**Embryology of the larynx:**

Larynx is derived from branchial arch system

**Anatomy of the larynx:**

It extends from tip of epiglottis C₃, to lower edge of cricoid C₆.

It is if formed of cartilaginous framework, connected by ligaments and muscles, and lined by mucous membrane.

**Laryngeal cartilages:**

A- Single cartilages

1- Thyroid

2- Cricoid

3- Epiglottis

B- Paired cartilage

1- Arytenoid

2- Corniculate

3- Cuneiform
Laryngeal ligaments & membranes

1- Crico thyroid membrane. 2- Thyrohyoid membrane.

3-Crico tracheal ligament. 4- Thyro epiglottic ligament.

5-Hyo epiglottic ligament

6- Two intrinsic ligaments: form a broad sheet beneath lining mucosa:

a- Superiorly: quadrangular ligament between lateral border of epiglottis & arytenoid.

b- Inferiorly: conus elasticus, from arch of cricoid to vocal ligament

Laryngeal folds:

1- Vocal folds: covering the vocal ligament that is attached on both sides from the vocal process of arytenoid to middle of inner surface of thyroid angle.

2- Ventricular folds (false vocal cords): above vocal folds

3- Ary epiglottic folds: between epiglottis and arytenoids.

4- Glosso epiglottic folds two lat & one median.
Laryngeal inlet:

Oblique, directed slightly posteriorly, bounded by: epiglottis, ary epiglottic folds, and arytenoids

Cavity of the larynx: 3 areas

1- Glottis space: between V.F extend to 1 cm below

2- Supraglottis: above V.F(from floor of ventricle) extend to tip of epiglottis

3- Subglottis: from below glottis to lower border of cricoid

Laryngeal muscles:

A- Intrinsic muscles: responsible for vocal cord mobility & tension

1- Abductor: Posterior crico arytenoid (posticus)

2- Adductors: Lateral crico arytenoid - Inter arytenoid

       - Thyro arytenoid & vocalis (V.F bulk) - Crico thyroid muscle

3- Tensors: Crico thyroid muscle.

       Vocalis (internal part of thyro arytenoid).

B- Extrinsic muscles

1- Depressors: sternohyoid, sterns thyroid, omohyoid.

2- Elevators: mylohyoid, geniohyoid, digastric, hyoglossus.

3- Inferior constrictor of the pharynx.
Laryngeal spaces:
- Pre epiglottic space
- Paraglottic space

Laryngeal mucosa
Larynx is lined by pseudo stratified columner ciliated epithelium, with goblet cells (respiratory epithelium)

Except:
- True vocal cords
- Tip of epiglottis
- Ary epiglottic fold

non-keratinized stratified squamous epithelium

Nerve supply
1- Motor: all muscles by RLN, except cricothyroid by external branch of superior laryngeal nerve.
2- Sensory: Above V.F: internal branch of superior laryngeal nerve
Below V.F: RLN

Blood supply: Arteries & veins are closely related to nerves
a- Sup. Laryngeal A&V: branches of sup thyroid A&V, join internal branch of sup. laryngeal nerve to pierce thyrohyoid membrane.
b- Inferior laryngeal A&V: branches from inferior thyroid A&V: accompany RLN

Lymphatic drainage:
- Supraglottis (rich): to UDCLN
- Glottis : no lymphatics in Rienk’s space
- Subglottis : pretracheal (delphian), LDCLN, supraclavicular, sup. mediastinal

Physiology (Functions of the larynx):
A: Air way protection: from aspiration by:
1. Closure of 3 sphincters: ary epiglottic fold, ventricular fold & true V.F.
2. Laryngeal elevation during swallow.
3. Reflex cough.
4. Reflex inhibition of respiration during swallow.

B: phonation
C: Respiration: adjustment of glottic aperture helps to regulate acid base balance
D: Fixation of chest during straining

**Laryngeal Symptoms & Examination**

**Laryngeal symptoms:**
1. Change of voice (hoarseness)
2. Dyspnea: difficulty in breathing.
4. Pain: local or referred.
5. Cough, expectoration, haemoptysis
6. Dysphagia
7. Chocking
8. Swelling

**Examination:**

A- External Examination

- inspection: position & movement, contour, swellings, and scars.
- palpation: tenderness, crepitus, crepitation, swellings, laryngeal click

Side to side movement of larynx over the vertebral column, normally a click is felt, if lost (+ve moure’s sign) … mass between larynx & vertebral column e.g. post cricoid carcinoma.

B-Indirect laryngoscopy
C-Flexible fiberoptic laryngoscopy
- When I.L is difficult, it is introduced via the nose.
- Photographic documentation.

D- **Direct laryngoscopy under GA:**
  By rigid endoscope
  Operating microscope can be used: Microlaryngoscopy (MLS)

**N.B.:**
- Any lesion affect laryngeal patency: stridor
- Any lesion affect vocal fold: hoarseness

**Laryngeal investigations:**
1. Direct laryngoscopy ± biopsy
2. Radiology (X-ray, CT, MRI)

**Congenital diseases**

**1-Congenital web**

**Def and Aet:** Incomplete canalization of the laryngeal lumen.

**Path:** Commonest site is glottic, may extend to subglottis.
  - May be small, large, or imperforate fibrous ring.

**Symptoms**
A: small: asymptomatic, hoarse cry, mild stridor.
B: large: weak hoarse cry, evident stridor.
C: imperforate: Cyanosis with no cry usually fatal.

**Signs:** Flexible or direct: symmetrical grayish white membrane may be a semi translucent triangular band, or thick membrane.

**Treatment:**
A: mild if no symptoms …………. no ttt
B: severe:
  - Tracheostomy if severe obstruction
  - Excision of web by:
    - microlaryngosurgery using laser or cold instruments
    - laryngofissure in very thick web
C: imperforate web: Urgent tracheostomy or rigid bronchoscope to rupture the web

2- **Laryngomalacia (congenital laryngeal strider)**

**Def:** stridor due to weak flaccid larynx.

**Aet:** cartilaginous framework of larynx is abnormally soft & gets collapsed during inspiration especially supraglottic structures.

