THYROID

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Today’s learning......

- Embryology
- Anatomy
- Physiology
- Thyroid function test
- Imaging
- Cytology
Embryology of thyroid
Embryology of thyroid...........

- Arises as an endodermal diverticulum from the floor of the pharynx.

- **Week 3:** Thickening in the floor between the 1\textsuperscript{st} and 2\textsuperscript{nd} pharyngeal pouches.

- Week 4: Endoderm evaginates ventrally (into the mesoderm) to form the thyroid diverticulum.

- **Week 5:**
  - Formation of thyroglossal duct.
  - Bifurcation on the tip of Thyroglossal duct forms isthmus and the lateral lobes of the gland.

- Weeks 5-6: Growth of duct down to the neck, migration down to the neck.

- **Week 7:** Final position in relation to the larynx and the trachea.
Important facts related to thyroid

- Thyroid tissue migrates inferiorly
- The duct portion begins to involute
- Site of connection thyroglossal duct with pharynx- "Foramen Caecum"
Important facts related to thyroid

- Distal part of the thyroglossal duct may develop “Pyramidal Lobe”.

- Thyroid gland may develop in any part at the midline of the thyroglossal duct.  
  - lingual, suprathyoid, retrothyoid or infrahyoid positions.

- Thyroid gland is relatively large in newborn babies.
Anatomy of thyroid

- Normal thyroid gland weighs about 15-25 g in adults.
- “Butterfly” in shape.
- Two lobes:
  - Consists of right and left lobes
  - Anterolateral to the larynx and trachea
- Thin isthmus unites the lobes over the trachea.
Anatomy of thyroid

- Anteriorly in the neck at the level of the C5 - T1 vertebrae.
- Deep to the sternothyroid and sternohyoid muscles
- Superior pole-
  - Lateral to inferior constrictor muscle and cricothyroid muscle.
  - At the level of 1st tracheal ring.
- Inferior pole-
  - Extends up to the level of 5th or 6th tracheal rings
Anatomy of thyroid........

Surgical importance:
Thyroid swelling never moves upward
Anatomy of thyroid

- Pyramidal lobe:
  - ~50% of thyroid glands.
  - Extends superiorly from the isthmus.

- “Levator glandulae thyroideae”:
  - Fibrous tissue connecting pyramidal lobe with hyoid bone.

- Accessory thyroid tissue
  - A band of connective tissue, often containing accessory thyroid tissue, may continue from the apex of the pyramidal lobe.
  - Surgical importance.
Anatomy of thyroid........

- **Thyroid Gland Capsule:**
  - **True capsule:**
    - A thin fibrous capsule, which sends septa deeply into the gland.
    - Divides the thyroid tissue into microscopic lobules.
  - **False/ Surgical capsule:**
    - External to the true capsule.
    - A loose sheath formed by the visceral portion of the pre-tracheal layer of deep cervical fascia.
Investing layer of deep cervical fascia

Prevertebral layer of deep cervical fascia

Pretracheal fascia
Anatomy of thyroid

- **Ligament of berry:**
  - Formed from thickened pre-tracheal fascia
  - On the inner surface of the gland
  - Connect gland to cricoid cartilage

- **Surgical importance:**
  - RLN often passes through this ligament.
  - Also contains the terminal branches of inferior thyroid artery.
Anatomy of thyroid

- Arteries of the Thyroid Gland:
  - Highly vascular.
  - Supplied by:
    - Superior thyroid arteries.
    - Inferior thyroid artery.
  - Vessels lie between the fibrous capsule and loose fascial sheath.
Anatomy of thyroid........

- Superior thyroid artery (STA):
  - Descend to the superior poles of the gland.
  - Pierce the pre-tracheal layer of deep cervical fascia.
  - Divide into anterior and posterior branches.
Anatomy of thyroid……..

- **Inferior thyroid arteries (ITA):**
  - Branches of the thyrocervical trunks.
  - Run supero-medially posterior to the carotid sheaths to reach the posterior aspect of the gland.
  - Supply postero-inferior aspect with inferior poles of the gland.

