The Orbit
Introduction

• The **orbital cavity** is the protective bony socket for the globe with the optic nerve, ocular muscles, nerves, blood vessels, and lacrimal gland. These structures are surrounded by **orbital fatty tissue**. The orbital cavity is shaped like a pyramid whose base opens to the face and apex opens towards the back.

• The six ocular muscles originate at the apex of the funnel around the optic nerve and insert into the globe. The globe moves within the orbital cavity as in a joint socket.

• In the adult human, the volume of the orbit is 30 ml, of which the eye occupies 6.5 ml.
• **The orbit functions to protect, support, and maximize function of the eye**

• The orbit holds the eye in the correct position.

• **The orbit also protects the eye because the bones surrounding the eye “stick out” further than the eye, objects tend to hit the orbit and not the eye.**

• **Transmission of nerves and blood vessels.**
Contents of the Orbit

1. Eyeball
2. Orbital Septum
3. Extraocular Muscles
4. Nerves (C.N II, III, IV, V, VI)
5. Blood Vessels
6. Extraocular Fat
7. Lacrimal gland, Lacrimal sac, Nasolacrimal duct
8. Eyelids
9. Ligaments
10. Conjunctiva
11. Trochlea
12. Ciliary ganglion
Orbital Bony Socket

→ Bony socket: This consists of seven bones:

• Frontal.
• Ethmoid.
• Lacrimal.
• Sphenoid.
• Maxillary.
• Palatine.
• Zygomatic.

• The bony rim of the orbital cavity forms a strong ring. Its other bony surfaces include very thin plates of bone.
Orbital Bony Socket – The Base

The base of the funnel, which opens in the face, has four borders which consist of the following bones:

- Superior margin: frontal bone
- Inferior margin: maxilla and zygomatic
- Medial margin: frontal, lacrimal and maxilla
- Lateral margin: zygomatic and frontal

- The apex lies near the medial end of superior orbital fissure and contains the optic canal which communicates with middle cranial fossa.
Orbital Bony Socket – The Apex

- The Apex (Posterior area) of the socket consists of:

1. The Roof: formed by the frontal and sphenoid (lesser wing).

2. The Floor: maxilla, Zygomatic & palatine.

3. The Lateral Wall: Zygomatic & sphenoid (greater wing).

4. The Medial Wall: maxilla, orbital plate of the Ethmoid, lacrimal & sphenoid (small part of the body of the sphenoid)

5. The optic foramen: which contains the optic nerve and the large ophthalmic artery, is at the nasal side of the apex, while a larger entry, the superior orbital fissure, through which veins, motor nerves, and non-visual sensory nerves (e.g., those for pain), among other fissures.
Orbital openings

The orbit has 5 openings:

1. Optic Foramen (C.N II & ophthalmic artery)
3. Inferior Orbital Fissure (C.N V₂, infraorbital vessels and ascending branches from sphenopalatine ganglion)
4. Supraorbital Foramen (supraorbital nerve, supraorbital vessels)
5. Lacrimal Fossa (lacrimal gland)
The Extra-Ocular Muscles

- **Levator palpebrae superioris**: innervated by the oculomotor nerve and smooth muscle fibers are innervated by sup. Cervical Sympathetic ganglion originated from carotid plexus.

- **The recti**:
  - superior rectus - superior medially
  - medial rectus - medially
  - inferior rectus - inferior medially
  - lateral rectus - laterally

- **Superior oblique**: inferior laterally
- **Inferior oblique**: superior laterally
The orbital Septum

- The **orbital septum (palpebral ligament)** is a membranous sheet that acts as the anterior boundary of the orbit. It extends from the orbital rims to the eyelids. It forms the fibrous portion of the eyelids.

- The orbital septum is an important landmark in distinguishing between orbital cellulitis and periorbital cellulitis.
Orbital Diseases

• Orbital diseases may be vascular, thyroid-related (Graves' disease), infectious, inflammatory, or neoplastic.

• Despite the number of different tissues present in the orbit, the expression of disease due to different pathologies is often similar.