**Incid:** Most common congenital anomaly.

**Path:** Elongated narrow folded epiglottic (omega), shortened approximated ary epiglottic fold, prominent elongated arytenoids & deep supraglottis.

**Symptoms:**

1- Inspiratory stridor: usually mild
   Increase on supine, decrease on prone.
2- No hoarse cry

**Signs:** (as pathology & aetiology)

**Treatment:**

1- Usually no ttt & condition improves by age of 12-18 months
   Give only vit D & Ca
2- Rarely tracheostomy or intubation in severe distress
3- Laser to remove excess mucosal folds, division of aryepiglottic fold

3- **Congenital subglottic stenosis**

4- **Subglottic haemangioma**

Reddish subglottic soft mass, situated posteriorly or laterally.

Stridor at age of 3-6 months, no hoarseness or bleeding.

Associated with cutaneous hemangioma in 50%, usually regress spontaneously but tracheostomy may be needed till then

5- **Congenital V.C paralysis**

Usually due to birth trauma, may be due to congenital CNS anomalies (meningocele) or mediastinal mass.
6- **Laryngo tracheo-oesophageal cleft**

Abnormal communication between larynx & trachea anteriorly and hypopharynx & oesophagus posteriorly........ stridor, choking & aspiration......... pneumonia

7- **Congenital cysts**

**Laryngeal (saccular) cyst**

Mucous filled cysts, arise from ventricle, false folds or aryepiglottic fold.

Asymptomatic if large: hoarseness & stridor.

Ttt: endoscopic excision or marsupialisation.

**Laryngocele:**

- Special type of congenital cyst develops from laryngeal saccule (anterior portion of the ventricle between false & true cords).
- May be internal, external, combined.
- Symptoms: hoarseness, stridor & neck swelling.
- Signs: bulge of the ventricle.
  - Soft, expansile, compressible mass, on lateral neck
  - **Invest:** X ray air filled sac
  - **TTt:** excision endoscopic: laser or MILS or external

---

**Laryngeal trauma**

**Types**

I- **Mechanical**

1- Sharp (penetrating): stab, gunshot, cut throat.
2- Blunt: blow, strangulation, motor car accident.
3- Inhaled F.B
4- Surgical: rough endoscopy, high tracheostomy
5- Intubation injury: rough intubation, prolonged intubation

II- **Chemical**

- Corrosive ingestion (potash)
- Inhaled irritant gases
III- Physical: Irradiation injury

**Symptoms:**

<table>
<thead>
<tr>
<th>History of trauma</th>
<th>Dyspnea &amp; stridor</th>
<th>Hoarseness of voice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe local pain</td>
<td>Dysphagia</td>
<td></td>
</tr>
<tr>
<td>Haemoptysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External swelling</td>
<td>Hge, shock (hypovolaemic or neurogenic)</td>
<td></td>
</tr>
</tbody>
</table>

**Signs:**

1- External:

- **Inspection:** Swelling due to oedema, haematoma, surgical emphysema
  - Deformity as depressed cartilage
  - External wound
- **Palpation:** Localized tenderness & crepitus
  - Surgical emphysema
  - Deformity

2- By flexible or direct laryngoscopy

- **Mucosa:** laceration
- **Submucosa:** oedema or haematoma
- **V.F:** paralysis or avulsion
- **Cartilage:** displaced
- **Joints:** dislocated
- **Arytenoids:** intubation granuloma

- **investigations:** - D.L - C.T

**treatment:**

Air way secure by tracheostomy or intubation

Shock management

Drugs: antibiotics  Steroids

Open reduction: suture laceration & fractured cartilage + stent

**F.B**

**In the larynx**

Rare, mostly goes to trachea, sharp or large FB may be impacted

Sudden severe respiratory obstruction
Tt: Heimlich maneuver: sudden abdominal compression
   Turn child upside down & slap back
   Removal by DL
   Tracheostomy or cricothyrotomy

*Inhaled FB*

- **incid:** children, mentally retarded
- **Types:** vegetable: seeds, beans   non vegetable: pins, buttons.
  endogenous: vomitus, blood
- **Sites:** rare in larynx (passes to esophagus or bronchus) in bronchi
  usually right main bronchus (wider & in line with the trachea).
- **Clinical picture:**
  A- initial stage sudden severe cough, cyanosis, dyspnea and
     sometimes haemtysis, this stage may pass unnoticed
  B- Latent stage: mild cough & expectoration  localized wheeze
  C- Manifest stage:
    I- Mechanical obstruction

<table>
<thead>
<tr>
<th>Complete (collapse)</th>
<th>Partial (emphysema)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyspnea, cough, expectoration</td>
<td>Dyspnea, cough, expectoration</td>
</tr>
<tr>
<td>mediastinum shift to same side</td>
<td>To opposite side</td>
</tr>
<tr>
<td>Dullness on percussion</td>
<td>Hyper resonance</td>
</tr>
<tr>
<td>No air entry</td>
<td>Localized wheeze</td>
</tr>
</tbody>
</table>

II- Inflammatory changes
   Bronchitis, bronchopneumonia, lung abscess (more in organic F.B)

D- Large F.B: Impacted in larynx may cause suffocation

- **Investigations:** 1- D.L & bronchoscopy   2- Xray neck &
  chest
- **Ttt:** 1-Urgent tracheostomy in large impacted F.B
  2- Removal by direct laryngoscopy or bronchoscopy

*Laryngeal stenosis*
**Def:** Fibrotic narrowing of endolarynx leading to respiratory distress

**Aet:**

- Congenital: Congenital laryngeal atresia, congenital laryngeal web
  - congenital subglottic stenosis
- Trauma (see before)
- Chronic inflammations (granulomas): Scleroma, T.B, $, leprosy
- Laryngeal neoplasms: chondroma, fibroma, carcinoma

**Incid:** most common is subglottic (& most difficult to treat)

**Path:**

1- supra glottic
2- glottic (ant, post, complete)
3- Subglottic

**Clinical picture:**

- Asymptomatic
- Biphasic stridor & dyspnea

**Investigations:**

1- DL & bronchoscopy
2- C.T to show length & degree of stenosis
3- Pulmonary functions for follow up

**Treatment:**

A) Tracheostomy in severe cases

B) Endoscopic procedure: Laser excision, repeated dilatation

C) External: laryngoplasty: split cricoid, insert costal graf & put Montgomery tube

  Resection & end to end anastomosis.

