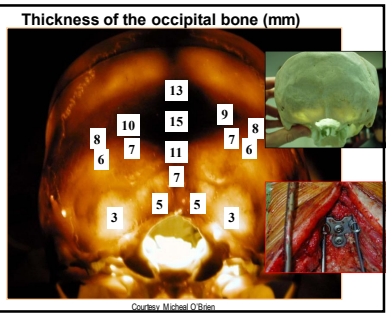


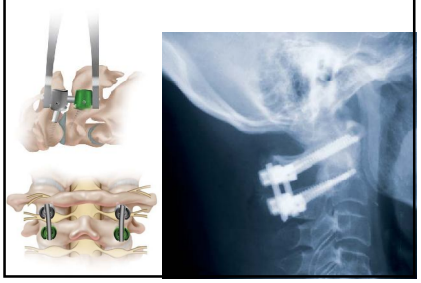
Posterior Cervical and Occipitocervical Fusion

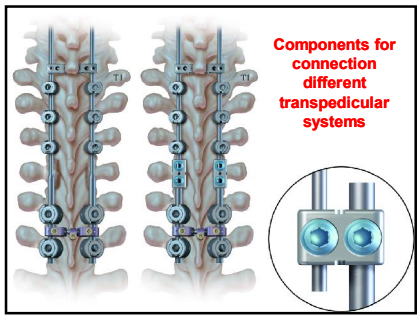
Thickness of the occipital bone (mm)



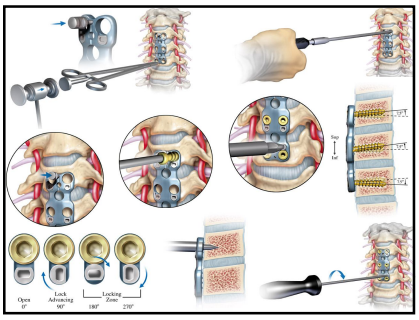
Courtesy Michael O'Brien

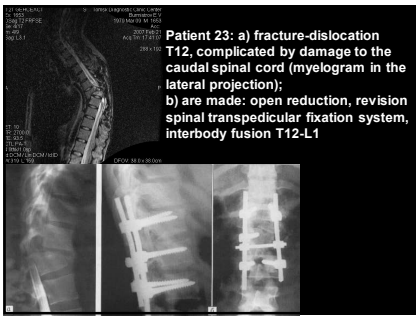
TRANSPEDICULAR FIXATION



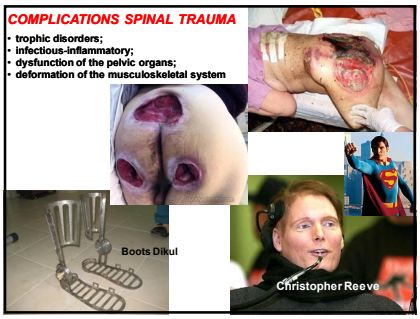


Components for connection different transpedicular systems





Patient 23: a) fracture-dislocation T12, complicated by damage to the caudal spinal cord (myelogram in the lateral projection);
b) are made: open reduction, revision spinal transpedicular fixation system, interbody fusion T12-L1


COMPLICATIONS SPINAL TRAUMA
• trophic disorders;
• infectious-inflammatory;
• dysfunction of the pelvic organs;
• deformation of the musculoskeletal system
Boots Dikul
Christopher Reeve


THANK YOU!