Objectives

• Learn the anatomy of the thoracic inlet (TI)
• Review the clinical and radiographic findings of common lesions encountered in this region
• Encourage the use of a systematic approach "Road Rules" for the evaluation of pathology in the TI

Thoracic Inlet Boundaries

- Posterior - 1st thoracic
- Lateral - 1st rib
- Anterior - Manubrium

Thoracic Inlet Sagittal View

- Anterior
- Posterior
- Subclavian vein
- Subclavian artery
- Bronchial plexus
- Anterior scalene
- Mediastinum
- Lung
- Scalene Anterior
- Alveoli
- Bronchial lumen
- Scalene posterior
- Brachial plexus
- Anterior scalene
- Mediastinum
- Lung
- Scalene Anterior
- Alveoli
- Bronchial lumen
- Scalene posterior
- Brachial plexus

ANTERIOR SCALENE

- Sagittal
- Coronal
Thoracic Inlet Nerves

- Vagus - recurrent laryngeal
- Phrenic
- Brachial Plexus
- Sympathetic Chain

Brachial Plexus

Cervical Sympathetic

Thoracic Inlet – Contents

- **Neural structures** – Vagus nerve, recurrent laryngeal nerve, cervical sympathetics, phrenic nerve and brachial plexus
- **Vascular** – Subclavian and brachiocephalic artery and vein, common carotid artery and internal jugular vein
- **Lymphatics** – Thoracic and right lymphatic duct
- Esophagus
- Trachea
- Thyroid

Road Rules

The thoracic inlet is a busy anatomic intersection.
- Certain disease processes have predictable patterns of disease spread "traffic patterns".
- A knowledge of these patterns aid in imaging interpretation.
- The "Road Rules" outlined in this lecture will help you remember the location and appearance of common lesions and their patterns of spread. This knowledge will increase your diagnostic accuracy.
Normal Anatomy

Neck Spaces Crossing the Thoracic Inlet

- Carotid Space
  - Formed by all three layers of the deep cervical fascia (DCF)
  - Extends from the skull base to the level of the aortic arch
  - In the lower neck contains jugular vein, carotid artery, and vagus nerve
  - Major pathology is vascular or neural in origin

Internal Jugular Vein Thrombosis

- Extent
- Etiology

Thrombosis - Internal Jugular, Brachiocephalic and Subclavian Veins

- Look up and down
- Thrombosis - Internal Jugular, Brachiocephalic and Subclavian Veins

- Extent
- Etiology
Venous Thrombosis - Etiologies

- Trauma
- Infection
- Mass compressing the vein
- Tumors that cause distant venous thrombosis (renal cell and pancreatic Ca)
- Indwelling catheter
- Birth control medications

Carotid Artery Thrombosis

- Artery
- Vein
- Node
- Abscess

Look up and down

Aortic Dissection

CTA

- Inflammatory disease affecting large elastic arteries
- F:M ratio is 8:1, age 15-30
- Commonly affects the aorta and its major branches
- Radiographs - aortic calcifications in later stage
- Findings on CTA: stenoses, occlusions, aneurysms and concentric arterial wall thickening
- MR similar findings + enhancement of the vascular wall

Takayasu’s Arteritis

- 32 y/o F with c/o pleuritic chest pain.

Visceral Space Divisions

- PRETRACHEAL aka Visceral Space Extends from the hyoid bone to the anterior mediastinum
- RETROPHARYNGEAL extends from the base of the skull to anywhere between C6 and T4 where the alar fascia fuses with the visceral fascia (MLDCF)

Visceral Space – Pretracheal Component

- Thyroid gland
- Parathyroid glands
- Larynx
- Trachea
- Esophagus
- Recurrent laryngeal nerve
Thyroid Lesions

- Most common lesion crossing the TI
- Inferior extent needs to be determined for surgical planning
- Lesion extending below the level of the aortic arch may require a combined neck and thoracic approach for removal

Tracheal Lesions

- Tracheal stenosis
- Saber sheath trachea
- Tracheal diverticulum

Tracheal Stenosis

- **Congenital** - ring shaped cartilage
- **Acquired** - prior intubation or tracheostomy
- Edema of the tracheal wall—intramural granulation tissue—fibrosis
- **Location** - Extra-thoracic
- Short segment concentric wall thickening (fixed)-hourglass shaped

40 yo old male S/P intubation presented with increasing dyspnea

Tracheal Stenosis - Stent

May migrate
Sabre Sheath Trachea

- COPD
- Tracheomalacia from chronic coughing or increased intrathoracic pressure
- Intrathoracic trachea
  - Transverse diameter
  - AP diameter
  - Normal wall thickness
  - Narrowing at expiration

Point: Always look at the trachea size on the frontal and lateral views of the chest.

Tracheoceles

- Aka right paratracheal air cyst
- COPD
- Focal herniation of the tracheal mucosa though the tracheal wall between the cartilaginous and mucosal portion of the trachea
- Asymptomatic
- Reservoir for secretions - cough, dyspnea and stridor secondary to chronic infection

Dilated Esophagus

- Motility disorder
- Carcinoma
- Strictures
- Achalasia
- Scleroderma
- Foreign bodies

Achalasia

- Etiology: unknown
- Neuropathy of the myenteric plexus incomplete relaxation of the lower esophageal sphincter
- 2nd esophageal Ca, metastasis, Chagas disease and vagotomy
- Stasis – esophagitis
Scleroderma

Esophageal Carcinoma

Look left

Ca Hypopharynx and Esophagus

• The risk factors for developing head and neck and esophageal carcinoma are the same.
• Synchronous aerodigestive tract lesions occur in 10–40% with H&N Ca.