**Laryngitis**

**I- Acute**

(A) **Non specific** in adults, in children, epiglottitis & laryngo tracheobronchitis

(B) **Specific:** Diphtheria

**II- Chronic**

(A) **Non specific**

  - hypertrophic: Diffuse
  - Localized: nodule, polyp, and leukoplakia
Atrophic

(B) Specific (granulomas): scleroma, TB, S, leprosy, & mycosis

I- Acute Laryngitis

(A) Acute non specific laryngitis

(1) In adults

Def.: acute catarrhal inflammation of laryngeal m.m.

Aet.: follow upper respiratory tract infection

Viral: influenza, rhinovirus     Bacteria: Strept. pneumonia, strept., straph.

- Predisposing factors:     - Smoking.
  - Voice abuse.     - Dust & fumes.
  - Post nasal discharge as in sinusitis.

Incid.: see above Path: congestion and edema

Symptoms:

General: fever (occasionally), headache, malaise, and fatigue.

Local: hoarseness.

- Discomfort & pain on phonation.
- Dry cough + yellow sputum.

Signs: Diffuse symmetrical congestion & oedema, + mucoid secretions.

Treatment:

1- Voice rest.  2- Fluids.

3- Humidificatoin :steam, tincture benzoini.

4- Systemic antibiotics.  5- Mucolytics.

(2) Acute non specific laryngitis in children

Def.: as before.

Aet.: as before.

Path: Difference between adult & child larynx.

1- Anatomical factors.

- Lumen is relatively smaller.
- Loose submucosal tissue.
- Funnel shaped lumen.
- More abundant lymphatic supply in mucosa.

→ More oedema, minimal edema cause marked obstruction.
2- Immature immune system.
3- Immature nervous regulation = spasm.

**Symptoms:**

**General:** as usual.

**Local:**
- Hoarseness.
- Dry cough.
- Stridor, dyspnea.

**Signs:**
- Diffuse congestion and oedema.
- + mucoid secretion.
- Subglottic oedema

**D.D.:** causes of stridor in children

**Treatment:** as adult +
- Hospitalization, oxygen.
- Steroids to decrease oedema.
- Careful observation of respiratory obstruction if severe distress → intubation, or rarely tracheostomy (avoided in children unless no other way).

(3) **Acute Epiglottitis**

**Def.:** Acute non specific laryngitis affecting mainly epiglottis.

**Aet.:** Haemophilus influenza usually.

**Incid.:** more in infants & children.

**Symptoms:**

**General:** high fever, malaise, headache, and anorexia.

**Local:**
- Severe odynophagia, drippling of saliva.
- Muffled voice (hot potato).
- Rapidly progressive stridor.

**Signs:**
- Oedema of supraglottis.
- Epiglottis appears as red swollen mass.
- Pharyngeal oedema & congestion.
- Enlarged UDCLN.

**Ttt:** as before.

(4) **Acute laryngo tracheobronchitis**

**Def.:** Acute respiratory infection spreading to entire respiratory system.

**Clinical picture:**

In adult: as laryngitis + cough, expectoration.

In children: as laryngitis + cough, expectoration.
**Treatment:** as laryngitis.

**(B) Laryngeal diphtheria.**

**Symptoms:**
General: Toxaemia →
Local: hoarseness, stridor, Dyspnea, cough.

**Signs:** grayish, white, dirty membrane.

**Treatment:** as usual. + Tracheostomy.

II- **Chronic Laryngitis.**

**(a) Chronic non specific laryngitis.**

**(1) Hypertrophic**

**(a) Chronic diffuse hypertrophic laryngitis.**

**Aet.:** - Repeated acute laryngitis → predisposing factors.

**Symptoms:**
- Hoarseness of voice - Cough & expectoration.
- Hemming (desire for frequent throat clearing).

**Signs:** Congested thickened V.F

in oedematous type (reinke oedema) : pale polypoidal VF.

**ttt:** 1- Remove predisposing factor. 2- Like acute but no antibiotics.

3- VF stripping: MLS or laser in resistant cases

**(b) Chronic localized hypertrophic laryngitis.**

**(1) Vocal cord nodules**

**Aet.:** - Voice abuse (singer).
- reflux

**Incid.:** More in females, children.

**Path:** Epithelial hyperplasia of

Free edge of V.F.
Fresh: soft & red

mature: hard & white

**Symptoms:** hoarseness, weakness

**(2) Vocal cord polyp.**

**Aet.:** - Voice abuse.

**Incid.:** More in males.

**Path:** Localized subepithelial oedema, or vascular engorgement, followed by

fibrosis.

**Symptoms:** hoarseness, weakness

- Hoarseness.
Rarely stridor if large.
- Choking.
- Unilateral
- Small or large
- Usually pendunculated.
- Grey, white or red.
- From undersurface or V.F.
- Site as nodule.

**Signs:** Bilateral.
- Small tiny nodules.
- Sessile
- White or pink.
- At free margin of V.F.
- Junction of ant 1/3 & post 2/3.

**Treatment:** Voice rest, avoid misuse.
- Removal by MLS
- Laser.
- Speech therapy.
- Voice rest, avoid misuse.

(3) Leukoplakia.

**Def.:** white patch on laryngeal mucosa.

**Aet.:** Irritation.

**Pathology:** Epithelial hyperplasia & hyperkeratinization.

**Symptoms:** persistent hoarseness.

**Signs:** white patch on V.F.

May appear as diffuse, villous, or verrucous.

