CT imaging in complications of sinusitis

Poster No.: C-0572
Congress: ECR 2018
Type: Educational Exhibit
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Keywords: eHealth, Emergency, Neuroradiology brain, CT, Diagnostic procedure, Infection, Inflammation, Acute
DOI: 10.1594/ecr2018/C-0572

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Learning objectives

The complications of sinusitis are an uncommon but extremely serious circumstance due to the importance of the anatomical structures that surround the paranasal sinuses: orbit, calotte and cranial cavity.

Therefore, a review of these complications and their clinical manifestations will be made as well as the findings visualized in CT.
Background

Complications of sinusitis at the orbital, bone and endocranial level are an infrequent circumstance, but of extreme severity.

CT with intravenous contrast of paranasal sinuses and orbits is of choice when the presence of complications is suspected.

ANATOMY OF PARANASAL SINUSES AND ORBITAL CAVITY.

The paranasal sinuses (Fig. 1, Fig. 2, Fig. 3) are air cavities that are in communication with the nostril and located in the surrounding bones. The mucosa that covers them is continued with that of the nostril through the drainage holes of the sinuses in the nasal cavity. There are eight: frontal, sphenoidal, maxilla and ethmoidal cells. There is a great anatomical variability between individuals and even in oneself with respect to the contralateral one.

The frontal sinuses are located in the thickness of the frontal bone, behind the superciliary arches, between the external and internal tables and above the anterior part of the roof of the nostrils. Both sinuses are separated by a septum that is generally deviated to the side; it is common to see incomplete partitions inside.

The size is extraordinarily variable. They can be small or invade large areas of the frontal. Drain the medium through the infundibulum.

The ethmoidal sinuses (ethmoidal cells) are a set of labyrinth cavities of the lateral masses of the ethmoid, complemented by the bordering bones (frontal, maxilla, lacrimal, sphenoid and palatal). They are arranged in the upper portion of the outer wall of the nostrils, inside the orbit and below the anterior cranial fossa. The number of cells is very variable; generally 7-9. It is classic to describe three groups of cells: anterior, middle and posterior. The anterior and middle ethmoidal cells drain into the middle meatus; the posterior ethmoidal cells drain into the superior meatus.

The sphenoid sinuses are found in the thickness of the sphenoid body, on the back of the roof of the nostrils. A septum, usually complete and diverted to the side, separates both sinuses. Drain in the sphenoethmoidal recess, behind the superior turbinate. We must remember that above is the Turkish chair, which houses the pituitary gland and the optic chiasm; and to the sides, is the cavernous sinus and the internal carotid artery.
The maxillary sinuses are located inside the body of the maxilas bone, on the sides of the nostrils and below the orbit. They are large cavities, of pyramidal form, whose base forms part of the external wall of the nostrils; the vertex reaches the zygomatic process; the roof constitutes the floor of the orbit, and the floor corresponds to the alveolar process. The sinus drains in the middle hiatus, at the level of the semilunar hiatus. The floor of the sinus descends approximately 1 cm below the bony palate, and in addition, the opening of the mouth of the maxillary sinus is located well above it, which makes it difficult to drain the secretions accumulated in the interior.

The orbits, are two broad cavities located between the bones of the skull and face. It has a quadrangular pyramid shape composed of four walls, a vertex in the bottom and the base open to the surface.

Upper wall or orbital roof is formed by the orbital lamina of the frontal and in the posterior area and by the inferior side of the lower wings of the sphenoid. In the anteroexternal angle, the lacrimal fossa is dug for the gland itself. In the antero-internal angle, there is a small depression, the trochlear fossa, where the reflection pulley is inserted into the superior oblique muscle.

Lateral wall is formed at the posterior level by the orbital aspect of the greater wing of the sphenoid and anterior, by the orbitary face of the frontal process of the zygomatic bone. It is separated from the orbital roof by the superior orbital fissure, which gives way to the middle cranial fossa. Similarly, it is separated from the orbital floor by the inferior orbital fissure (spheno-maxillary cleft) that connects the orbit with the infratemporal and pterygopalatine fossae.

Inferior wall or orbital floor is formed mainly by the orbital face of the maxillary bone, which is completed anterolaterally with the frontal process of the zygomatic and at the posteromedial level by the orbital process of the palatine bone. This wall is intimately related to the maxillary sinus. The sulcus and infraorbital duct are observed in it.

Medial wall is formed from anterior to posterior by the frontal process of the maxilla, the lacrimal bone, the lamina papyrace of the ethmoid, and part of the lateral aspect of the sphenoid body. In the anterior part, the lachrymal canal is located, located between the lacrimal and the frontal apophysis of the maxilla.

