

Ryazan State Medical University named after academician I.P. Pavlov

Department of eye and ENT diseases

Orbital and intracranial rhinosinusogenic complications

Methodical recommendations

for students of the 4th course of medical faculty

Ryazan, 2018

Федеральное государственное бюджетное образовательное учреждение высшего образования
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Кафедра глазных и ЛОР-болезней

ОРБИТАЛЬНЫЕ И ВНУТРИЧЕРЕПНЫЕ РИНОСИНУСОГЕННЫЕ ОСЛОЖНЕНИЯ

Методические рекомендации
для студентов 4 курса лечебного факультета

Рязань, 2018

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O-68

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In these methodical recommendations for students of the 4th course of medical faculty in accordance with the program in discipline «Otorhinolaryngology» you find the information about orbital and intracranial rhinosinusogenic complications. This information is systematized and consistently presented.

Knowledge of the classification, pathogenesis, clinical presentation and treatment of orbital and intracranial rhinosinusogenic complications will help future doctors to better diagnose and differentiate these life-threatening diseases.

Methodical recommendations are intended for students of the 4th course of medical faculty and contribute to better mastering of theoretical material on otorhinolaryngology.

Pic.: 23

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О-637 Орбитальные и внутричерепные риногенные осложнения: методические рекомендации для студентов 4 курса лечебного факультета/ сост.: Т.И. Карасева; ФГБОУ ВО РязГМУ Минздрава России. – Рязань: ОТСиОП, 2018. – 28 с.

В настоящих методических рекомендациях для студентов, обучающихся специальности 31.05.01 Лечебное дело по дисциплине «Оториноларингология», в соответствии с программой по данной дисциплине систематизированы и последовательно представлены сведения об орбитальных и внутричерепных риногенных осложнениях. Знание классификации, патогенеза, клинической картины и методов лечения орбитальных и внутричерепных риногенных осложнений поможет будущим врачам лучше диагностировать и дифференцировать эти жизнеугрожающие заболевания.

Методические рекомендации предназначены для студентов 4 курса лечебного факультета и способствуют более качественному освоению теоретического материала по оториноларингологии.

Ил.: 23

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Introduction:

The paranasal sinus is a group of air-filled spaces in the skull that surround the nasal cavity extending superiorly to the skull base and laterally to encompass the medial wall and floor of the orbit.

Paranasal sinus infection is most frequently encountered in the medical practice. Orbital complication of rhinosinusogenic origin has been described even during the days of Hippocrates. Due to the close proximity of the orbit with the ethmoid, maxillary, frontal and sphenoid sinuses any rhinosinusogenic infection, if not diagnosed early and treated adequately, can lead to the spread of infection through the neurovascular foramina via congenital and acquired bony dehiscence and indirectly through the valveless ophthalmic veins draining the sinuses and orbit as a result of thrombophlebitis and embolism. The erosion and destruction of the lamina papyracea, a paper-thin bone separating the ethmoid sinus and orbit, provides the most common pathway for the contagious spread of sinus infection to the orbit.

Orbital complications of sinusitis include edema, orbital cellulitis, subperiosteal abscess, orbital abscess, cavernous sinus thrombosis and in advanced stage intracranial complications such as meningitis and brain abscess. Orbital complication of rhinosinusogenic origin should always be treated as an emergency and treated aggressively as it poses life-threatening intracranial complications and blindness. Prompt recognition, correct diagnosis and appropriate treatment is necessary to avoid orbital complications of rhinosinusogenic origin.

The aim of our methodical recommendations is to evaluate the clinical features, radiological finding, bacteriology, treatment of the diseases.

Maxillary Sinus: Anatomy

Largest and first sinus to develop

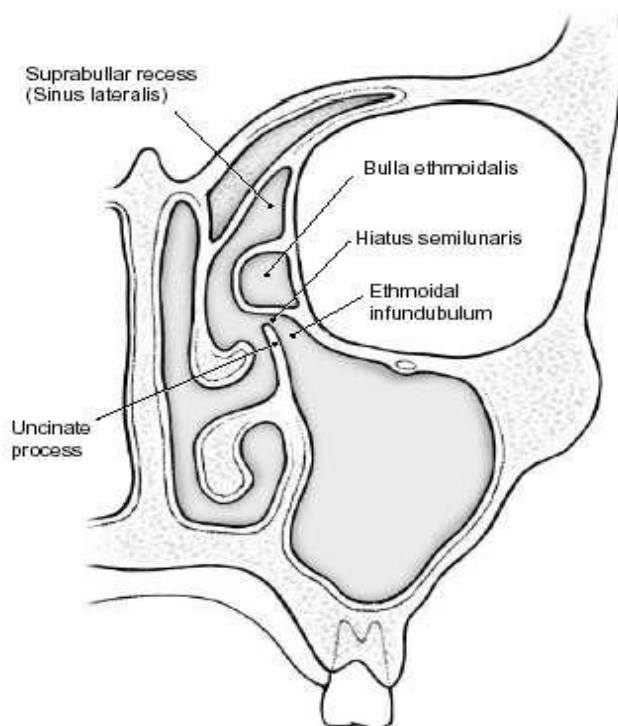
- At 3 months gestation
- Volume 6-8cm³ at birth
- Volume 15cm³ by adulthood