**ttt:** Excision by MLS or Laser, follow up as it is pre cancerous.

(2) Atrophic.

**Aet:** dusty atmosphere - Industrial fumes - Post irradiation therapy
Incid: more in women

**Symptoms:** hoarseness, offensive breath & dyspnea (crusts)

**Signs:** dry pale atrophic mucosa, & crusts

**Ttt:** Avoid predisposing factors, moisture, menthol inhalation, laryngoscopy to remove crusts

(B) **Chronic specific laryngitis (Granuloma).**

(1) **Laryngoscleroma.**

**Def.**: chronic specific inflammation affecting upper respiratory tract.

**Aet.**: gram – ve bacilli; klebsiella rhinoscleromatis.

**Incid.**: endemic in Egypt. Usually 2ry to nasal scleroma may be 1ry.

Usually subglottic region.

**Path.** see nose.

**Symptoms:**
- stridor & dyspnea.
- Hoarseness may be present.
- Cough & expectoration.

**Signs:** pale pinkish smooth swelling on both side of subglottis covered by greenish crusts → fibrosis & subglottic stenosis.

**Investigations:**
- DL & biopsy.
- CT for length & degree of stenosis.

**ttt:**
1- Medical as in rhinoscleroma.
2- Voice rest & humidification.
3- Tracheostomy, if severe distress.
4- Excision of the web by Laser.

External: graft & stent
Resection anastomosis

(2) **T.B laryngitis.**

**Aet.** 2ry to pulmonary T.B.

**Path.:** affect post part of larynx.

**Symptoms:**

I- **General:** 1- T.B toxemia: night fever, night sweat, loss of weight, loss of appetite.
2- Pulmonary T. B cough, expectoration, haemptysis.

II- Local:

1- Hoarseness: progressive, phonosthesia( weak voice)
2- Stridor & dyspnea.
3- Pain & referred otalgia.
4- Odynophagia (marked).

**Signs:**

I- External: Tenderness due to perichondritis.

II- by I.L or flexible:

1- T.B granulations on arytenoids.
2- T.B ulcer: thin undermined edge, yellow caseous floor.
3- Impaired V.F mobility.

**Investigations:**

1- DL & biopsy. 2- Chest X ray for T.B. 3- Tuberculin test: good negative.

**Treatment:**

1- Tracheostomy in severe distress.
2- Anti tuberculous drugs e.g. rifampicin, PASA, streptomycin & pyrazinamide.
3- Local anesthetic spray before meals.

(3) **Syphilis of the larynx.**

**Aet.:** Treponema pallidum (spirochete).  
**Incid.:** Very rare.

**Path.:** 1ry chancre. 2ry mucous patches. 3ry gumma (commonest).

**Symptoms:** - Hoarseness.
- Stridor.
- Cough & discomfort (no pain).

**Signs:** $ affects ant. part of larynx

- Gumma of epiglottis appears swollen & ulcerated.
• Diffuse symmetrical infiltration without ulcerated.

**Investigations:**
1- DL & biopsy.  2- Radiology.  3- Serology for $.

**Ttt:**
1- Tracheostomy if needed.
2- Penicillin.

(4) **Lupus**

**Aet.:** attenuated T.B.  **Incid.:** mostly 2ry to nasal lupus.

**Path.:** apple jelly nodule.
- Ulceration on one side.
- Fibrosis, notched epiglottis.

**Symptoms:** vague discomfort.

**Signs:** see pathology.

**Investigation:**  DL & biopsy.  - X ray chest.

**Ttt:** like T.B + vit. D.

(5) **Leprosy**
- Lepromatous or tuberculoid types.
- Nodules → ulceration → fibrosis.
- **Ttt:** Dapson + rifampicin.

(6) **Fungal infection (mycosis).**

a) **candidiasis (moniliasis)**
- Caused by candida albicans, whitish grey fibrinous membrane.
- **Ttt:** Remove the underlying cause, topical nystatine or miconazole.

b) **Aspergillosis.**

**Perichondritis**

**Def:** inflammation of the perichondrium of laryngeal cartilage

**Aet:** trauma…………
- Infection: TB, S, typhoid
- Advanced carcinoma

**Path** perichondritis……subperichondrial abscess… cartilage necrosis & stenosis

**Symptoms:** fever, malaise, pain increase on swallowing, hoarseness, & stridor

**Signs:** marked tenderness, enlarged laryngeal framework
Laryngeal mucosa is red, edematous, & covered with pus

**Ttt:** hospitalization, high dose of antibiotics, steroids
Incision of abscess, remove necrosed cartilage.
Tracheostomy or intubation. - Laryngectomy in advanced cases.

**Laryngeal oedema**

**Aet:** trauma………..
Infection: laryngitis, perichondritis, spread of infection from quinsy, ludwig
Angioneurotic oedema: allergic (foods, inhalants & drugs) or hereditary
Non inflammatory oedema: heart renal or liver failure, myxodema.

**Symptoms:** hoarseness, stridor & dyspnea

**Ttt:** Rest, oxygen, ttt of the cause
Tracheostomy or intubation in sever cases
Antihistaminics, & hydrocortisone

**Tumors of the larynx**

I- Benef

A) **Epithelial** Papilloma. Adenoma.
B) **Mesenchymal** Haemangioma, Chondroma, Fibroma.

**Papilloma (commonest benign)**

(A) Single papilloma
   Adult papilloma
(B) Multiple papillomatosis
   recurrent papillomatosis.
   Juvenile multiple papillomatosis

**Aet.:** - True papilloma
   - Viral HPV
   Autoimmune
   Hormonal imbalance

**Incid.:** - Adult 30-50 y
   Male: female 2/1.
   - Children.
   Equal sex.

**Path.:** - Commonest site is free
   extend
   edge of V.F, may to trachea, bronchi,
affect other sites.  
- Vascular C.T core covered by hyperplastic st. sq. epithelium.  
- Similar.