• Clinical features are:

1. Exophthalmos (Proptosis)
2. Endophthalmos
3. Pain
4. Eyelid and conjunctival changes
5. Diplopia
6. Visual acuity disturbances
I. Exophthalmus

- It is a protrusion of the eyeball, it may be unilateral or bilateral.

- Causes are classified into:
  1. **Intra-conal lesions:** the lesion lies within the cone formed by extra-ocular muscles, thus the eye globe is displaced **directly forwards**, e.g. most commonly dysthyroid eye disease, others like Optic nerve sheath meningioma.

  1. **Extra-conal lesions:** the lesion is outside the cone, so the eye is **displaced to one side**, e.g. mostly tumors, tumor of the lacrimal gland displaces the globe nasally.
Exophthalmus - Causes

 Causes of exophthalmos:

✓ **The most common cause is** Graves disease, it usually causes bilateral proptosis.

✓ Infections (Orbital cellulitis)
✓ Orbital Inflammatory disease

✓ Vasculitis (wegener’s granulomatosis)
✓ Neoplastic (unilateral): Lacrimal, Lymphoma, Metastatic.
✓ Orbital vascular disease (orbital varices...causes transient proptosis on valsalva manoeuvre)

✓ Trauma

✓ Pseudoproptosis (pseudoexophthalmos)
  ✓ Buphthalmos (congenital open angle glaucoma)
  ✓ Contralateral enophthalmos (posterior displacement of the eye)
  ✓ Ipsilateral lid retraction
– **History:**
  - duration, rate of onset.
  - associated ocular symptoms (pain, decreased visual acuity or field, diplopia, transient visual loss).
  - complaints of foreign body sensation or dry gritty eyes
  - history of trauma
  - family history

– **Examination:**
  - Full ophthalmic & systemic examination
  - Exophthalmometer: normally **14-21 mm**, if > **21 mm** or a **2mm** difference between the two eyes is abnormal.

– **Treatment:** depends on the underlying cause, but if left untreated it could lead to:
  1. **Failure of the eyelids to close, causing corneal ulcerations and damage.**
  2. **Compression on the optic nerve or ophthalmic artery leading to blindness**
  3. **Restriction of eye movements & squint ...**
Ophthalmometer
Exophthalmus – Complications

- Failure of the eyelid to close leading to corneal damage & ulceration.
II. Enophthalmos

**Definition:** Relative recession (backward or downward displacement) of the globe into the bony orbit.

- The three basic structures that determine globe position are the bony orbits, the ligament and muscle system and the orbital fat

- Change in the volumetric relationship between the rigid bone cavity, the orbit, and its contents (predominantly the orbital fat and the eye)

- **Presentation:** Presents clinically as a *sunken* appearance to the eye with *pseudoptosis*
Enophthalmos - Causes

1. **Primary enophthalmos indicates a congenital etiology** (Postnatal, inadequate, orbital cavity development)

2. **Acquired (secondary):**
   - **Blow out trauma**
   - **Horner’s Syndrome**
   - Bone growth arrest (eg, ionizing radiation for retinoblastoma)
   - Postsurgical muscle shortening

This patient has severe displacement of the right eye caused by tumor.
Enophthalmous
Enophthalmos - Complications

• Complications: **Long-standing enophthalmos**, especially associated with very extensive orbital trauma, may be associated with severe **orbital scarring**, and correction can be very difficult or impossible.

• Treatment involves reconstruction of the bony orbit with restoration of bony orbital volume and repositioning of the globe

*Blow out trauma might lead to enophthalmos*
Investigation of orbital disease

1. CT
2. MRI
3. Systemic tests depending on the DDx.
Differential diagnosis of orbital diseases

- Trauma
- Disorders of extra-ocular muscles (Dysthyroid eye disease and ocular myositis, rhabdomyosacroma)
- Infective disorders (orbital cellulitis and preseptal cellulitis)
- Inflammatory diseases (Sarcoidosis, orbital pseudo-tumors caused by lymphofibroblastic disorders)
- Vascular abnormalities (Carotico-Cavernous sinus fistula, orbital varix, capillary hemangioma)
- Orbital tumors (lacrimal gland tumors, meningioma of the optic nerve, optic nerve glioma, rhabdomyosarcoma)
- Dermoid cysts
trauma

The Signs of the damaged orbit (blow out):
1. emphysema air in the skin
2. a patch paraesthesia below the orbital rim (infraorbital neve damage)
3. enopthalamos
4. limitation of eye movement
Dysthyroid Eye Disease

- **Autoimmune disorder** with orbital involvement frequently associated with thyroid dysfunction.