Biphasic periods of rapid growth

- First 3 years and between 7-18 years
- Coincides with dental development

Natural ostium drains into ethmoidal infundibulum

- Accessory ostia in 15-40%
- Haller cell can impair drainage



Pic.1 Maxillary sinus

Notes: The anterior wall forms the facial surface of the maxilla, the posterior wall borders the infratemporal fossa, the medial wall constitutes the lateral wall of the nasal cavity, the floor of the sinus is the alveolar process, and the superior wall serves as the orbital floor.

Innervation via V2 distribution

- Infraorbital nerve
- Dehiscent intraorbital canal in 14%

Vasculature

- Maxillary artery and vein
- Facial artery

First and second molar roots dehiscent in 2%

Ethmoid Sinus: Anatomy

NOTES: Haller cell is an ethmoidal cell that pneumatizes between maxillary sinus and orbital floor.

First seen at 5 months gestation

- Five ethmoid turbinals
 - Agger nasi
 - Uncinate
 - Ethmoid bulla
 - Ground/basal lamella
 - Posterior wall of most posterior ethmoid cell
- Between 3-4 cells at birth

Adult size by 12-15 years

- Between 10-15 cells
- Volume 2-3cm³ by adulthood

NOTES: The lateral portions form the medial walls of the orbits, the sphenoid establishes the posterior face, the superior surface is formed by the skull base of the anterior cranial fossa, and many of the key structures of the lateral nasal wall, derived from basal lamellas, extend posteroinferiorly from the skull base. The lateral wall of the ethmoid sinus, or lamina papyracea, forms the paper-thin medial wall of the orbit. The midline vertical plate of the ethmoid bone is composed of a superior portion in the anterior cranial fossa called the crista galli and an inferior portion in the nasal cavity called the perpendicular plate of the ethmoid bone that contributes to the nasal septum. The anterior cranial fossa is separated from the ethmoid air cells superiorly by the horizontal plate of the ethmoid bone, which is composed of the thin medial cribriform plate and the thicker, more lateral ethmoid roof. The ethmoid roof articulates with the cribriform plate at the lateral lamella of the cribriform plate, which is the thinnest bone in the entire skull base.

The ethmoid sinuses are separated by a series of recesses demarcated by five bony partitions or lamellae. These lamellae are named from the most anterior to posterior: first (uncinate process), second (bulla ethmoidalis), third (ground or basal lamella), fourth (superior turbinate), and fifth (supreme turbinate).

Drainage

- Anterior cells via ethmoid infundibulum
- Posterior cells via sphenoethmoid recess

Innervation via V1 distribution

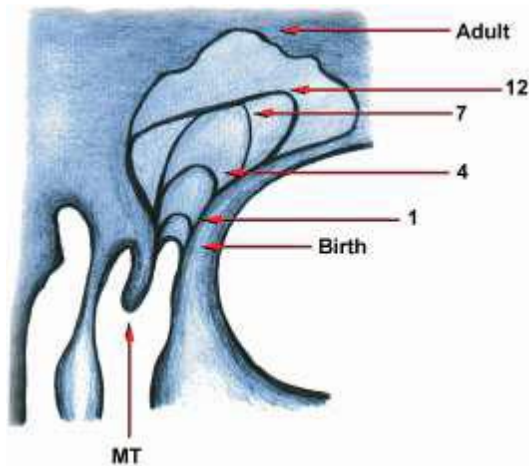
- Branches from nasociliary nerve
- Anterior and posterior ethmoids

Vasculature

- Ophthalmic artery
- Maxillary and ethmoid veins

Posterior cells drain into superior meatus. Ophthalmic artery provides anterior and posterior ethmoidal arteries. Cavernous sinus gives off maxillary and ethmoidal veins.

Frontal sinus: Anatomy



Pic. 2 Development of the frontal sinus

Not present at birth

- Starts developing at 4 years
- Radiographically visualized at 5-6 years

Development not complete until 12-20 years

- Volume 4-7cm³ by adulthood
- No or poor pneumatization in 5-10%

Drainage via frontal recess

- Anterior: posterior agger nasi
- Lateral: lamina papyracea
- Medial: middle turbinate

NOTES: The anterior table of the frontal sinus is twice as thick as the posterior table, which separates the sinus from the anterior cranial fossa. The floor of the sinus also functions as the supraorbital roof, and the drainage ostium is located in the posteromedial portion of the sinus floor.

A markedly pneumatized agger nasi cell or ethmoidal bulla can obstruct frontal sinus drainage by narrowing the frontal recess.