**Symptoms:**
- hoarseness  
+ stridor if large.  
- Stridor.  
Hoarseness.

**Signs:**
- single, white or pink.  
- Multiple white or pink.  
warty like growth sessile or warty, sessile affecting any pedunculated variable size.  
portion of the larynx.

**ttt:** Surgical excision by: MLS using cold instruments or laser  
MLS using cold instruments or laser laryngofissure.  
Tracheostomy usually needed (try to avoid……spread).  
Interferon.

**Malignancy:**
- 3%  
- no

**Recurrence:**
- rare  
- very common

**II- Malignant (Cancer larynx)**

**Def.** malignant tumor of the larynx.

**Aet** Pre disposing factors  
tobacco: smoking the most important.
alcohol ingestion → supra glottic carcinoma.

irradiation.

Precancerous lesions: Leukoplakia Adult papilloma.

**Incid:** Old over 40 with peak in 60. Male to female 8:1 (now less).

Common neoplasm, 1% of all malignancies.

**Path.:**

(A) Site: glottic 70% Supraglottic 25% Subglottic 5%

(B) G.P: Malignant ulcer. Fungating mass. Infiltrating nodule.

(C) M.P: commonest is squamous cell carcinoma.

(D) Spread:

1- Direct

   Glottic Supraglottic subglottic

2- Lymphatic spread.
   a) Glottic: very rare, as there is no lymphatics in Rinek’s space.
   b) Supraglottic: common & early due to rich lymphatics → UDCLN.
   c) Subglottic: common may be bilateral → pre laryngeal, pre tracheal, paratracheal → middle & LDCLN.

3- Blood spread rare & late: lungs, liver, bone, brain.

(E) T.N.M classification

(a) T for primary tumor
T\textsubscript{is} Carcynoma in situ.
T\textsubscript{1} One region (in glottic T\textsubscript{1a}: one cord, T\textsubscript{1b}: two cords).
T\textsubscript{2} Two regions.
T\textsubscript{3} Fixed cord.
T\textsubscript{4} Extra laryngeal spread.

(b) N: LN metastasis.
N\textsubscript{0}: No palpable LN.
N\textsubscript{1}: Single, 3 cm or less, ipsilateral.
N\textsubscript{2}\textsubscript{a}: Single, 3-6, ipsilateral.
N\textsubscript{2}\textsubscript{b}: Multiple, 3-6 ,ipsilateral.
N\textsubscript{2}\textsubscript{c}: Bilateral < 6cm.
N\textsubscript{3}: more than 6 cm.

(c) M Distant metastasis.
M\textsubscript{0}: No clinical or radiological evidence of metastasis.
M\textsubscript{1}: Present clinical or radiological evidence of metastasis.

**Symptoms:**
1- Hoarseness of voice - progressive. -early in glottic cancer.
2- Dyspnea & stridor due to air way obstruction.
3- Discomfort in the throat.

Late symptoms:
4- Pain, referred otalgia along Arnold branch of X.
5- Cough & irritation.
6- Neck swelling: LN metastasis or direct tumor infiltration.
7-Dysphagia, haemoptysis. 8-Foetid breath, cachexia.

**Signs:**
II- Local: (Larynx)
(1) External (Neck):
- L.N, describe.  - Swelling, broadening.
- Tenderness.  - Thyroid.
(2) by I.L flexible or D.L examine:

- **Tumor:** - hyper keratotic warty or papillary growth.
  - Malignant ulcer.
  - Raised nodule.
- **V.F mobility:** - Freely mobile.
  - Fixed: deep muscle invasion.
  - Limited: weight of tumor or moderate invasion.
- **Extension:** to hypopharynx, trachea or tongue.

*NB:* some areas are difficult to be examined: ventricle, subglottis, posterior surface of epiglottis.

**Investigations:**

1- CT or MRI neck most important radiological diagnosis for accurate staging.

2- DL & biopsy. Site, extent, biopsy.

3- Metastatic work up.(chest X ray, abdominal sonar & bone scan)

4- Routine preoperative investigations.

**Treatment:**

**T\(_{1S}\):** surgery: V.F stripping by MLS.or Laser , followed by regular follow up

Radiotherapy (not preferred).

**T\(_{1}, T\(_{2}\):** surgery: Partial laryngectomy aiming at complete tumor excision with preservation of phonation, normal breathing & deglutition

Endoscopic Laser excision.

Radiotherapy.

**T\(_{3}\):** Total laryngectomy + post operative radiotherapy

Also in subglottic tumors & recurrent cases after conservative surgery or radiation

- Large T\(_{2}\) or small T\(_{3}\): subtotal laryngectomy (cricohyoidoepiglottopexy).

**T\(_{4}\):** - Total laryngectomy + post operative radiotherapy.

- Trail of chemo radio therapy.
Management of cervical metastasis.

If palpable LN → RND.

If no palpable LN → Glottic (nothing)

Supra glottic → prophylactic neck dissection, or radiotherapy.

Sub glottic → prophylactic neck dissection, or radiotherapy.

**Indications of total laryngectomy:**

1- T₃, T₄ glottic, supraglottic.
2- All subglottic & transglottic.
3- Recurrence or failure after conservative surgery.
4- Recurrence or failure after radiotherapy.
5- Contraindication for conservative or radiotherapy.
6- Certain histological types.

**Contra indications of total laryngectomy:**

1- Poor general condition.
2- Patient refusal.
3- Distant metastasis.
4- Involvement of unresectable structures.

**Disadvantages of total laryngectomy.**

1- Loss of voice.
2- Inability to increase intra thoracic pressure.
3- Permanent tracheostomy.
4- Loss of nasal functions.
2- Limitation of activities.

**Rehabilitation after surgery:**

1- After partial laryngectomy: voice therapy.
2- After total laryngectomy: Oesophageal speech.
Tracheo oesophageal puncture.

Electronic larynx.