- Right and left STA and ITA arteries form anastomoses within the gland.
Anatomy of thyroid

- **Thyroid Ima Artery:**
  - Approx. 10% of people have small *unpaired* thyroid ima artery
  - Possible sources of Ima artery:
    - Branch of brachiocephalic trunk
    - Arch of the aorta
    - Right common carotid/subclavian/internal thoracic arteries
  - Ascends on the anterior surface of the trachea and continues to the thyroid isthmus.
  - Presence of this artery must be considered before tracheotomy (as a potential source of bleeding!)
Anatomy of thyroid........

Veins of the Thyroid Gland:

Form thyroid plexus of veins on the anterior surface of the thyroid gland- Three pairs of thyroid veins (superior, middle, inferior)

1. Superior thyroid veins - accompany the STA.
2. Middle thyroid veins - do not accompany but run essentially parallel courses with the ITA.
3. Inferior thyroid veins - accompany the thyroid ima artery (if artery is present)
Anatomy of thyroid

- Important nerves:
  - Superior Laryngeal Nerve (SLN)
    - Two branches: internal and external
  - Recurrent Laryngeal Nerve (RLN)
Anatomy of thyroid……..

- **Superior laryngeal nerve:**
  - Originates at the inferior ganglion of vagus nerve.
  - Average length of SLN is about 1.5 to 2 cm.
  - Courses:
    - Posterior and medial to the internal carotid artery.
    - Descends antero-inferiorly to reach the larynx.
  - At the level of Greater Cornu of hyoid bone it divides:
    - Large- Internal laryngeal branch.
    - Smaller- External laryngeal branch.
Anatomy of thyroid

- **Internal Laryngeal Nerve:**
  - Passes between thyrohyoid muscle and the thyrohyoid membrane.
  - Pierces the thyrohyoid membrane along with superior laryngeal artery and vein.
  - After entering into the larynx this nerve divides into three branches i.e. superior, middle and inferior.
  - Supply sensation to:
    - Interior of larynx.
    - Supraglottis and pyriform sinus.
Anatomy of thyroid

- **Internal Laryngeal Nerve:**
  - **Superior division** divides into 2-3 branches supplying sensations to
    - Lingual surface of epiglottis, lateral aspect of glosso-epiglottic fold.
  - **Middle division** innervates
    - Aryepiglottic fold, vocal folds, vestibular folds and the posterior aspect of arytenoid.
  - **Inferior division**
    - The largest of the branches of superior laryngeal nerve.
    - It lies along the medial aspect of pyriform fossa.
Anatomy of thyroid

- External laryngeal nerve
  
  **Course:**
  
  - At the level of superior horn of thyroid cartilage turns medially.
  - And runs posterior and parallel to the oblique line.
  - Lies deep to the STA.
  - Relationship with the superior pole of thyroid gland is highly variable.
Anatomy of thyroid........

- Anatomical Relationships between STA and External Branch of SLN:
  - Closely related to external laryngeal nerve at its origin.
  - Nerve moves away from the artery as artery approaches the upper pole of the gland.
Anatomy of thyroid........

- In order to avoid injury of External Laryngeal Nerve:
  - STA need to be ligated just near the superior pole.

- Complication:
  - Superior laryngeal nerve injury:
    - Paralysis of the cricothyroid muscle.
    - Changes in the pitch of the voice.
    - Inability to make explosive sounds.
    - Bilateral injury presents as a tiring and hoarse voice.
Anatomy of thyroid

- Relationship of the EB-SLN and STA:
  - Originally described by Cernea And Colleagues.
    - Type 1 anatomy- nerve crosses the artery ≥1 cm above the superior aspect of the thyroid lobe.
    - Type 2 anatomy-
      - 2a- nerve crosses the artery <1 cm above the thyroid pole
      - 2b- nerve crosses the artery <1 cm below the thyroid pole
Anatomy of thyroid

- RLN - Always asymmetric.
Anatomy of thyroid........

- Right recurrent laryngeal nerve:
  - Arises from vagus in the chest.
  - Reaches neck by crossing anterior to right subclavian artery.
  - Loops around Right subclavian artery to reach the trachea-oesophageal groove.
  - Ascends posterior to thyroid gland.
  - Enters the larynx behind the cricothyroid articulation and inferior cornua of thyroid.
Anatomy of thyroid

- Left recurrent laryngeal nerve:
  - Arises from vagus in the chest.
  - Crosses the arch of aorta to reach the neck.
  - Ascends posterior to gland to reach the trachea-oesophageal groove.
Anatomy of thyroid……..

