ABSTRACT: Clinical cases are used to demonstrate important aspects of orbital anatomy, including bone, extraocular muscles, lacrimal gland, orbital fat, and vascular supply. The importance of understanding orbital anatomy and surrounding structures for proper clinical examination and accurate diagnosis is emphasized through the clinical cases.

Course Learning Objectives:
1. To realize the importance of the optometrist’s role in understanding orbital anatomy.
2. To understand the anatomy of the bony orbit, and its clinical applications.
3. To understand the anatomy of the extraocular muscles, and its clinical applications.
4. To understand the anatomy of the lacrimal gland, and its clinical applications.
5. To understand the anatomy of the orbital fat, and its clinical applications.
6. To understand the anatomy of the vascular supply of the orbit, and its clinical applications.
7. To discern the differential diagnoses for a variety of clinical presentations involving the orbit.
8. To be comfortable with the work-up, management, and treatment of neuro-ophthalmic disease conditions affecting the orbit.

OUTLINE:
Components of orbital anatomy that will be demonstrated through actual clinical cases are included in the outline below.

ANATOMY

1. ORBITAL BONES
   Frontal Bone
   Sphenoid Bone
   Zygomatic Bone
   Lacrimal Bone
   Palatine Bone
   Ethmoid Bone
   Sphenoid Bone
Weakest area in orbital floor is the area of the intraorbital groove. Common site of orbital
blow-out fracture.

The nasal wall is also weak (ethmoid). Blow out fracture may occur there as well.
Medial rectus may become entrapped.
Crepitus may occur. Sound of air going through fracture site. Be sure patient does not
blow their nose.

**Associated Clinical Cases:**
- Orbital Blow Out Fracture
- Sphenoid Wing Meningioma
- Mucocele
- Orbital decompression in Thyroid Eye Disease

2. **MENINGES**

Dura

Periorbitum is the continuation of the outer layer of the dura
Lines the bony orbit
At the optic foramen, it splits into 2 layers
Outer layer remains as periosteum
Inner layer surrounds optic nerve (optic nerve sheaths)

Superior Rectus and Medial Rectus take partial origin
from meninges around the optic nerve

Arachnoid

Pia

**Associated Clinical Cases:**
- Sphenoid Wing Meningioma
- Optic Neuritis (pain on eye movements)

3. **NERVES OF THE ORBIT**

Trigeminal Nerve – Ophthalmic Branch (V1)
Supplies upper 2/3 of orbital contents
Branches into:
- Lacrimal
  - Innervates lacrimal gland
- Frontal
- Nasociliary
  - Innervates cornea, conjunctiva, iris, and anterior chamber angle

Nerves that innervate extraocular muscles
- Oculomotor (CN III) – innervates SR, IR, IO, MR
- Trochlear (CN IV) – innervates SO
- Abducens (CN VI) – innervates LR

**Associated Clinical Cases:**
- Orbital Blow Out Fracture (decreased sensation in distribution of infraorbital nerve)
- Orbital Apex Syndrome / Tolosa Hunt Syndrome
4. **PARANASAL SINUSES**

Maxillary Sinus
   Inferior to orbit
   Prolapse of orbital contents into maxillary sinus with inferior fracture

Ethmoid Sinus
   Nasal to orbit. Thin wall separates orbit and ethmoid air cells.

Sphenoid Sinus
Frontal Sinus

Inflammation / infection of any of the paranasal sinuses can cause orbital cellulitis.

**Associated Clinical Cases:**
- Mucocele
- Orbital Blow Out Fracture

5. **LACRIMAL GLAND**

Lacrimal fossa in lacrimal bone

Supplied by Lacrimal Nerve – sensory – feel pain

Produces tears

Can be inflamed / infiltrated. Concern if lacrimal gland is enlarged.

**Associated Clinical Cases:**
- Sarcoidosis
- Lymphoma
- Orbital Inflammatory Pseudotumor

6. **EXTRAOCULAR MUSCLES**

Superior Rectus
Inferior Rectus – most commonly affected by thyroid eye disease

Inferior Oblique
Superior Oblique
Medial Rectus
Lateral Rectus

Divide the orbit into 2 zones

Intraconal - internal to the extraocular muscles
Extraconal – external to the extraocular muscles

**Associated Clinical Cases:**
- Thyroid Eye Disease
- Idiopathic Orbital Inflammatory Pseudotumor
- Entrapment of muscles in orbital blow out fracture

7. **ORBITAL FAT**

Fills both the intraconal and extraconal zones of the orbit.