Drainage of the frontal sinus also depends on the attachment of the superior portion of the uncinate process.

Vasculature

- Supraorbital artery and vein
- Supratrochlear artery
- Ophthalmic vein
- Foramina of Breschet

Innervation via V1 distribution

- Supraorbital
- Supratrochlear

NOTES: Foramina of Breschet: small venules that drain the sinus mucosa into the dural veins.

Sphenoid Sinus: Anatomy

Evagination of nasal mucosa into sphenoid bone

- First seen at 4 months gestation
- Pneumatization begins in middle childhood
- Minimal volume at birth
- Volume 0.5-8cm³ by adult

Reaches adult size by 12-18 years

Innervation via sphenopalatine nerve

- V2 distribution
- Parasympathetics

Vasculature via maxillary artery and vein

- Sphenopalatine artery
- Pterygoid plexus

Complications of Sinusitis

Three main categories

- Orbital
- Intracranial
- Bony

Radiography

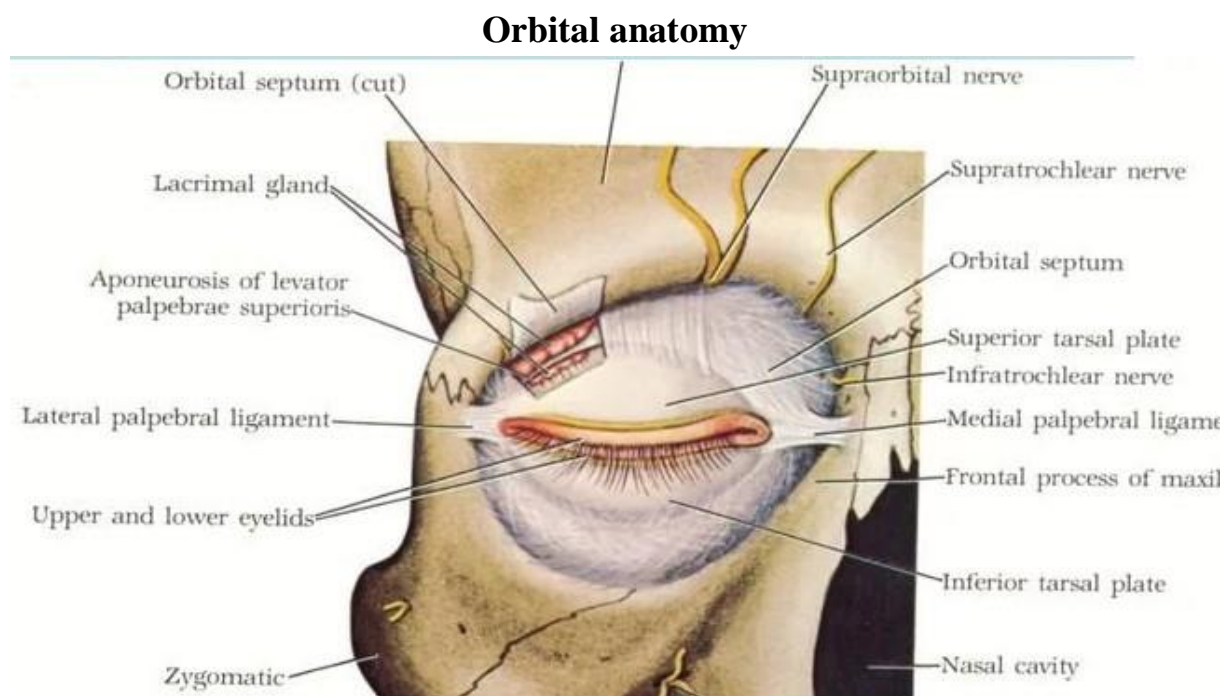
- Computed tomography (CT) best for orbit
- Magnetic resonance imaging (MRI) best for intracranium

Orbital complications

Pathogenesis

The orbit is susceptible to contiguous spread of infection from the sinuses as it is surrounded by sinuses on three sides. This is more accentuated in children, because of their thinner bony septa and sinus wall, greater porosity of bones, open suture lines, and larger vascular foramina. Differential diagnosis of orbital involvement should include bacteremia (caused by *Haemophilus influenzae* or *Streptococcus pneumoniae*), facial infections, trauma, iatrogenic causes, tumors, and dacryocystitis. However, sinusitis is responsible for a least 75% of cases, and orbital complication may be the first and only presenting sign of sinusitis.

The orbit is separated from the ethmoid cells and maxillary sinus by thin bony plates (called the lamina papyracea) only, which have naturally congenital bony dehiscences. Infections can spread directly by penetration of the thin bones or through the small bony dehiscence.