Base of the orbit is the anterior opening, whose contour is limited by the orbital rim, in which the frontal bone, zygomatic and maxilla participate.
Orbital cavity contains the lacrimal gland, the ocular globe, the extrinsic musculature, the optic nerve and the orbital vascularization.

**Ocular globe** constitutes the peripheral organ of vision. It is cushioned by orbital fat and separated from it by a thin aponeurotic capsule called Tenon's capsule. The eye is formed by two segments of sphere of different size. The anterior segment, smaller and more prominent, extends between the cornea and the lens and is divided into anterior and posterior chamber by the iris, communicating through the pupil. The posterior segment, constitutes most of the ocular volume and contains the vitreous humor.

The **intraconal space** (Fig. 4, Fig. 5) is the space between the Tenon's capsule and the extrinsic ocular musculature. It contains the orbital and canalicular portion of the optic nerve, the intraorbital nerve branches (III, IV, VI and first branch of V cranial nerve), as well as the ophthalmic arteries and veins and the intraconal fat.

The extraocular musculature is composed of the superior, inferior, external and internal rectus muscles and the inferior and superior oblique muscles and levator palpebrae muscle.

The **extraconal space** (Fig. 4, Fig. 5) is the space between the external portion of the extrinsic muscles and the bony walls of the orbit. Contains the lacrimal apparatus and extraconal fat. Its anterior limit is the orbital septum, which is a thin layer of fibrous tissue that originates from the orbital rim and is directed towards the orbital globe and constitutes the barrier that separates intraorbital structures, preventing the spread of infections.
Images for this section:

Fig. 1: Sinus frontal

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Fig. 2: Anatomy

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Fig. 3: Anatomy

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**Fig. 4:** Extraconal and intraconal space

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**Fig. 5:** Extraconal and intraconal space

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Findings and procedure details

In this section, it will be reviewed by location of the different complications.

ORBIT COMPLICATIONS

The orbit is the structure most commonly affected by extension of rhinosinusitis (approximately 3% of rhinosinusitis). The most common origin is from the ethmoidal sinus.

Children are more likely to develop orbital complications secondary to rhinosinusitis.

In general, the bacteria involved in the pathogenesis are the same that cause rhinosinusitis: *S. pneumoniae, H. influenzae, M. catharralis, S. pyogenes*. *S. aureus* is most often seen in chronic infections in the older child.

The extent of involvement can be direct, via hematogenous or via lymphatic (rare). The extension by direct route is facilitated by the morphology of the orbital walls and the lamina papyracea, which are particularly thin and can present bone dehiscence.

Knowing the signs and symptoms that these patients present may condition different clinical management. Thus, it is important to assess whether there is a postseptal commitment assessing the presence of clinical signs such as the limitation of ocular motility, visual impairment or exophthalmos.

The vision must be evaluated in all patients. Careful observation should be maintained throughout the treatment of visual acuity, ocular motility and febrile curve.

To specify it, it is necessary to perform CT with contrast, especially if the suspicion is of retroseptal compromise.

The different orbital complications that we are going to assess are preseptal cellulitis, orbital cellulitis, subperiosteal abscess and orbital abscess.

1. Preseptal cellulitis:
   
   • It presents as edema and erythema that affects the eyelids without retroseptal commitment. There are no alterations in vision or ocular motility.
• Early treatment should be performed, since the orbital septum is a poor barrier to prevent extension.
• CT would be useful to rule out retroseptal involvement, but the diagnosis is fundamentally clinical.
• Treatment: outpatient basis with antibiotics. In very young children --> hospitalize.

2. Orbital cellulitis:
• It is a diffuse infection of the intraorbital tissues at the retroseptal level.
• It produces chemosis, proptosis and alterations in extraocular motility.
• Visual disturbances occur when the infection progresses.
• CT: involvement of the intraorbital fat with or without involvement of other structures will be visualized.
• Treatment: Hospitalization and intravenous antibiotics.

3. Subperiosteal abscess:
• Origin: ethmoidal sinusitis.
• Abscess between the lamina papyracea of the ethmoid and the medial orbital periosseum.
• It can manifest with inferolateral displacement of the ocular globe, suffering the patient diplopia.
• CT: collection of the abscess that displaces the orbital content without actually infiltrating it.
• Treatment: intravenous antibiotics and early abscess drainage.

4. Orbital abscess:
• A purulent collection occurs around the eyeball secondary to infection of the orbital fat.
• There is proptosis, chemosis and ophthalmoplegia.
• It can associate visual acuity decrease, including involvement of the optic nerve.
• The diagnosis will be made by means of CT with iv contrast.
• Treatment: intravenous antibiotics, corticosteroids and nasal vasoconstrictors. Surgical is urgent and can be by endoscopic or external drainage.

**BONE COMPLICATIONS:**

The appearance of osteomyelitis as a complication of an acute or chronic sinusitis is due to a process of septic thrombophlebitis of the veins of the diploe or the Haversian system.
The most frequent affectation is frontal osteomyelitis. Clinically there is fever and sometimes confusional state.