**Palliative ttt**

Indicated in: unresectable tumors, surgery refusal, distant metastasis & poor general condition

1- Tracheostomy.  
2- Ryle or ghurstomy for feeding.  
3- Palliative laser, radiotherapy, chemotherapy.  
4- Pain killers.  
5- Antibiotics.

**Prognosis:** early cancer has good prognosis.

Glottic cancer has best cure rate up to 90% due to early presentation (hoarseness) & absent lymphatic spread.

**Vocal Cord Paralysis**

*a- Unilateral v.c paralysis*

**Aet:** Vagal or RLN injury.

**(A) Peripheral**

1- *Congenital* Hydrocephalus

2- *Surgical trauma* 20%.

- Thyroidectomy - Radical neck dissection.

- Pharyngeal pouch - Esophageal surgery.

- Cardio vascular surgery.

3- *Non surgical trauma* 20%.

- Neck trauma e.g. stangulation, open injuries.

- Cricothyroid joint dislocation.

- Fracture skull base.

4- *Inflammatory* 5%.

- Apical pulmonary T.B. - Meningitis, osteomyelitis.

5- *Peripheral neuritis*
- Infections: herpes, influenza, and diphtheria. - DM
- Chemicals: alcohol, lead. - Ascending polyneuritis

6- Neoplastic 25%.
- Thyroid malignancy. - Hypopharyngeal malignancy.
- Bronchogenic carcinoma. - Oesophageal carcinoma.
- Malignant L.N.

7- Miscellaneous
- Myasthenia gravis. - Rheumatoid arthritis, SLE.

8- Idiopathic: unknown cause usually viral in aetiology.

(B) Central causes. (Bulbar):
- Head trauma.
- Thrombosis, Hge, embolism.
- Encephalitis, polio, diphtheria.
- Medullary tumors.

Vocal cord positions

1- Median: both cords in midline.
2- Paramedian: glottis 3-5 mm.
3- Cadaveric: glottis 7 mm.
4- Slight abduction: glottis 14 mm.
5- Full abduction: 18 mm.

Explanation of vocal cord position:

(A) Semon’s law

In progressive RLN injury, abductor paralysis occurs 1st → v.c in median or paramedian position, then adductor paralysis → cadaveric position.

(B) Adductors are more powerful than abductors so, when RLN is injured, adductors takes upper hand.
(C) Wegner – Grossman theory.

In RLN → paramedian position by cricothyroid muscle.

In vagal → cadaveric position.

**Symptoms:**

1- May be asymptomatic when compensated.

2- Hoarseness: may improve if compensation

(其他cord crosses midline to meet paralyzed one).

3- No stridor.

4- Aspiration: may improve.

**Signs:** By indirect or flexible laryngoscopy:

a) In RLN injury: median or paramedian position.

b) In vagal injury: cadaveric position.

The paralyzed cord appears bowed (flaccid), at a lower level, with the arytenoids leaning inwards

Full head, neck, chest exam for cause.

**Investigations:**

(1) **Radiology**

- X ray chest, nasopharynx, and neck.  - CT from skull base to mid thorax.

- CT & MRI brain.  - Barium swallow.  - Thyroid scan.

(2) **Endoscopy**

Panendoscopy: nasopharyngoscopy, laryngoscopy, hypopharyngoscopy, oesphagoscopy & bronchoscopy + biopsies.

(3) **Blood exam.**

CBC, ESR, viral studies, blood sugar.

**Treatment:**

1- Treat the causes if possible.

2- Most cases requires no ttt: compensation or Spontaneous recovery may occur

3- Surgical ttt, after 6-12 months.
• Indicated in: persistent hoarseness or aspiration.
• Operation performed (medialization)
  a) Teflon or Collagen injection.
  b) Throplasty: external medialization.
  c) Nerve muscle pedicle reinnervation.

\[b- \quad \textit{Bilateral Vocal Cord Paralysis}\]

\[a- \quad \textit{(Bilateral Abductor Paralysis)}\]

\textit{Aet.:} injury to both RLN (peripheral).

1- \textbf{Surgical trauma}. Thyroidectomy, esophageal surgery.

2- \textbf{Peripheral neuritis}.

3- \textbf{Neoplastic}: cancer thyroid.

\textit{Symptoms:}

1- Good voice but tries easily.

2- Stridor may be severe, increase by exertion & infection.

\textit{Signs:}

1- By indirect or flexible laryngoscopy: Vocal cords are in median or paramedian position.

2- Head, neck, chest exam for cause.

\textit{Investigations}: same

\textit{Treatment:}

1- If sever stridor → Tracheostomy.

2- In established cases: laryngeal widening procedure, 3-6 months later.
   (a) Endoscopic arytenoidectomy with posterior cordectomy using MLS or laser.
   (b) Woodman’s operation. External operation to fix arytenoid laterally.
   (c) Reinnervation procedure.
   (d) Tracheostomy with speaking valve.

\[b- \quad \textit{Bilateral adductor paralysis}\]

Presents with aphonia & aspiration (fatal)

Ttt: tracheostomy with speaking valve

Laryngeal closure
Total laryngectomy

**Tetany neonatorum & laryngismus stridulus**

**Def:** active laryngeal spasm  
**Aet:** Ca deficiency

**Incid:** young under nourished rickety children, commonly with adenoids

**Clinical picture:** stridor suddenly at night, cyanosis, may be carpo-pedal spasm

**Ttt:**  
A: during the attack: slapping child back, traction on the tongue  
B: in between attacks: adenoidectomy, Ca

**Laryngeal symptoms**

**Stridor**

**Def.:** noisy respiration indicating partial airway obstruction in larynx &/or trachea.

**Types:**  
a. inspiratory laryngeal: at or above glottis.  
b. Biphasic: subglottic or tracheal.  
c. Expiratory: bronchial.

**Causes:**

**I- Congenital:**

- Congenital web  
- Subglottic stenosis  
- Congenital cyst

**II- Traumatic:**

Mechanical: sharp, blunt, surgical, intubation, F.B.  
Physical: radiotherapy, thermal.  
Chemical: corrosives.

