Better understand the anatomy of orbits by multi-slice imaging

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Learning objectives

Through some illustrations, the aim of this educational exhibit is to:

1) To illustrate the different components of the orbits and the spaces they define.

2) To learn to recognize them in multi-slice imaging.

3) To show main pathological findings.

Background

The orbit is located within a bone cone and includes muscle structures, oculomotor muscles, the optic nerve, the ophthalmic artery and its branches, the upper and lower ophthalmic veins, lacrimal gland, eyeball, the orbital septum and fat. The bony pyramid consists of top, bottom, lateral, and medial. It communicates with the anterior cranial fossa through the optic canal, crossing the optic nerve, with the middle cranial fossa through the superior orbital fissure and with the pterygopalatine fossa through the inferior orbital fissure. In its interior, the upper and lower lacrimal canaliculi will continue with the nasolacrimal duct, thus communicating the orbit with the inferior meatus.

I- General

The orbit is a bone cavity in the upper part of the solid facial

#The two orbital cavities separated by the nasal cavity, and containing protect the eyeball and its annexes # Each orbit is constituted by a set of juxtaposed bone forming cavity lined with a fibrous membrane: the periorbital # The orbit has many holes making contact neighboring regions # The orbit has the shape of a quadrangular pyramid open forward, it has four walls joined by four corners or edges, a base and a top.

1) Location:

• A the top of the facial bones.

• Zones junction between the face and the skull bone.

• Séparées one another by the nasal cavity.
2) Shapes:

Pyramide quadrangular : Wide anterior :Base / Narrow posterior :Sommet

3) Measurements and orientations:

- Orbital cavity is open in front and beyond.

- Major axis forms with the visual axis, anteroposterior, an angle of 23 degree on average. (Fig 1)

- Average depth of the orbit : 45 mm.

II-Walls of the orbit:

1. The upper wall: (Fig 2)

- It is formed from front to back:
  • Orbital pit of frontal bone (1)
  • Bottom face of the small wing of the sphenoid (2)

- In the anterior part:
  * Tear pit (lachrymal gland which is located).
  * Trochlear dimple (upper oblique muscle trochlea).

- Reports:
  • Anterior floor of the skull base
  • Frontal sinus (most prominent) . 1.

2. The lateral wall: (Fig 3)

- The more solid wall of the orbit.

- It consists of Three bones:
  • The frontal bone at the top (1)
  • The zygomatic bone (2) low
• The greater wing of sphenoid back (3)

3. The lower wall: (Fig 4)

Or floor of the orbit: it exists only in anterior two-thirds of the orbit.

It consists of three bones:

• The zygomatic bone (1) forward and outside
• The maxillar bone forward and inward (2)
• Orbital process of the palatine on the back (3)

• It is traversed in its posterior part by an infraorbital gutter or groove (4) which pass the infraorbital nerve

• This wall is very fragile easily prone to fractures in the orbital trauma

4. The medial wall: (Fig 5)

It is formed by four bones

• the ascending branch (1) of the jawbone
• lacrymal bone (2)
• the planum bone (3)
• the sphenoid bone (4)

III- Holes of the orbit:

1. optic canal: (Fig 7):

The optic canal is a rounded canal, located in the lesser wing of sphenoid near the base where it joins the body of sphenoid. It transmits the optic nerve and ophthalmic artery.

Bony canal communicating the orbit and anterior skull base fossa.

Bounded by: (Fig 7)

• Lateral side of the body of the sphenoid
• Two roots of the small wing of the sphenoid (top and bottom).
• Anterior clinoid process (posterolateral wall)

Orifices:
• Posterior hole opens in the anterior fossa of the skull base
• Anterior hole: orbital located above the superior orbital fissure.

2. Superior orbital fissure: (Fig6/8)

Lies between the lesser and the greater wing of sphenoid. Comma-shaped lower inner part wide and a tapered upper outer extremity. Located outside and below the optical channel. Communicates orbit with the average fossa of the skull base, and is the anterior wall of the cavernous sinus. This fissure allows the passage to the nerves III, IV, VI, branches of the V(1) and ophthalmic veins.

The superior orbital fissure is the communication between the cavernous sinus and the apex of the orbit. It is straddled by the tendinous ring which is the common origin of the four rectus muscles (extraocular muscles).

3. Inferior orbital fissure: (Fig9)

Or spheno-maxillary fissure: directed obliquely forward and out. It connects the orbit to the pterygopalatine fossa. Lies between the greater wing of sphenoid, the orbital process of the maxillary bone, and, laterally, the zygomatic bone. This fissure allows the passage of branches of the V(2) as well as ophthalmic veins.

4. Nasolacrimal canal: (Fig10)

Located down and inwards; it opens at the bottom of the pit of the lacrimal sac. Limits: The upper edge of the maxilla. The lower part of the posterior lacrimal crest. It gives rise to the nasolacrimal duct that opens into the nasal cavity at the lower meatus.