Can be inflamed in Thyroid Eye Disease
**Associated Clinical Cases:**
Thyroid Eye Disease
Orbital Inflammatory Pseudotumor

8. **EYELID ANATOMY**
Levator Aponeurosis insertion
Tarsal Plate
Orbital Septum
  Pre-septal portion of eyelid
  Post-septal Portion of eyelid

**Associated Clinical Cases:**
Pre-septal Cellulitis
Orbital Cellulitis

9. **ORBITAL BLOOD SUPPLY**
Superior Ophthalmic Vein
Inferior Ophthalmic Vein

Ophthalmic Veins drain to the cavernous sinus. This is why orbital cellulitis can cause cavernous sinus thrombosis.

Ophthalmic Artery
  Orbital branches
  Lacrimal – lacrimal gland, lids
  Supraorbital – upper lid, forehead, scalp, frontal air cells
  Anterior Ethmoidal – ethmoidal air cells
  Posterior Ethmoidal- ethmoidal air cells
  Medial Palpebral - lids
  Dorsal Nasal – lids, lacrimal sac, nose
  Supratrochlear – upper lid, forehead, scalp

  Ocular branches
  Central Retinal Artery
  Posterior Ciliary Trunks
  Muscular – give rise to anterior ciliaries

**Associated Clinical Cases:**
Ocular Ischemic Syndrome
Orbital Varix
Carotid-Cavernous Fistula

10. **ORBITAL APEX / CAVERNOUS SINUS**
Superior Orbital Fissure
  Outside Tendinus Annulus
    Recurrent Lacrimal Artery
    Lacrimal Nerve
    Frontal Nerve Trochlear Nerve
    Superior Ophthalmic Vein

  Inside Tendinus Annulus
Oculomotor Nerve (superior division)
Oculomotor Nerve (inferior division)
Abducens Nerve
Nasociliary Nerve
Inferior Ophthalmic Vein

Optic Foramen
  Optic Nerve
  Ophthalmic Artery
  Sympathetic Nerves

Cavernous Sinus
  Internal Carotid Artery
  Abducens Nerve (CN VI)
  Oculomotor Nerve (CN III) with parasympathetic pre-ganglionic fibers
  Trochlear Nerve (CN IV)
  Trigeminal Nerve - Ophthalmic branch V1
  Trigeminal Nerve – Maxillary branch V2
  Sympathetic post-ganglionic fibers

Associated Clinical Cases:
Sphenoid Wing Meningioma
Tolosa Hunt Syndrome

BRIEF OVERVIEW OF CLINICAL DIAGNOSES DISCUSSED

Orbital Blow Out Fracture
A blowout fracture is a fracture of the walls or floor of the orbit. Intraorbital material may be pushed out into one of the paranasal sinuses. This is most commonly caused by blunt trauma of the head.
Presents with diplopia, enophthalmos, hypoesthesia in region of nasociliary nerve.

Mucocoele
Mucocoeles are epithelium-lined cavities in the paranasal sinuses filled with mucus. They develop because of scarring and obstruction of the sinus ostium, whether from chronic sinusitis, trauma, or surgery. They commonly erode the bony sinus wall and can have serious complications of brain and orbital invasion, with potential for abscess and rupture. Mucocoeles may arise from any of the paranasal sinuses and, because of the close proximity of these spaces to the orbit, may initially manifest with visual and ocular signs and symptoms.
Presents with diplopia, proptosis, pain.

Thyroid Orbitopathy
- Disorder of Immune Regulations
- Cytotoxicity directed at thyroid gland and EOMs.
- Affects women more than men.
- Increased likelihood with smoking.
- Can cause optic neuropathy
- Most commonly affected muscle: inferior rectus, followed by medial rectus.
- Presents with proptosis, eyelid retraction, eyelid edema.
**Idiopathic Orbital Inflammatory Pseudotumor**

Idiopathic orbital inflammatory disease "pseudotumor" is a nonspecific inflammation involving the orbit. It is a hypocellular lymphoid lesion, often incompletely replacing the orbital fat, lacrimal gland and extraocular muscles. Males and females are equally affected.