**III- Inflammatory:**

- Acute non-specific laryngitis, in children  
- Acute laryngo tracheo brochitis in children.  
- Chronic specific laryngitis (granulomas)

**IV- Neoplastic**

Benign: multiple papillomatosis.  
Subglottic chondroma.  
Malignant: carcinoma.

**V- Miscellaneous**

Neurological: bil abductor paralysis.


*Laryngeal spasm e.g. tetany*

Tumor like conditions: Laryngeal cysts, laryngocele, amyloidosis.

*Laryngeal oedema.*

**VI- Tracheal causes**

*Retrosternal goiter, mediastinal LN, thymus hyperplasia, & deep neck infection*

**Clinical picture:**

1- Stridor
2- Dyspnea & tachypnea.
3- Irritability, restlessness, fatigue, sweating.
4- Working ale nasi.
5- Suprasternal, supraclavicular & intercostal retraction.
6- Working accessory muscles.
7- Tachycardia.
8- Congested neck veins during expiration.
9- Late: cyanosis, bradycardia
Finally: coma & cardiac arrest.

± Hoarseness of voice. 

**NB: Stridor in children.**

**Hoarseness of voice**

*Def.:* change in quality & timbre of voice, so it becomes rough, harsh & low pitch. caused by incomplete coaptation, tension or vibration.

***Causes of hoarseness.***

I- Congenital: web.

II- Traumatic: Mechanical, physical, chemical + voice abuse.

III- Inflammatory: all except subglottic scleroma.

IV- Neoplastic: Benign & malignant.

V- Miscellaneous: Unilateral cord paralysis

Crico arytenoid arthritis.

General weakness: myasthenia or convalescence

Lack of mucus secretion: atropine

Hysterical.
NB: Stridor without hoarseness.

Hoarseness without stridor.

**Laryngeal operations**

**Tracheostomy**
Creation of surgical opening, in anterior tracheal wall.

**Indications:**

I- Upper respiratory tract obstruction.

a- Congenital →

b- Traumatic →

c- Inflammatory →

d- Neoplastic →

e- Miscellaneous →

f- Extra laryngeal causes (injury, infection, oedema, tumors)

- Injury: maxillofacial.
- Infection: retropharyngeal abscess.
- Edema: tongue & neck edema
- Tumors: oral cavity, tongue, pharynx.

II- Lower respiratory tract obstruction

1- Secretory obstruction.

- **Value:**

  1- Frequent accurate aspiration of secretion.
  2- Elimination of dead space.
  3- Prevent aspiration by cuffed tube.
  4- Avoids complications of prolonged intubation.

- **Causes:**

  A) Central

  1- Head injury: contusion, laceration.
  2- Drug intoxication
  3- Uraemia, ketoacidosis.
  4- Brain tumors & abscess.
  5- Stroke: Hge, embolism, thrombosis
B) Peripheral
   1) Respiratory muscle paralysis.  2) Chest injury e.g. ribs fracture.

2- Respiratory failure:
   - COPD  - Neurological disorders e.g. polio, myasthenia.

III- Elective
   A) Before laryngeal surgery.
   B) Before major operations in head e.g. angiofibroma, maxillectomy,

Types:

<table>
<thead>
<tr>
<th>Site</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Easy</td>
<td>Cricoid injury</td>
</tr>
<tr>
<td>1\text{st}, 2\text{nd} rings</td>
<td>Rapid</td>
<td></td>
</tr>
<tr>
<td>3\text{rd}, 4\text{th} behind isthmus</td>
<td>Avoid previous disadvantages.</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Papillomatosis</td>
<td>Difficult</td>
</tr>
<tr>
<td>5\text{th}, 6\text{th}</td>
<td>Subglottic Cancer</td>
<td>Pleural injury.</td>
</tr>
<tr>
<td>7\text{th}, 8\text{th}</td>
<td>Subglottic Stenosis</td>
<td>Innominate v. injury.</td>
</tr>
<tr>
<td>3\text{rd}, 4\text{th} behind isthmus</td>
<td></td>
<td>Slips easily.</td>
</tr>
</tbody>
</table>

Technique:

1- Anesthesia: Usually local infiltration.
   General: in elective cases, better in children.
   No anesthesia in real emergency.(better do cricothyroidotomy).

2- Position: Supine with extended neck.
   If patient distressed: sitting or semisitting.

3- Incision: Vertical: rapid, lower border of thyroid….manubrium
Transverse: cosmetic, between lower border of cricoid and supra sternal notch

4- Incise fat, fascia, separate pretracheal muscles.
5- Dissect, incise & transfix isthmus.
6- Open the trachea as a flap.
7- Put a suitable tube.
8- Adequate haemostasis.
9- Close the wound not too tight, fix tube to skin.

**Types of Tracheostomy tubes:**

1- Metal of silastic. 2- Cuffed or not.
3- Tubes with inner & outer layers. 4- Tubes with expiratory value.

**Complications:**

1- Anesthetic complications local or general.
2- Apnea
   - When operation done under L.A
   - Due to rapid wash out of CO$_2$ which is stimulus for respiratory center.
   - ttt: close the opening for a short time, allow patient to breath 95% O$_2$ in 5% CO$_2$, or assisted ventilation.

3- Bleeding
   a) Primary ant. jugular v. Thyroid gland. Innominate v.
   b) Reactionary slipped ligature, from previously collapsed v.(open the wound & ligate the vessel)
   c) Secondary due to infection.(antibiotics & fresh blood)
4- Pneumothorax.

Due to: pleural injury. Manifested by: dyspnea ↓ air entry, X ray.
ttt: intercostal tube connected to underwater seal.

5- **Pneumomediastinum.**

Due to: Excessive inferior dissection.

If mild: resolve spontaneously.  
If severe: acute heart failure.

6- **Crustation.**

No filtration of inspired air.  
Decreased mucociliary clearance.