RT Planning CT

Congenital Lesions

• Lymphatic venous malformations
• Thymic cysts

Ca Hypopharynx and Esophagus

Lymphatic Venous Malformation

• Most common lesion involving the thoracic inlet in children
• Locations
  • 75% neck
  • 20% axilla
  • 5% mediastinum, retroperitoneum, pelvic and groin
  • 10% extend into the mediastinum

Thymic Cyst

• Uncommon
• 1st decade of life
• Lower neck – left predominance
• 50% mediastinal extension
• Path – thymic tissue and Hassall’s corpuscle
• Intermittent occlusion of the brachiocephalic vein

Thymic embryology:
• Derived from 3rd pharyngeal pouch
• 6th week – descends from pharynx along paired thymopharyngeal ducts into the anterior/superior mediastinum
• Thymopharyngeal duct eventually atrophies; if portions persist a cyst may develop
• Cyst location – deep to thyroid gland, sternocleidomastoid muscle and medial to the carotid sheath.
Thoracic duct

Travels posterior to the left common carotid artery and terminates in the posterolateral aspect of the venous angle (junction of the left IJ and subclavian vein).

Thymus - Cervical Extensions

Newborn with a palpable mass in the lower neck.

Thymic tissue is found in the neck in 21-42% of infants.

Infection and Spaces

Pretracheal (Visceral) Space Abscess

• Infection can extend inferiorly into the posterior mediastinum
• Look for carotid artery spasm

Retropharyngeal Space

• Extends from the base of the skull to anywhere between C6 and T4 where the alar fascia fuses with the visceral fascia (MLDCF)
• Contains:
  - Suprathyroid - lymph nodes & fat
  - Infrahyoid - FAT

Retropharyngeal Space Abscess

• Infection can extend inferiorly into the posterior mediastinum
• Look for carotid artery spasm
**Danger Space**

- Anterior, lateral and posterior walls formed by the DLDCF (prevertebral fascia)
- Extends from the skull base to the diaphragm
- On imaging it is difficult to differentiate pathology in this space from the retropharyngeal space unless it extends below T4
- Pathology in this space can extend from the neck to the diaphragm

**Perivertebral Space**

- Space between the prevertebral fascia (DLDCF) and the vertebral column, two divisions:
  - Prevertebral: posterior to danger space
  - Paraspinal: deep to posterior cervical space
- Extends from the skull base to the coccyx
- Contains the prevertebral and paraspinal muscles, brachial plexus, sympathetic chain, phrenic nerve, vertebral artery and vein

**Prevertebral Space Abscess**

Cases courtesy of Dr. Yoshihisa Anzai

**Apical Mass**

- Neural Tumors
- Pancoast (Superior Sulcus) Tumors
- Thyroid Lesions
- Vascular Lesions

**Subclavian Artery Aneurysm**

Remote history of trauma

Remote history of trauma

**Nerves in the Perivertebral Space**

- Phrenic nerve
- Cervical nerve root
- Cervical Sympathetic chain

Cases courtesy of Dr. Rakesh Shah
North Shore Medical Center
Asymptomatic 25 yr. old male with an abnormal CXR.

Vertebral Artery and Sympathetic Ganglion

Pancoast Tumor

58 year-old male with weight loss, right brachial plexopathy and Horner’s Syndrome.
### Recurrent Laryngeal Nerve (RLN)

**Imaging Findings of Vocal Cord Paralysis**
- Anteromedial positioning of the arytenoid cartilage
- Ipsilateral dilatation of pyriform sinus and laryngeal ventricle
- Paramedian position of the vocal cord due to paralysis

### RLN Palsy Etiologies

- Tumor
- Trauma
- Infection
- Cardiovascular
- Neurologic
- Idiopathic

### Denervation Atrophy CN X

- **46 y/o F with a Lt. vocal cord paralysis.**
  - Heterogenously enhancing mass is splaying the CCA and IJV.
  - Mass is anterior to the subclavian artery on sagittal image. This is where the vagus nerve is located.

### Vagal Schwannoma

### Left Vocal Cord Paralysis

### Phrenic Nerve
Phrenic Nerve

What nerve palsies could this patient have?

Esophageal Carcinoma

What nerves could be involved in this patient?

Lung Carcinoma

Most of the lesions that cross the thoracic inlet originate in the neck.

Vascular lesion and Pancoast tumors are the exception.

Cervical Aortic Arch

Phrenic Nerve Palsy

CXR and scout film for CT taken two weeks apart

Metastatic Lymph Node:
Mass anterior to the right subclavian artery where the phrenic and vagus nerves cross the TI.
Summary

- Anterior scalene muscle
- Spaces – carotid, visceral (pretracheal and retropharyngeal), danger and perivertebral
- Neural structures (location)
- Lesion

Don’t Panic

Traffic Patterns

- Most lesions grow down not up
- Vascular lesions are the exception to the rule
- Pancoast tumors can grow into the base of the neck

You must be familiar with the traffic patterns.

Remain calm and use the ‘Road Rules’

Traffic Patterns

- Look up and look down (neck and chest) especially when evaluating:
  - Vascular lesions
  - Infection
  - Thyroid lesions
  - Thymic lesions in children
- Dilated esophagus – look down
- Look right and left
- Look left
- Look up

- Lesions in the perivertebral (paraspinal) region and posterior cervical space - look medially

- Lung Ca
- Neural Tumors
- Vascular Lesions
- Thyroid Lesions