Pic. 3 Orbital septum

The orbital septum is the fascia behind that portion of the orbicularis muscle that lies between the orbital rim and the tarsus; it serves as a barrier between the lid and the orbit. The superior orbital septum blends with the tendon of the levator palpebrae superioris and the superior tarsus; the inferior orbital septum blends with the inferior tarsus.

Infection can also extend directly by traversing through the anterior and posterior ethmoid foramina. Since the ophthalmic venous system has no valves, the extensive venous and lymphatic communication between the sinuses and the surrounding structures allows flow in either direction, which enables retrograde thrombophlebitis and spread of the infection.

Orbital complications have been categorized by Chandler into five separate stages according to severity:

class 1: Inflammatory edema and preseptal cellulites.

class 2: Orbital cellulitis.

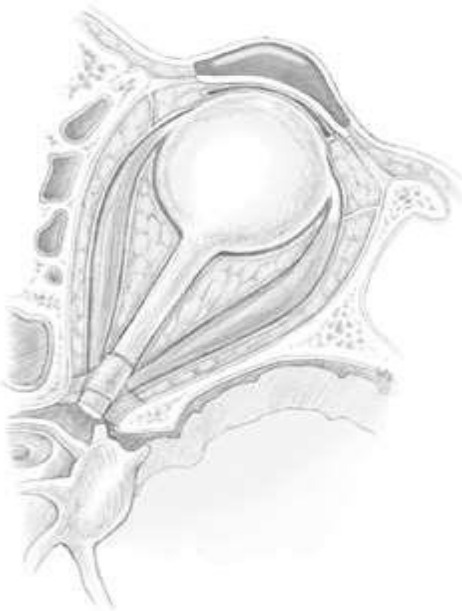
class 3: Subperiosteal abscess.

class 4: Orbital abscess.

class 5: Cavernous sinus thrombosis.

Preseptal cellulites

Preseptal cellulites which results from venous obstruction caused by infection-induced inflammatory pressure on the ethmoid vessels. Barriers that limit the progression and spread of the infection to the orbit are the orbital septum and the tarsal plate.



Symptomatology

Eyelid edema and erythema

Extraocular movement intact

Normal vision

May have eyelid abscess

CT reveals diffuse thickening of lid and conjunctiva.

Pic.4 Preseptal cellulites



Pic. 5 CT of preseptal cellulites

Orbital Cellulitis

Symptomatology

- Post-septal infection
- Eyelid edema and erythema
- Proptosis and chemosis
- Limited or no extraocular movement limitation
- No visual impairment
- No discrete abscess

NOTES: Patients may complain of pain and diplopia and a history of recent orbital trauma or dental surgery.

Low-attenuation adjacent to lamina papyracea on CT.



Pic. 6 Orbital cellulitis



Pic. 7 CT of orbital cellulitis



Pic. 8 Clinical presentation of orbital cellulitis

Facilitate sinus drainage

- Nasal decongestants
- Mucolytics
- Saline irrigations

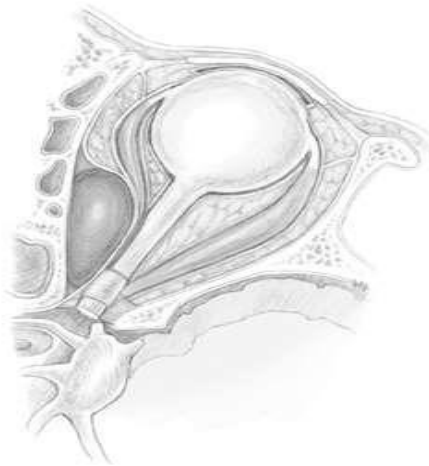
Medical therapy typically sufficient

- Intravenous antibiotics
- Head of bed elevation

May need surgical drainage

- No improvement or progression within 48 hours

Subperiosteal Abscess



Pic. 9 Subperiosteal abscess

Symptomatology

- Pus formation between periorbita and lamina papyracea
- Displace orbital contents downward and laterally
- Proptosis, chemosis, ophthalmoplegia
- Risk for residual visual sequelae
- May rupture through septum and present in eyelids



Pic. 10 CT of subperiosteal abscess

Rim-enhancing hypodensity with mass effect

- Adjacent to lamina papyracea
- Superior location with frontal sinusitis etiology
- Diagnostically accurate 86-91%

NOTES: Patients will complain of diplopia, ophthalmoplegia, exophthalmos, or reduced visual acuity. The patient has limited ocular motility or pain on globe movement toward the abscess; may have normal movement early on. Orbital signs include proptosis, chemosis, and visual impairment.