The diagnosis will be given by the clinic and the CT. CT demarcates the extension of the lesion, but can show the changes late.

Treatment: prolonged antibiotic therapy and drainage with elimination of areas of bone necrosis.

**INTRACRANIAL COMPLICATIONS**

It occurs in about 4% of patients hospitalized with rhinosinusitis. Its extension occurs through the diploic veins that lack a valvular system, through the facial veins, congenital dehiscence, extension through the paranasal sinus walls, sites of trauma and bone foramina.

1. Meningitis
   - the most common intracranial complication.
   - origin is usually due to ethmoidal and sphenoidal infection.
   - It is important to suspect it because of the importance of its early treatment.
   - The diagnosis is made by the clinic, by lumbar puncture and by CT.
   - Treatment: High doses of parenteral antibiotics and sometimes drainage surgery of the paranasal cavities.

2. Extradural abscess
   - the second most frequent intracranial complication.
   - more frequently by frontal sinusitis, producing an abscess between the dural and the bone table of the skull.
   - frontal headache is usually.
   - The diagnosis is made using contrast-enhanced CT where we will visualize a hypodense collection with peripheral enhancement and biconvex morphology, usually located at the frontal level and frequently associated osteomyelitis of the adjacent bone.
   - Treatment: intravenous antibiotherapy and surgical drainage.

3. Subdural abscess
   - infrequent.
   - It is located between dural layer and the arachnoid space.
   - Worse prognosis than epidural abscess.
• It usually occurs one or two weeks after an episode of sinusitis, by dissemination of the infection by thrombophlebitis of the venous sinuses or by direct extension through the bone and dura, as a result of erosion of the posterior wall of the sinus frontal.
• It often presents with meningeal signs sometimes accompanied by neurological symptoms.
• The diagnosis is made with contrast-enhanced CT where a hypodense collection with peripheral enhancement at the level of the hemispheric convexity or at the level of the cerebral sickle will be visualized.
• Treatment: intravenous antibiotics and urgent neurosurgical drainage.

4. Brain abscess

• Infrequent.
• Focal suppurative process within the cerebral parenchyma.
• It usually occurs by extension of a thrombophlebitis from an ethmoidal focus.
• Frontal lobe is the most commonly affected.
• Symptoms include severe headache and altered behavior. It may associate increased intracranial pressure.
• The diagnosis is made with CT with contrast where we will determine the size, location and evolutionary phase (cerebritis phase or encapsulated abscess). In the encapsulated abscess phase we will visualize a predominantly hypodense intraparenchymal intraaxial collection with peripheral enhancement and perilesional edema. We must assess the effect of mass that produces with or without deviation of the midline and the presence of secondary hydrocephalus.
• Treatment: early initiation of antibiotic therapy and assessing individually the need for surgical treatment.

5. Septic intracranial thrombophlebitis:

• Infection of the cerebral venous system secondary to an infection whose origin is usually located in the paranasal sinuses, the middle ear, the mastoid cells, the face or the oropharynx.
• It can be located in the draining cortical veins or in the dural venous sinuses. If it is localized in the cortical veins, it can be oligosymptomatic if the collateral venous system works properly but if it is affected, it usually manifests with involvement of the consciousness, seizures and intracranial hypertension symptoms.
• The cavernous sinus, the transverse sinus and the longitudinal sinus are the most frequently affected. In the complications of sinusitis, the venous sinus that is most affected is the cavernous sinus.
• Its characteristic clinical presentation includes headache, fever and periorbital edema. It can be accompanied by the cranial nerves that pass through the sinus (III, IV, V and VI) causing ophthalmoplegia, fixed pupil in the middle position, loss of corneal reflex and hypoesthesia facial.
- MRI is the diagnostic procedure of choice, but sometimes it is not available for urgent study and a CT scan can be performed, although it is less sensitive, it allows its diagnosis in many occasions.
- Treatment: Early and adequate antibiotic and control of neurological complications. The anticoagulant treatment with heparin is controversial.

In this section, it will be review some cases of nasosinusal complications diagnosed in our Hospital.

I. (Fig. 6) (Fig. 7) (Fig. 8) (Fig. 9)

A 38-year-old man presented with superior parapebral swelling, headache, greenish rhinorrhea of months of evolution and diplopia for 4-5 days. In the ophthalmological examination, limitation was observed to upper ocular motility and evident ocular protrusion with signs of cellulitis.