- Histologic examination reveals **inflammatory infiltration of the orbital cavity**.

- Dysthyroid eye disease usually occurs in persons with **hyperthyroidism**.

- The eye symptoms may appear long before the thyroid gland becomes hyperactive, however, about 10% of patients with dysthyroid eye disease never develop hyperthyroidism.

- 90% of the patients have hyperthyroidism, 6% normal TFT, 3% Hashimoto, 1% hypothyroidism.

- 90% occurs in smokers.
Dysthyroid Disease - Epidemiology

- **Women** are affected eight times as often as men. Occurs around the age of 30-50 years.
- 60% of all patients have hyperthyroidism.
- 10% of patients with thyroid disorders develop Graves’ disease during the course of their life.
- Some patients with Graves’ disease never exhibit any thyroid dysfunction during their entire life.
- **Graves’ disease is the most frequent cause of both unilateral and bilateral Exophthalmos.**
Dysthyroid Disease - Etiology

• The precise etiology of this autoimmune disorder is not clear. Histologic examination reveals lymphocytic infiltration of the orbital cavity.

• The ocular muscles are particularly severely affected. Fibrosis develops after the acute phase.
Dysthyroid Disease - Symptoms

- The onset of this generally painless disorder is usually between the ages of 20 and 45.
- Patients complain of reddened dry eyes with a sensation of pressure (symptoms of keratoconjunctivitis sicca) and of cosmetic problems.
- Ocular motility is also limited, and patients may experience double vision.
Dysthyroid Disease – Diagnostic Considerations

1. Cardinal symptoms include **exophthalmos**, which is unilateral in only 10% of all cases, and eyelid changes that involve development of a characteristic eyelid sign.

2. Thickening of the muscles (primarily the rectus inferior and medialis) and subsequent fibrosis lead to **limited motility and double vision**. Elevation is impaired; this can lead to false high values when measuring intraocular pressure with the gaze elevated.

*Patient with Graves’ disease, more severe in the left than in the right eye.*

Typical signs include exophthalmos, which here is readily apparent in the left eye, retraction of the upper eyelid with visible sclera superior to the limbus (Dalrymple’s sign), conjunctival injection, and fixed gaze (Kocher’s sign).
Signs and Symptoms

- Red & painful eyes (exposure)
- Blurred vision
- Decreased visual acuity (sometimes associated with optic neuropathy).
- Proptosis
- Retraction of upper eyelid
- Lid lag
- Chemosis (edema of conjunctiva)
- Restriction of eye movements or squint (inferior rectus is the most commonly affected)
- Double vision
Dysthyroid Disease - DDx

- Rarer clinical syndromes such as orbital tumors and
- orbital pseudotumors must be excluded.
Dysthyroid Disease – Complications

**Acute serious complications:**
1) Cornea & conjunctival exposure leading ulcers & perforation.
2) Optic neuropathy leading to visual field loss & blindness.

**Lab & Investigations:**
- Biochemical tests for hyperthyroidism *(TFT & antibodies)*
- **Orbital CT & MRI** (to assess the E.O.M involvement at the orbital apex, which may lead to blindness)
Dysthyroid Disease - Management

*Emergency (corneal problem & pressure of optic nerve) is managed by systemic steroids, surgical orbital decompression & radiotherapy.