Surgical drainage

- Worsening visual acuity or extraocular movement
- Lack of improvement after 48 hours
- Open ethmoids and remove lamina papyracea

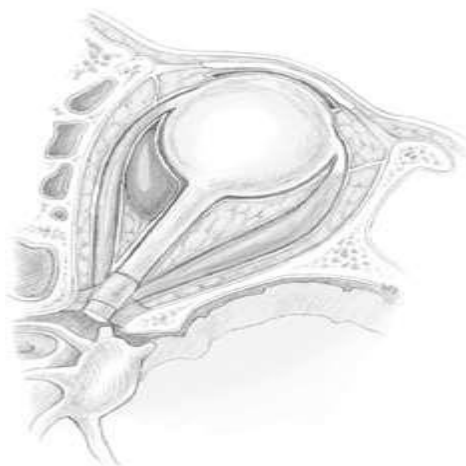
Approaches

- External ethmoidectomy (Lynch incision) is most preferred
- Endoscopic ideal for medial abscesses
- Transcaruncular approach: transconjunctival incision or extend medially around lacrimal caruncle



Pic. 11 Extranasal approach to ethmoid sinus

Orbital Abscess



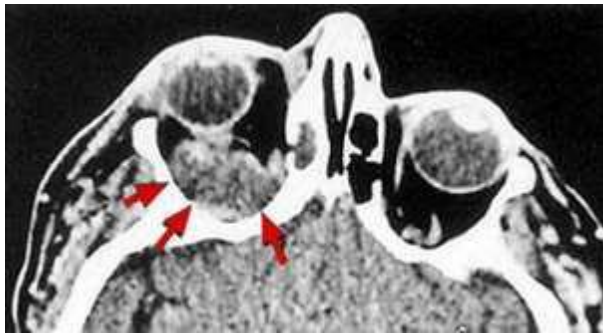
Pic. 12 Orbital abscess

Symptomatology

- Pus formation within orbital tissues
- Severe exophthalmos and chemosis
- Ophthalmoplegia (cranial nerves II, III, IV, V, and VI are involved)
- Visual impairment
- Risk for irreversible blindness
- Can spontaneously drain through eyelid

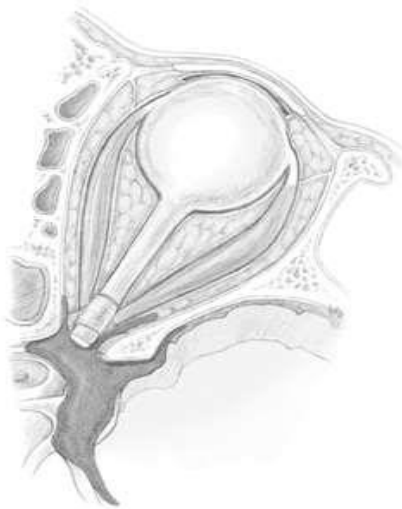
Drain abscess and sinuses

- Incise periorbita and drain intraconal abscess
- Approaches as with subperiosteal abscess
- Lynch incision
- Endoscopic



Pic. 13 MRI of orbital abscess

NOTES: Transcaruncular approach allegedly does not utilize a facial incision.



Cavernous Sinus Thrombosis

Symptomatology

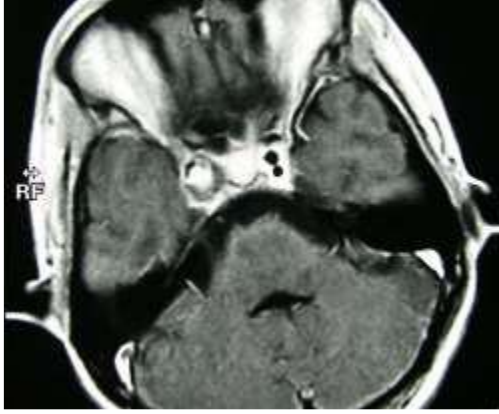
- Orbital pain
- Proptosis and chemosis
- Ophthalmoplegia
- Symptoms in contralateral eye
- Associated with sepsis and meningismus

Radiology

- Poor venous enhancement on CT
- Better visualized on MRI

Pic. 14 Cavernous sinus thrombosis

NOTES: Contralateral involvement is distinguishing feature of cavernous sinus thrombosis. MRI findings of heterogeneity and increased size suggest the diagnosis. MRI better especially if suspecting intracranial involvement.



Pic. 15 MRI of cavernous sinus thrombosis

- Mortality rate up to 30%
 - Surgical drainage
 - Intravenous antibiotics: high-dose, cross blood-brain barrier
- Anticoagulant
- Prevent thrombus propagation
 - Risk intracranial or intraorbital bleeding

Intracranial complications

Direct extension

- Sinus wall erosion
- Traumatic fracture lines
- Neurovascular foramina (optic and olfactory nerves)

Hematogenous spread

- Diploic skull veins
- Ethmoid bone

NOTES: Thrombophlebitis originating in the mucosal veins progressively involves the emissary veins of the skull, the dural venous sinuses, the subdural veins, and, finally, the cerebral veins. By this mode, the subdural space may be selectively infected without contamination of the intermediary structure; a subdural empyema can exist without evidence of extradural infection or osteomyelitis.