Upon suspicion of intraorbital involvement, the ophthalmologist requests a CT scan of orbits with iv contrast, which showed the existence of right maxillary and right ethmoidal sinusitis and bilateral frontal complicated at right frontal level with bone erosion (osteomyelitis) and extension of the infectious process to both the anterior cranial fossa and the right extraconal intraorbital space, appreciating a large frontal abscess with Intraorbital, sinus and epidural component that causes proptosis and inferior displacement of the orbital globe. Abscess component was also associated with the right palpebral preseptal level.

II. (Fig. 10) (Fig. 11)

A 78-year-old woman with left orbital headache and inflammation in the left periorbital skin. On examination, it presents orbital edema, isochoric and reactive pupils and preserved ocular mobility, but painful.

A CT of orbits and paranasal sinuses with IV contrast is performed, where an intraorbital abscess of superior extraconal location is visualized, with preseptal component and peripheral enhancement by contrast. This abscess causes imprinting and inferior displacement of the superior rectus and superior oblique muscles, as well as anterior-inferior displacement of the ocular globe. It was associated with left maxillary, frontal and ethmoidal sinusitis, origin of the orbital abscess.

III. (Fig. 12) (Fig. 13) (Fig. 14) (Fig. 15) (Fig. 16) (Fig. 17)
A 40-year-old man with left otalgia, rhinorrhea and headache of two days of evolution and low-grade fever.

First, CT brain without contrast was performed due to suspicion of meningitis, a hypodense subdural collection frontoparietotemporal left is seen, which associates generalized cerebral edema of left predominance, collapse of the left lateral ventricle and subfalcination herniation. The extraaxial collection shows isolated pneumocephalus bubbles. It is also observed almost complete occupation of frontal and sphenoid sinuses, and ethmoidal cells, as well as mucous thickening of maxillary sinuses, in relation to pansinusitis. After administration of the contrast iv. the subdural collection does not show peripheral enhancement, but there is evidence of a parietal leptomeningeal giral enhancement.

All these findings are compatible with meningoencephalitis and right subdural empyema, secondary to complicated sinusitis.

IV. (Fig. 18) (Fig. 19) (Fig. 20) (Fig. 21)

A 48-year-old woman, low level of consciousness, headache and fever in previous days. In the exploration it presents arreactive and anisocoric pupils. Leukocytosis with neutrophilia and elevation of procalcitonin. CT brain is requested with the suspicion of meningitis, where it is observed poor corticosubcortical differentiation at right parietal level in relation to meningoencephalitis confirmed by MRI and lumbar puncture and occupation by secretions of maxillary, frontal, sphenoid sinuses, ethmoidal cells and nasal passages in relation to pansinusitis.
Fig. 6: Frontal sinusitis

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Fig. 7: Large frontal abscess with Intraorbital, sinus and epidural component.

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Fig. 8: Large frontal abscess with Intraorbital, sinus and epidural component.

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**Fig. 9:** Right maxillary sinusitis and preseptal edema.

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Fig. 10: Intraorbital abscess of superior extraconal location is visualized, with preseptal component and peripheral enhancement.

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**Fig. 11:** Intraorbital abscess of superior extraconal location is visualized, with preseptal component and peripheral enhancement.

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**Fig. 12:** Pneumocephalus and frontal sinusitis.

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Fig. 13: Pneumocephalus and frontal sinusitis.

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Fig. 14: Sphenoid and ethmoid sinusitis.

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Fig. 15: Subdural abscess with mass effect.

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**Fig. 16:** CT with contrast: Subdural abscess without enhancement, with mass effect.

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Fig. 17: Same case, subfalcinal herniation.

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Fig. 18: CT without contrast iv. visualization of grooves and poor corticosubcortical differentiation at right parietal level in relation to meningoencephalitis confirmed by MRI and lumbar puncture and occupation by secretions of maxillary, frontal, sphenoid sinuses, ethmoidal cells and nasal passages in relation to pansinusitis.

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Fig. 19: In the brain CT without contrast visualization of grooves and poor corticosubcortical differentiation at right parietal level in relation to meningoencephalitis confirmed by MRI and lumbar puncture and occupation by secretions of maxillary, frontal, sphenoid sinuses, ethmoidal cells and nasal passages in relation to pansinusitis.

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Fig. 20: In the brain CT without contrast visualization of grooves and poor corticosubcortical differentiation at right parietal level in relation to meningoencephalitis confirmed by MRI and lumbar puncture and occupation by secretions of maxillary, frontal, sphenoid sinuses, ethmoidal cells and nasal passages in relation to pansinusitis.

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**Fig. 21:** Occupation by secretions of maxillary, frontal, sphenoid sinuses, ethmoidal cells and nasal passages in relation to pansinusitis.

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Conclusion

Knowing the clinical presentation of the different complications of sinusitis in order to make an early diagnosis and establish an adequate treatment.

Paranasal sinus CT with contrast is the main tool for the first diagnostic approach of these pathologies, and may be completed, if necessary, with other techniques in a programmed manner.
References