May present with pain, diplopia, proptosis, enlarged lacrimal gland.

**Lymphoma**

- A group of blood cancers that develop in the lymphatic system – associated with lymphocytes (WBCs).
- The two main types are:
  - Hodgkin lymphoma
    - Contain a giant cell (Reed-Sternberg cell)
    - Respond better to radiation
  - non-Hodgkin lymphoma (NHL).
    - contain 16 different conditions
    - Grouped by aggressiveness

When affecting the orbit, may cause lacrimal gland enlargement.

**Sarcoid**

Sarcoidosis is a multisystem granulomatous disease characterized by T-lymphocyte infiltration, non-caseating granuloma formation, and distortion of the microarchitecture in affected tissues. The lacrimal gland is most common periocular tissue affected by sarcoidosis.

When affecting the orbit, may cause enlarged lacrimal gland, optic neuropathy.

**Sphenoid Wing Meningioma**

One-quarter of all brain and spinal tumors are meningiomas, and up to 85% of them are benign.

Account for about 27 percent of all primary brain tumors

- **Benign**
  - About 5% of all meningiomas
    - exhibit increased tissue and cell abnormalities. These tumors grow at a faster rate than benign meningiomas and on occasion can invade the brain. Atypical meningiomas have a higher likelihood of recurrence than benign meningiomas
  - **Atypical**
    - About 3-5% of all meningiomas
      - increased cellular abnormalities, and grow at a faster rate than either benign or atypical meningiomas

May present with proptosis, reduced visual acuity, diplopia, visual field loss, reduced color vision.

**Tolossa Hunt Syndrome**

- Unilateral
- Intense pain around eye
- Ophthalmoplegia
- Possible involvement of CN III, IV, V, and VI
- Can have proptosis, fatigue, vertigo
- Exact cause is unknown
- Inflammation of cavernous sinus and/or superior orbital fissure
• Diagnosis of exclusion
• Need to rule out all other causes with labs, imaging, and LP
• Treat with steroids / good prognosis
• Can recur in 30-40% of cases
• May present with pain, diplopia, reduced vision.

**Orbital Varix**
Orbital venous varix (OVV) is an uncommon vascular malformation which is composed of enlarged single or multiple tubular venous channels with direct communication to the systemic venous system.

Orbital varix is a rare entity, accounting for less than 1.3% of all orbital tumours. Although it is believed to be congenital, and thus present at birth, patients typically do not become symptomatic until later childhood or early adulthood (10-30 years of age)

May present with variable diplopia, pain, proptosis, which worsen with Valsalva maneuver.

**Carotid Cavernous Fistula**
Carotid-cavernous sinus fistula is an abnormal communication between the internal or external carotid arteries and the cavernous sinus. Depending on the type of fistula, patients can present with a red eye, diplopia, pulsatile exophthalmos, bruit, and vision loss.

**Ocular Ischemic Syndrome**
- A 40% mortality rate has been reported in patients with OIS
- The most common symptom is slowly progressive vision loss, but 10% report sudden vision loss
- 40% present with pain
- 67-87% present with iris neovascularization
- 10-20% are asymptomatic at time of diagnosis
- 86% of patients are smokers
- Risk factors include diabetes, ischemic heart disease, cerebro-vascular disease, trauma, and vasculitis (need to R/O GCA)
- Can present with vision loss, pain, red eye, visual field loss.

**Orbital Cellulitis or Preseptal Cellulitis**
Preseptal cellulitis (periorbital cellulitis) is infection of the eyelid and surrounding skin anterior to the orbital septum. Orbital cellulitis (postseptal cellulitis) is infection of the orbital tissues posterior to the orbital septum.
Symptoms of preseptal cellulitis include eyelid pain, discoloration, and swelling; orbital cellulitis also causes fever, malaise, proptosis, impaired ocular movement, and impaired vision.