Types

Five types (not exclusive)

- Meningitis
- Epidural abscess
- Subdural abscess
- Intracerebral abscess
- Cavernous sinus, venous sinus thrombosis

Common signs and symptoms

- Fever
- Headache
- Nausea, vomiting
- Altered consciousness
- Seizure
- Hemiparesis
- Visual disturbance
- Meningismus

Meningitis

Most common intracranial complication of sinusitis

Symptomatology

- Headache
- Meningismus
- Fever, septic
- Cranial nerve palsies

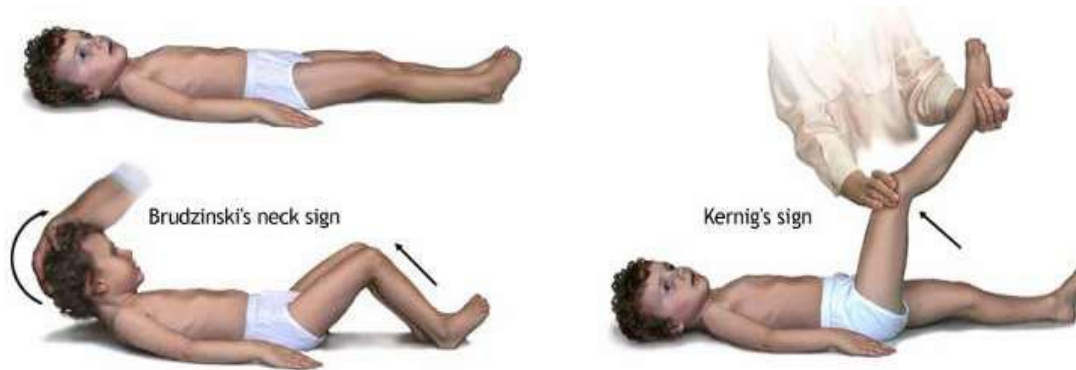
Sinusitis is unusual cause of meningitis

- Sphenoiditis
- Ethmoiditis

Usually amenable with medical treatment.

Drain sinuses if no improvement after 48 hours.

Hearing loss and seizure sequelae.



Pic. 16 Meningeal symptoms

Microbiology

Children

Streptococcus pneumonia
 Staphylococcus aureus
 Other Streptococcus species
 Anaerobes (Bacteroides and
 Fusobacterium species)
 Gram-negative rods

Adults

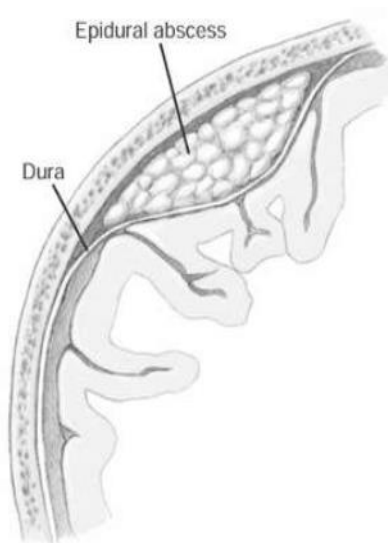
Streptococcus pneumoniae
 Hemophilus influenzae

Epidural Abscess

- Second-most common intracranial complication
- Generally a complication of frontal sinusitis

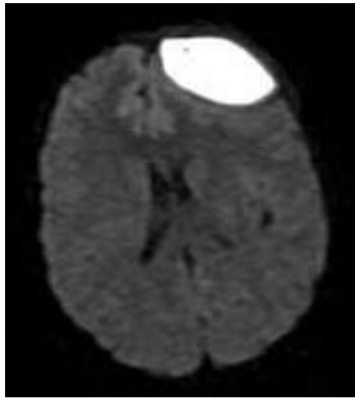
Symptomatology

- Fever
- Headache
- Nausea, vomiting
- Papilledema
- Hemiparesis
- Seizure



Pic. 17 Epidural Abscess

- Crescent-shaped hypodensity on CT.



Pic. 18 CT of epidural abscess

- Lumbar puncture contraindicated
- Prophylactic seizure therapy not necessary

Antibiotics

- Good intracerebral penetration
- Typically for 4-8 weeks

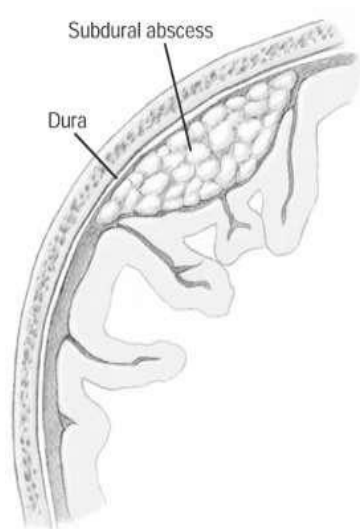
Drain sinuses and abscess

- Frontal sinus trephination
- Frontal sinus cranialization
- Stereotactic-guided drainage

NOTES: Will likely need antibiotics for 4-8 weeks; usually vancomycin and 3rd or 4th generation cephalosporin. Prophylactic seizure therapy not necessary unless there's an associated subdural abscess.