7- **Delayed complications:**

a) Subglottic stenosis: due to cricoid injury.

b) Tracheal stenosis: due to erosion by tube or infection.

c) Difficult extubation.

d) Tracheo oesophageal fistula.

e) Tracheo cutaneous fistula.

8- **Emphysema (surgical).** Air accumulation under skin.

Due to:  - Improperly fitting tube.  
- Excessive lateral neck dissection.

***ttt:*** Remove a skin suture  
Insert a more fitting tube.

9- **Embolism (air embolism):** due to injury of large neck vein.

***ttt:*** Pour saline into wound.  
Compression of opened vein.

Elevate foot of bed.  
Blood transfusion.

10- **Injury**

- Thyroid gland → Hge.  
  - Apex of pleura → pneumothorax.

- Cricoid cartilage → subglottic stenosis.

- Posterior tracheal wall → Tracheo oesophageal fistula.

  ***ttt:*** Ryle feeding, surgical repair.

- Big vessels → Hge.  
  - RLN → V.F paralysis.

11- **Infection**

Wound infection.  
Chest infection.

12- **Tube complications:**

a) Slipped tube:

Due to low tracheostomy, wide stoma, short neck, or short tube.

***ttt reposition.***
b) Blocked tube by dried secretions.
   Frequent suction. Cleaning with NaHCO₃.

Post Operative Care.
1- Patient lies in semi sitting position.
2- Observation for vital signs.
3- Observation for bleeding.
4- Observation for respiratory distress.
   Known by recurrence of stridor, absence of air current, absence of
   mirror dimness, patient can speak without closing the tube.
5- Humidification by steam inhalation.
6- Antibiotics.
7- Mucolytics.
8- Care of tube:
   a) Frequent suction, NaHCO₃ to dissolve mucous.
   b) Regular removal of inner tube for cleaning.
9- Extubation: tube is closed with cork for daytime, then day & night
   and then removed.

Cricothyroidotomy (Laryngotomy)
A surgical opening made into the cricothyroid membrane.

Indications:
It is done only in real emergency.
If facilities or experience for tracheostomy are not available.

Technique:
A transverse stab is made with any available knife or even scissors.
A special combined laryngostomy tube and introducer (if available) is
used, however, if it is not present any tube is inserted e.g. a ball point pen
barrel.

Total laryngectomy (see before)

Laryngofissure (Median thyrotomy):
Opening the larynx in the mid-line through an external incision by
splitting the thyroid cartilage.

Indications:
1- Post-traumatic laryngeal stenosis  
2- Impacted F.B.  
3- Post-inflammatory laryngeal stenosis e.g. scleroma.  
4- Large benign tumors  

2- Malignant tumors: T1 glottic carcinoma.

**Partial laryngectomy**

A: partial vertical (for glottic carcinoma)

Types: Vertical hemilaryngectomy: one cord

- Frontolateral hemilaryngectomy: extends to ant. Commissure, up to third of opposite cord
- Frontal partial laryngectomy: ant. Commissure, or third of one or both cords

B: Partial horizontal: (for supraglottic tumors)

- Limited to supraglottis with free mobile cord

C: Cricohyoidopexy or cricohyiodoepiglottopexy: a special type of partial laryngectomy, leaving only one or two arytenoids.

**Direct laryngoscopy**

This is direct visualization of the larynx under general anesthesia.

**Indications:**

*Diagnostic*

1- Examination of the larynx in infants and children.

2- Examination of the larynx in adults with difficult indirect laryngoscopy (mirror examination) is difficult.

3- To assess extent & site of a lesion, as for staging of malignant tumors.

4- To take a biopsy.

*Therapeutic*

1- Removal of a foreign body.

2- Microlaryngosocpic sugery (MLS) e.g. to remove a polyp, nodules, or small localized tumors under magnification.

**Phoniatrics**

*Phoniatrics:* medical branch that deals with disorders of language, speech & voice
**Language:** the communication of meanings by means of symbols, it has 4 modalities comprehension, speaking, reading, & writing.

**Speech:** articulation of different speech sounds, controlled via: pyramidal tract, extra pyramidal, cranial nuclei (5, 7, 10&&12) & cerebellum.

**Voice:** physical act of sound production by means of VF with the exhaled air stream

**A: language disorders**

**1-Delayed language development (DLD)**

_Causes:_ brain damage (mental retardation, cerebral palsy)

- Sensory deprivation (hearing or visual)
- Psychiatric disturbance

_Assessment:_ investigations for the cause, investigations for language level

_Management:_ correction of auditory, visual, nervous, or endocrinal problems

- General language stimulation

**2-Aphasia**

_Def:_ acquired impairment of language processes.

_Causes:_ stroke, cranial trauma, cerebral tumors, degenerative diseases (Alzheimer), metabolic, & infections

_Assessment:_ neurological examination, radiological investigations

- Psychological & language assessment

_Ttt:_ of the cause & language stimulation

**B: speech disorders**

**1-stuttering**

_Def:_ intraphoneme disruption resulting in part-sound, part-word repetition

_Aet:_ obscure, may be due to organic or a learnt behavior

_Clinical picture:_ may be associated with muscular activity, vocal abnormalities, breath disturbance

_Ttt:_ speech therapy, tranquilizers or muscle relaxants

**2-velopharyngeal incompetence**
Def: velum does not close oropharyngeal ithmus properly

aet: (causes of nasal regurge)

Clinically: hypernasality, nasal regurge, ear & psychological problems

Diagnosis: history, endoscopy, radiology & speech analysis

DD: hyponasality

Ttt: correct cleft palate, pharyngeal flap & speech therapy

3-dyslalia

Def: persistent defective speech sounds

aet: tongue tie, dental problem, hearing loss or functional

Ttt: of the cause & speech therapy

C: voice disorders

1-Organic: congenital, traumatic, inflammatory, neoplastic or neurological.

2-Minimal associated pathology: VF polyp, cyst, nodules, or edema.

3-Functional: no organic cause, excessive muscular force or faulty respiration.