III-Contents:

1. EYE (Fig11):

The globe is divided into two compartments by the lens

• anterior segment itself divided by the iris into two parts:
The anterior chamber between the cornea and the iris: average depth of 3.25 mm

The posterior chamber between the iris and the lens

• posterior segment represented by the vitreous cavity, constituting the bulk of the orbital contents

2. ORBITAL SEPTUM (Fig12)

The orbital septum is a thin sheet of fibrous tissue that originates in the orbital periosteum and inserts in the palpebral tissues along the tarsal plates. The orbital septum provides a barrier against the spread of periorbital infections into the orbit proper.

3. ORBITAL FAT

It fills the entire intra-orbital space outside of the eyeball, muscles, blood vessels and nerves. Basically, this fat is split by the musculoaponeurotic cone. Intraconal fat

Extra conical fat

4. LACRIMAL GLAND (Fig13)

The lacrimal gland lies in the superolateral aspect of the orbit and is responsible for tear production.

The lacrimal gland is roughly almond-sized, lies in the extraconal part of the orbit, and extends deep into the orbital septum. Its structure is similar to the salivary glands but it is unique in that it is composed of both epithelial and lymphoid tissue.

5. OPTIC NERVE:(Fig 14)

The optic nerve is the second cranial nerve is really an extension of the central nervous system, not surrounded by Schwann cells with first sensory bipolar cell body located peripherally in the retina.

The optic nerve is divided into four segments:

the intraocular segment

the intraorbital segment which passes posteriorly and centrally within the orbit and surrounded by dural covering and CSF; hence it is directly communicated with the
subarachnoid space (hydrocephalusà papillooedema) Additionally the dural covering can develop a meningioma

**The intracanalicual segment** where the optic nerve exits through the tendinous ring and optic canal inferior to the opthalmic artery and enters the middle cranial fossa as the **intracranial or cisternal** segment

6. THE EXTRAOCULAR MUSCLE : (Fig 15)

The **extraocular muscles** are the six muscles that control eye movements:

- Superior rectus - elevation
- superior oblique - intorsion
- Medial rectus - adduction
- Lateral rectus - abduction
- Inferior oblique - extorsion
- Inferior rectus - depression

7. OPHTHALMIC ARTERY: (Fig 16)

**Origin:**

OA rises medial to the anterior clinoid process as the internal carotid artery exits the cavernous sinus. It originates from the antero- or supero-medial surface of the ICA

**Course:**

OA passes into the orbit via the optic canal

It has numerous branches which are often grouped into those that supply the orbital content and those that supply the globe and related structures.

8. OPHTHALMIC VEIN:

Superior ophtalmic vein
Inferior ophthalic vein

IV-Multi-slice radioanatomy orbit:

CT
+ most versatile
+ bony detail or calcifications
+ temporal / spatial resolution
- radiation-induced cataracts
- beam hardening artifacts from dental fillings

MRI:
+ better for optic nerve and tumors
+ no radiation
- poor temporal resolution
- must screen for metallic foreign bodies in orbit before MRI

1. OPTIC CANAL: (Fig17)

CT +++
The best cuts offer a better analysis of the optical channel (OC) are:
Axial
Coronal perpendicular to the axis of ON (optical nerve)
Sagittal cuts parallel to the axis of ON

2. SUPERIOR ORBITAL FISSURE (Fig18):

Study methods:
CT +++
Axial and coronal cuts +++.
Normal Appearance:

CT: solution of continuity of the orbital apex bone, located outside the optical channel, with a isodense tissue content (neurovascular bundle)

MRI: solution of continuity of fat content (high intense T1 relative to gray matter)

3. INFERIOR ORBITAL FISSURE (Fig 30/31)

Or sphen- maxillary fissure: directed obliquely forward and out. It connects the orbit to the pterygopalatine fossa

Lies between the greater wing of sphenoid, the orbital process of the maxillary bone, and laterally, the zygomatic bone.

This fissure allows the passage of branches of the V (2) as well as ophthalmic veins.

4. NASOLACRIMAL CANAL (Fig32)

Located down and inwards; it opens at the bottom of the pit of the lacrimal sac

Limits: The upper edge of the maxilla The lower part of the posterior lacrimal crest.

It gives rise to the nasolacrimal duct that opens into the nasal cavity at the lower meatus.

5. EYE (Fig33/34):

Location: Anterior part of the orbit.

Bicanthal line: junction between the anterior two-thirds and one-third after

Closer to the sidewall than the medial wall of the orbit.

6. LACRIMAL GLAND

CT:

Study of lesions compared to orbital walls

calcification Research.

MRI: Morphological analysis of the gland.
• T1 sequence: appreciates relations with extraocular muscles.
• sequence with fat suppression: a cystic component associated research.
• sequence with gadolinium injection: appreciate the limits of the tumor.

V-Pathology of the orbit:

1. Traumatic:

Fractures (Fig 19/20/21)
Anterior chamber injury/hyphaema
Lens subluxation and dislocation/Globe trauma/rupture/Ocular detachments/Intra-orbital haemorrhage / Penetrating injuries and foreign bodies Optic nerve injury...