Subdural Abscess

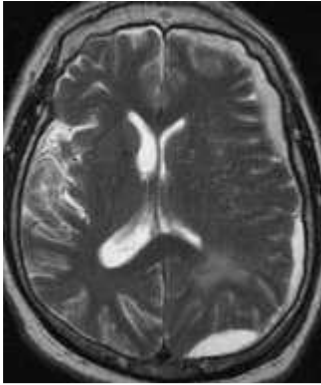
- Generally from frontal or ethmoid sinusitis



Symptomatology

- Headaches
- Fever
- Nausea, vomiting
- Hemiparesis
- Lethargy, coma

Pic. 19 Subdural Abscess



Third-most common intracranial complication, rapid deterioration

- Mortality in 25-35%
 - Residual neurologic sequelae in 35-55%
- Accompanies 10% of epidural abscesses

Pic. 20 Radiology of subdural abscess

Lumbar puncture potentially fatal

Aggressive medical therapy:

- Antibiotics
- Anticonvulsants
- Hyperventilation, mannitol
- Steroids

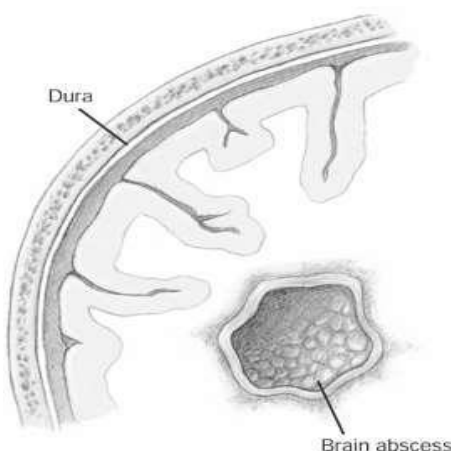
Drain sinuses and abscess:

- Medical therapy possible if < 1.5cm
- Craniotomy or stereotactic burr hole
- Endoscopic or external sinus drainage

NOTES: Need antibiotics with good intracerebral penetration, typically 3-6 weeks. Craniotomy is favored over burr hole placement due to better exposure.

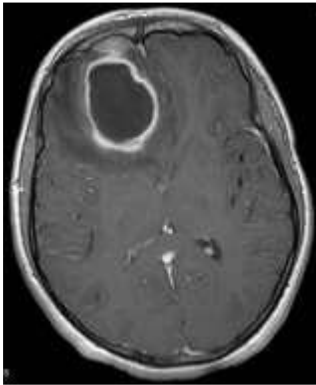
Intracerebral Abscess

- Uncommon, frontal and frontoparietal lobes
- Generally from frontal sinusitis



Pic. 21 Brain abscess

- Sphenoid
 - Ethmoids
- Symptomatology
- Headache
 - Mental status change
 - Focal neurological deficit
 - Fever
 - Mortality 20-30%
 - Nausea, vomiting
 - Papilledema
 - Neurologic sequelae 60%



NOTES: May have mood swings and behavioral changes with frontal lobe involvement. Worsening headache with meningismus suggests possible rupture of the abscess.

Pic. 22 Radiology of brain abscess

- Lumbar puncture potentially fatal

Aggressive medical therapy:

- Antibiotics
- Anticonvulsants
- Hyperventilation, mannitol
- Steroids

Drain sinuses and abscess:

- Medical therapy possible if abscess < 2.5cm
- Excision or aspiration
- Diagnostic aspiration if < 2.5cm or cerebritis
- Stereotactic-guided aspiration
- Endoscopic or external sinus drainage

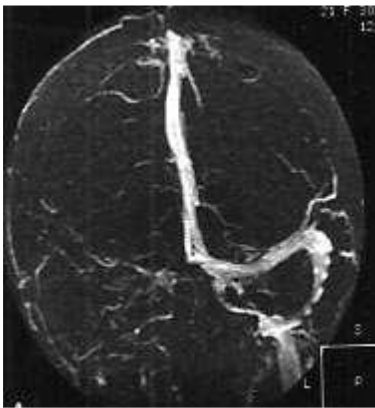
NOTES: Antibiotic regimen is typically 6-8 weeks; typically ceftriaxone, vancomycin and metronidazole.

Corticosteroid use is controversial. Steroids can retard the encapsulation process, increase necrosis, reduce antibiotic penetration into the abscess, increase the risk of ventricular rupture, and alter the appearance on CT scans. Steroid therapy can also produce a rebound effect when discontinued. If used to reduce cerebral edema, therapy should be of short duration. The appropriate dosage, the proper timing, and any effect of steroid therapy on the course of the disease are unknown. The procedures used are aspiration through a bur hole and complete excision after craniotomy. Aspiration is the most common procedure and is often performed using a stereotactic procedure with the guidance of CT scanning or MRI.