*The long term management aims to restore E.O.M function & cosmetic. The first step is the regulation of thyroid hormones levels. Artificial tears (prevent corneal drying and ulceration) Glasses to correct any double vision (diplopia) Guanethidine 5% drops may reduce lid retraction Eyelid surgery to overcome lid retraction Stop smoking.
Dysthyroid Disease - Prognosis

- Visual acuity will remain good if treatment is initiated promptly.
- In the postinflammatory phase, exophthalmos often persists despite the fact that the underlying disorder is well controlled.
- Men has a worse prognosis than women.
ORBITAL CELLULITIS

- Inflammation and infection of the orbital soft tissues **posterior to the orbital septum**.
- It is called **Post Septal Cellulitis**.
- 90% are caused by H. Influenza, the rest are due to **trauma or bacteremia**.
- Mostly rise from **ethmoid sinus**.
- It can cause blindness if left untreated esp. in children.
Signs & Symptoms:
1. Preorbital inflammation & swelling
2. Red painful eyes
3. Reduced eye movements
4. Chemosis
5. General systemic illness (fever, headache, malaise...)
6. Blindness

Serious complications:
1. Brain abscess
2. Cavernous sinus thrombosis
3. Meningitis
Diagnosis:
1. Mainly by clinical evaluation
2. MRI (CST)
3. CT Scan (ascertain precipitating sinus involvement, identify orbital abscess)

Treatment:
Admission & Broad spectrum IV antibiotics.

Surgical intervention (draining the abscess) is indicated when there is:

* Poor response to antibiotics
* Decreased vision because of optic nerve compromise
* Relative Afferent papillary defect (RAPD)
* Patients older than 16 years old
PERIORBITAL CELLULITIS

Pre septal cellulitis:
Inflammation and infection of the eyelid and preorbital soft.

Tissue anterior to the orbital septum.
Periorbital cellulitis
Presentation

• Signs & Symptoms:
  Only preorbital Inflammation & swelling.

1) Red, tender and swollen eyelid
2) Conjunctivitis

✓ Note:
  ▪ No reduced eye movement
  ▪ No proptosis
  ▪ No fever
  ▪ No systemic signs
  ▪ No optic disc swelling.
Causes:
1. Trauma (local infection)
2. Infections (URTI especially sinusitis)
3. Recent surgeries near eyelids or oral procedures
4. Bug bites
5. Chalazion
6. Dacrocystitis
7. Systemic diseases (asthma, neutropenia, nasal polyp)

Complications:
1. Orbital abscess
2. Orbital mucocele
Lab & Investigations:
Not useful, a sample of conjunctival discharge, eyelids lesions, lacrimal sac material could be sent for culture.

Treatment:
If mild, treat with oral antibiotics (Augmentin or 1st generation cephalosporins), warm compressors.

If severe, the patient should be admitted and given IV antibiotics (2nd or 3rd generation cephalosporins with or without Clindamycin)

Improvement should be noted after 2 – 3 days.

Surgery is indicated for eyelid abscess drainage.
<table>
<thead>
<tr>
<th>Pathogenesis</th>
<th>Age</th>
<th>Clinical Finding</th>
<th>Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbital cellulitis</td>
<td>21 months</td>
<td>Periorbital, erythema, tenderness</td>
<td>Staphylococcus/ Streptococcus/ strep pneumonia</td>
</tr>
<tr>
<td>Orbital cellulitis</td>
<td>12 years</td>
<td>Proptosis, chemosis, ophthalmoplegia, decreased visual acuity</td>
<td>Haemophilus inf, strep pneumonia</td>
</tr>
</tbody>
</table>
ORBITAL VASCULAR
LESIONS & DERMOID CYST
CAROTICOCAVERNOUS FISTULA

• This is an abnormal connection between the carotid artery or dural artery and the CS itself, causing abnormal arteriovenous shunting within the cavernous sinus, so the veins are exposed to a high intravascular pressure.
CAROTICOCAVERNOUS FISTULA

- Etiology

1) **Direct**: Caused by communication between carotid artery branches and orbital veins.