2. Vascular:

Hemangioma (Fig23/24)
Vascular malformations (Fig22)

3. Neoplastic:

Lymphoma (Fig25)
Meningioma (Fig26)
Dermoid
Metastases

4. Inflammation/Infection:

Orbital pseudotumor (Fig 27)
Thyroid ophthalmopathy (Fig29)
Sarcoid
Orbital cellulitis/Abscess (Fig28)

Images for this section:
**Fig. 1:** The orbit is open forward and out. Its long axis the visual axis, strictly antero-posterior an angle 23 degrees on average.
Fig. 2: 1: Orbital pit of frontal bone 2: Bottom face of the small wing of the sphenoid
**Fig. 3:** (1) The frontal bone at the top (2) The zygomatic bone low (3) The greater wing of sphenoid back
Fig. 4: 1) zygomatic bone 2) maxillary bone 3) Orbital process of the palatine 4) infra orbital foramen
Fig. 5: 1) the ascending branch of the jawbone 2) lacrimal bone 3) planum bone 4) sphenoid bone
Fig. 6: --> superior orbital fissure
Fig. 7: --> optic canal
Fig. 8: --> superior orbital fissure
Fig. 9: This image of the right orbit shows superficial landmarks, optic canal, and superior and inferior orbital fissures.
Fig. 10: lacrimal gland
Fig. 11: EYE
Fig. 12: ORBITAL SEPTUM
Fig. 13: lacrimal gland
**Fig. 14:** optic nerve

**Fig. 15:** extraocular muscles
Fig. 17: OPTIC NERVE OPTIC CANAL

Fig. 18: SUPERIOR ORBITAL FISSURE
Fig. 31: inferior orbital fissure
Fig. 30: Inferior orbital fissure
Fig. 19: Blow fracture

Fig. 20
Boy, 9 years old, punch of a horse hoof at the right orbit.
CT coronal and sagittal cut: Fracture overlap of the inferior wall of right orbit with oedema of the inferior rectus.
**Fig. 22:** Carotico-cavernous fistulas

CT axial orbital cut shows:
- **Proptosis**
- **Enlarged superior ophthalmic veins**
- **Extra ocular muscles may be enlarged**
- **Orbital oedema**
**Fig. 23:** Hemangioma

**Fig. 24:** Hemangioma
**Fig. 25:** Signal characteristics include: T1: iso to hypointense to muscle T2: iso to hyperintense to muscle T1 C+ (Gd): homogeneous enhancement DWI: increased signal intensity-restricted diffusion ADC: reduced values-restricted diffusion
**Fig. 26:** spheno orbital meningioma

**Fig. 27:** Orbital pseudo-tumor Orbital pseudotumour: is an idiopathic inflammatory condition that usually involves the extraocular muscles although, in some cases there is inflammatory change involving the uvea, sclera, lacrimal gland and retrobulbar soft tissues. The condition has been associated with many wider inflammatory and autoimmune conditions including: sarcoids, LES, Wegner

**Fig. 28:** orbital cellulitis /abscess
**Fig. 29:** Thyroid ophtalmopathy

**Fig. 32:** Nasolacrimal Canl
Fig. 33: EYE Bicanthal line: junction between the anterior two-thirds and one-third after

Fig. 34: EYE: T2 MRI axial cut
Findings and procedure details

The two methods of clinical orbital imaging are CT and MRI. CT and MRI however have different strengths and weaknesses in orbital imaging. Multidetector CT is now available to study bony detail, to visualize calcification and metallic foreign bodies and provides a good spatial resolution. MRI has advantages over CT in its superior soft tissue contrast, its ability to image the orbit and intracranial structures free of beam hardening artifacts from the skull base. Use of gadolinium contrast enhancement and fat suppression aids in disease detection and characterization.

Multidetector CT is used for the first-line for traumatic and infectious disease.

CT is the imaging modality of choice in orbital trauma, particularly in the emergency setting. Thin-section axial datasets are acquired from dedicated protocols or retrospective reconstructions can be rendered from the volume CT head dataset. Thicknesses of 0.625-1.25mm are optimal. At our institution, the CT head study is performed as part of a standardised traumogram incorporating a non-contrast CT head volume-acquisition CT examination is performed processes with intravenous contrast to search for abeces or tissue processes.

MPR reconstruction is very useful for a better analysis of bones fractures or extraocular muscles diseases.

1.5 tesla MRI is used to perfor exams. Protocol included systematically a sagittal T1 and coronal T2 spin completed according the results by 3D T1 post gadolinium injection.

Conclusion

A good knowledge of the anatomy of the orbit’s necessary as it represents a crossroads located within a bone cone containing muscles, nerve, artery, veins, eye and providing communication to the endocranium and facial bones via foramina and canals.

CT and MRI occupy a large place in the exploration of the orbital pathology.

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