Microbiology

- * Anaerobes (anaerobic Streptococcus, Bacteroides, Fusobacterium species)
- * Staphylococcus aureus
- * Other Streptococcus species (Streptococcus milleri)
- * Gram-negative bacilli (Haemophilus influenzae)
- * Staphylococcus epidermidis
- * Eikenella corrodens
- * Polymicrobial

Venous Sinus Thrombosis



Sagittal sinus most common

Retrograde thrombophlebitis from frontal sinusitis

Extremely ill

- Subdural abscess
- Epidural abscess
- Intracerebral abscess

Elevated mortality rate

Pic. 23 Radiology of venous sinus thrombosis

Aggressive medical therapy:

- Antibiotics
- Steroids
- Anticonvulsants

Anticoagulation controversial

- Heparin inpatient, warfarin outpatient
- Thrombus resolution by 6 weeks
- Increased intracranial pressure outweighs bleeding risk

Drain sinuses

- External
- Endoscopic

MCQ

1. Management of rhinogenic cerebral abscess is:
 1. conservative treatment with antibiotics;
 2. drainage of abscess only;
 3. drainage of abscess followed by frontotomy;
 4. radical frontotomy.
2. The walls of the maxillary sinus are sinus is related to:
 1. the floor of the orbit;
 2. the floor of the orbit and the upper posterior teeth;
 3. the floor of the orbit, the upper posterior teeth and the infratemporal fossa;
 4. the floor of the orbit, the upper posterior teeth, the infratemporal fossa and the hard palate.
3. A patient is most likely to experience pain due to infection of the ethmoidal air cells sinus:
 1. at the base of the skull;
 2. on the forehead;
 3. in the cheeks;
 4. between the eyes.
4. Sign, characteristic for a meningitis is:
 1. central tetraparesis;
 2. normal cell count in CSF;
 3. a stiff neck;
 4. inflammation of brain's tissue.
5. What important structure lies laterally on either side of the sphenoid sinus:
 1. sella tursica ;
 2. optic nerve ;
 3. cavernous sinus ;
 4. facial nerve.
6. Lumbar puncture is not fatal in case of ?
 1. brain abscess;
 2. subdural abscess;
 3. epidural abscess;
 4. meningitis.

7. What surgical approach is most preferred in case of subperiosteal abscess?
 1. endoscopic ;
 2. external ethmoidectomy;
 3. no surgical treatment;
 4. combined approach.
8. What is orbit septum?
 1. muscle;
 2. bone;
 3. fascia;
 4. mucous.
9. Into how many stages orbital complications have been categorized by Chandler?
 1. 2;
 2. 3;
 3. 5;
 4. 4.
10. Where does the sphenoid sinus drain?
 1. inferior nasal meatus;
 2. common nasal meatus;
 3. superior nasal meatus;
 4. middle nasal meatus.
11. What is the most common site for brain abscess in case of sinusitis (frontitis)?
 1. cerebellum;
 2. parietal lobe;
 3. frontal lobe;
 4. temporal lobe.
12. Choose the indications for lumbar puncture?
 1. meningitis;
 2. brain abscess;
 3. epidural abscess;
 4. subdural abscess.

13. The commonest cause of unilateral exophthalmos is:
1. thyroid eye disease;
 2. lacrimal gland tumour;
 3. orbital cellulitis;
 4. cavernous sinus thrombosis.
14. Ophthalmoplegia ?
1. cranial nerves II, III, IV, V, and VI are involved;
 2. cranial nerves III, IV, V, and VI are involved;
 3. cranial nerves II, III, V, and VI are involved;
 4. cranial nerves II, III, IV, V are involved.
15. The orbit is separated from the ethmoid cells and maxillary sinus by thin bony plates called?
1. the lamina papyracea;
 2. the lamina horizontalis;
 3. the lamina perpendicularis;
 4. lacrimal lamina.

Responses for MCQ

1. 3;
2. 3;
3. 4;
4. 3;
5. 3;
6. 4;
7. 2;
8. 3;
9. 3;
10. 3;
11. 3;
12. 1;
13. 4;
14. 1;
15. 1.

Literature and Internet Resources

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Contents

Introduction:	5
Maxillary Sinus: Anatomy	6
Ethmoid Sinus: Anatomy	7
Frontal sinus: Anatomy	8
Sphenoid Sinus: Anatomy	9
Orbital complications	10
Preseptal cellulites	11
Orbital Cellulitis	12
Subperiosteal Abscess	13
Orbital Abscess	14
Cavernous Sinus Thrombosis	15
Intracranial complications	16
Meningitis	17
Epidural Abscess	18
Subdural Abscess	19
Intracerebral Abscess	20
Venous Sinus Thrombosis	22
MCQ	23
Responses for MCQ	26
Literature and Internet Resources	27
Contents	28