- Major difference in course between Right and Left RLN:
  - Loops around subclavian and aortic arch respectively
  - In lower part - left RLN is more closely related to the trachea than right side.
  - In middle part of the course - RLN is found within the trachea-oesophageal groove commonly.
  - At the lower pole of thyroid gland - right nerve is slightly more anterior than the left.
Anatomy of thyroid........

- Motor supply of RLN:
Anatomy of thyroid....... 

- Relationship of RLN to the ITA
Anatomy of thyroid........

- Intraoperative localization of nerves:
  - EB-SLN:
    - Joll’s Triangle
    - Space of Reeve
  - RLN:
    - Boehar’s Triangle
    - Simon Triangle
Anatomy of thyroid

- Non-recurrent laryngeal nerve:
  - An anomaly of the RLN.
  - Origin is cervical.
  - Direct course from the vagus nerve to the larynx without looping around.
Anatomy of thyroid

- Types of NRLN:
  - Type 1 - arises directly from the vagus and travels with the Superior Thyroid Pedicle vessels.
  - Type 2A - travels transversely, parallel and superficial to the trunk of the Inferior Thyroid Artery.
  - Type 2B - travels in a transverse path parallel, but deep to or between the branches of the Inferior Thyroid Artery.
Anatomy of thyroid........

**Surgical importance of RLN:**

- **Unilateral RLN injury:**
  - Paralysis of I/L intrinsic muscles of larynx i.e. loss of abduction
  - Unopposed action of cricothyroid muscle i.e. adduction
  - Paramedian position of I/L vocal card
  - Voice will be breathy but compensation occurs i.e. near to normal
  - Airway will be patent but can be compromised during exertion
Anatomy of thyroid

- Surgical importance of RLN:
  - Bilateral RLN injury:
    - Paralysis of B/L intrinsic muscles of larynx i.e. loss of abduction.
    - Unopposed action of cricothyroid muscle i.e. adduction.
    - Paramedian or median position of vocal card.
    - Stridor during breathing because compromised airway.
Anatomy of thyroid........
Anatomy of thyroid........

- Zuckerkandl’s tubercle (ZT)
  - Posterior extension of the lateral lobes.
  - Composing of thyroid tissue only.
Anatomy of thyroid........

- **Surgical importance of ZT:**
  - Dissection and excision of ZT for total thyroidectomy.
  - Close relationship between ZT and recurrent laryngeal nerve (RLN).
  - Needs careful, fine, and very close dissection around the nerve.
  - Safe identification of the nerve and resection of the tubercle.
Anatomy of thyroid........

- Lymphatic Drainage of the Thyroid Gland
  - Thyroid lymphatic vessels communicates with:
    - 1st level: Pre-laryngeal, Pre-tracheal, and Para-tracheal lymph nodes
    - 2nd level:
      - Superior deep cervical nodes (from the prelaryngeal nodes)
      - and Inferior deep cervical nodes (from the pretracheal and paratracheal nodes).
    - Some lymphatic vessels may drain into the brachiocephalic lymphatic nodes.
  
- Presence of metastases in lymphatic nodes of neck can be first sign of thyroid carcinoma!!!
Anatomy of thyroid........

- Innervation of Thyroid Gland:
  - Derived from - (Superior, Middle, and Inferior) Cervical Sympathetic Ganglia
  - Nerves reach the thyroid through -
    - Cardiac periarterial plexus
    - Superior and inferior thyroid plexus
  - Only vasomotor fibers - constriction of blood vessels
  - No secretomotor supply

- Endocrine secretion from the thyroid gland is hormonally regulated by the pituitary gland through TSH!
Histology of thyroid

- Each lobule contains:
  - 20 to 40 follicles.
  - Composed of follicle cells and colloid.
  - Colloid fills the follicle cavities.

- Follicle cells produce thyroglobulin.

- Between follicles are Para-follicular cells, which produce Calcitonin.
THANKS