2) **Indirect**: Communication between the cavernous sinus and the branches of the internal carotid artery, external carotid artery, or both significant head trauma
Internal Carotid
External Carotid
Carotid Artery

Vascular Malformation behind the Eye
The C-C fistula would lead to venous exposure to a high intravascular pressure:

1. Dilated conjunctival veins & proptosed eyes
2. E.O.M engorgement leading to decreased eye movements
3. Increased pressure in veins draining the eye leading to increased IOP
4. Pulsatile tinnitus
5. Bruit might be heard over the eye

* **Diagnosed by:** angiography

* Treated by Embolizing and thrombosing the affected vessel using radiological techniques.
Gross chemosis in a patient with a high-flow carotid-cavernous fistula

Enlargement of the conjunctival and episcleral blood vessels in a patient with a low-flow carotid-cavernous communication
Orbital Varix

- Dilated orbital veins that causes **intermittent proptosis** when the venous pressure is raised due to a certain position or maneuver.

- **Usually unilateral & painless.** The patient might complain from **tightness across the eye & nose.**

- Treatment:
  Avoid activities that cause the symptoms. Surgery is indicated when the symptoms get worse by **emobilizing the affected vein.**
Capillary Hemangiomas

- Capillary hemangiomas are one of the most common benign orbital tumors of infancy. They are benign endothelial cell neoplasms that lead to vessel growth stimulation.

- They are typically absent at birth and characteristically have rapid growth in infancy with spontaneous involution in the first 5 years of life.

- Treated by local injections of steroids only when the size & position obstructs the visual axis risking the development of Amblyopia.

- Incisional surgical techniques also have had variable success
DERMOID CYST

• Caused by overgrowth of ectodermal tissue beneath the surface.

• Etiology: congenital defect that occurs during embryonic development when the skin layers do not properly grow together.

• Commonly observed as a painless mass in the superiotemporal area at the lateral portion of the eyebrow.
• Clinical feature:
• 1) small, often painless
• 2) the lump may be skin-colored or slight yellow tinged.

• If a dermoid cyst was more to the medial side, a possibility of encephalocele increases.

• Diagnosis by history & physical examination

• Treatment includes surgery to remove the cyst
• Excision is performed for cosmetic reasons and to avoid traumatic ruptured.
ORBITAL TUMORS

Primary:
- Rhabdomyosarcoma (malignant)
- Optic nerve glioma
- Lacrimal gland tumors
- Meningiomas
- Lymphoma

Secondary (Metastasis)
**RHABDOMYOSARCOMA**

- **Commonest orbital tumor in children (sarcoma)**

- **Rapidly growing arises from striated muscles. appears everywhere there is skeletal muscles.**

- 40% in the H&N around the eyes (usually found in the superonasal orbit)

- 90% occurs before the age of 16.
Types:
1. Embryonal (most common, most treatable, arises in H&N region & GU)
2. Botryoid (arises in hollow organs)
3. Alveolar (most aggressive, extremities)
4. Pleomorphic (in adults and arises in muscles of the extremities)

Signs & Symptoms:
Painless visible mass, proptosis, ptosis.

Diagnosis:
CT Scan; help to show adjacent bones invasion.
MRI to show if a mass adjacent or attached to ocular/orbital muscles.
Complications:

Metastasis to the lungs or brain.

Treatment:

Radiotherapy & chemotherapy, if there is no recurrence after 3 years then it is controlled. Surgery might be used but it is difficult because the tumor is embedded deep in the tissue.

Prognosis depends on the site, type & stage.
OPTIC NERVE GLIOMA

• Most common 1\textsuperscript{st} primary neoplasm of the optic nerve.

• Glial cells, These tumors include the astrocytomas, ependymomas and oligodendrogliomas.

• Occurs before the age of 16 years old.

• Mostly associated with type I Neurofibromatosis
Signs & Symptoms:
1. **Proptosis (mainly)**
2. **Strabismus**
3. **Decreased vision**
4. **Ptosis**

Diagnosis:
**CT Scan**, **MRI** is preferred.

Treatment:
Requires no intervention only observation. They are slowly growing & the treatment is very difficult.
**Surgery, radiation, chemotherapy.**
SECONDARY TUMORS

Metastasis to the Orbit from:

- Breast cancer (40%)
- Lung cancer
- Prostate cancer
- Liver cancer