

LARYNX



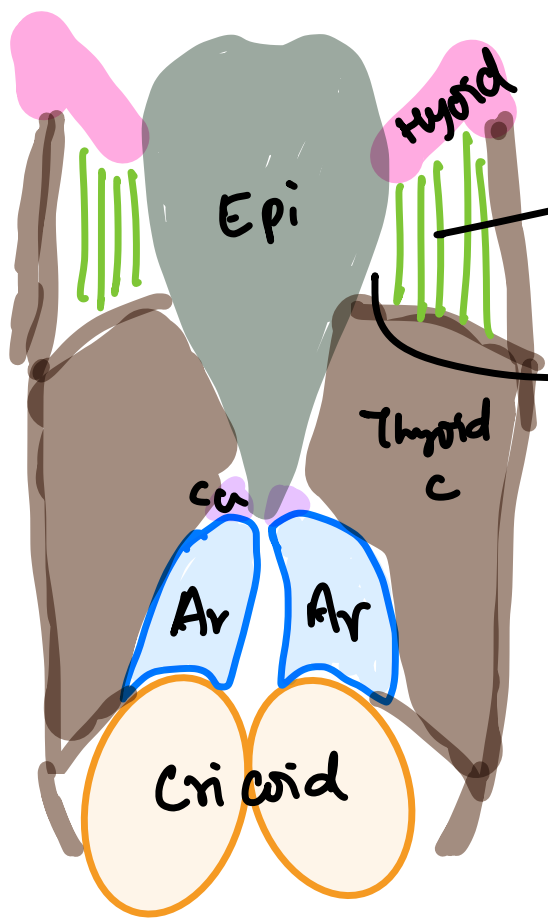
## → surgical anatomy of larynx:

- suspended from hyoid bone - continues as trachea below.

### Paired & unpaired cartilage

Arytenoid  
corniculate  
cuneiform

Thyroid  
Cricoid → only complete cartilage.  
epiglottis



Quadrangular membrane

Pre-epiglottic space

↓  
Space in front of epiglottis and behind hyoid.

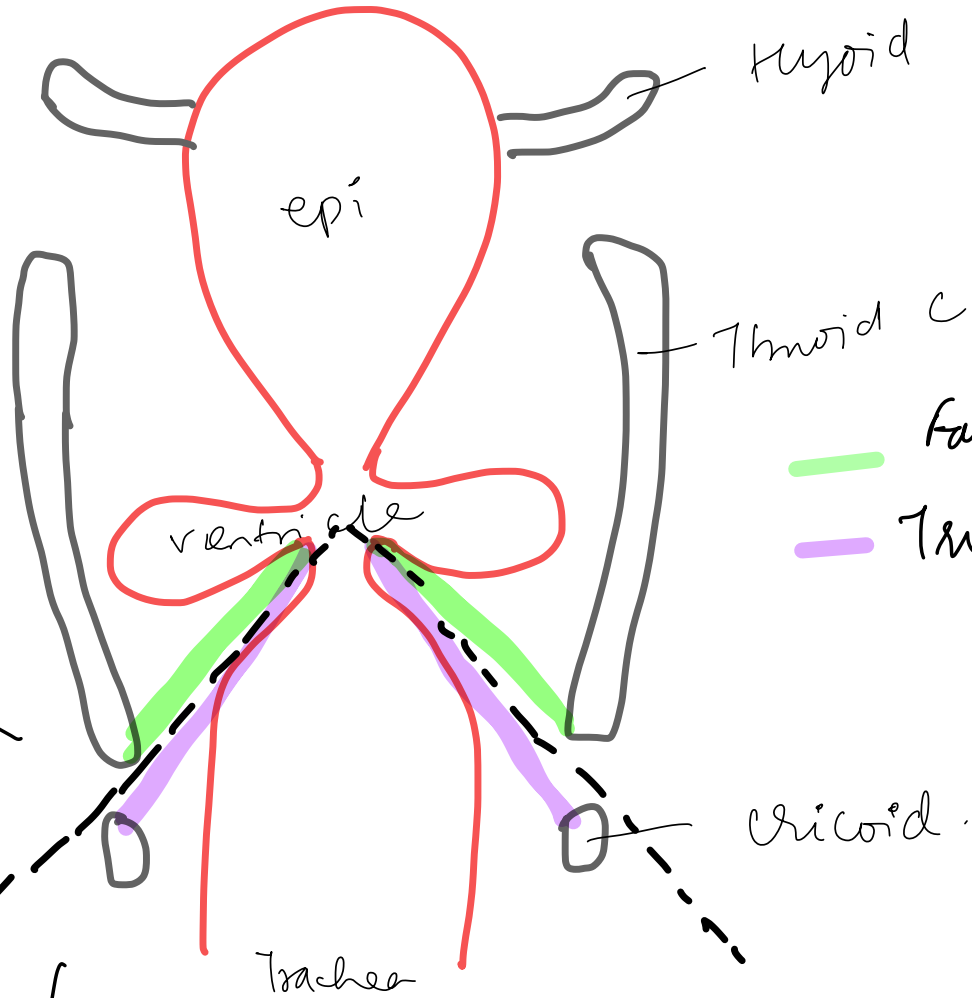


# → Barriers to spread:

\* **anadyspharyngeal membrane**  
 Prevents spread of  
 supraglottic cancer to glottis.

## Supraglottis

- epiglottis
- ventricles
- false vocal cords.



False vocal cord - lower edge of  
 anadyspharyngeal ligament.

True vocal cord

\* **Conus elasticus**  
 Prevents subglottic spread  
 of glottic cancer.

## Glottis

- true vocal cords and space between them known as rima glottis

## Subglottis

- Below ventricular apex to lower margin of cricoid.

\* **Vulnerable areas with accelerated spread and destruction of thyroid cartilage**

- Pre epiglottic space
- Anterior commissure tumours.

# → History & physical exam

## ① Hoarseness of voice

- Causes
- Laryngeal etiology - Glottic
  - Outside the larynx
    - Thyroid CA
    - Lung CA → Rec infiltration
    -
  - Neurological
    - Idiopathic Rec palsy.

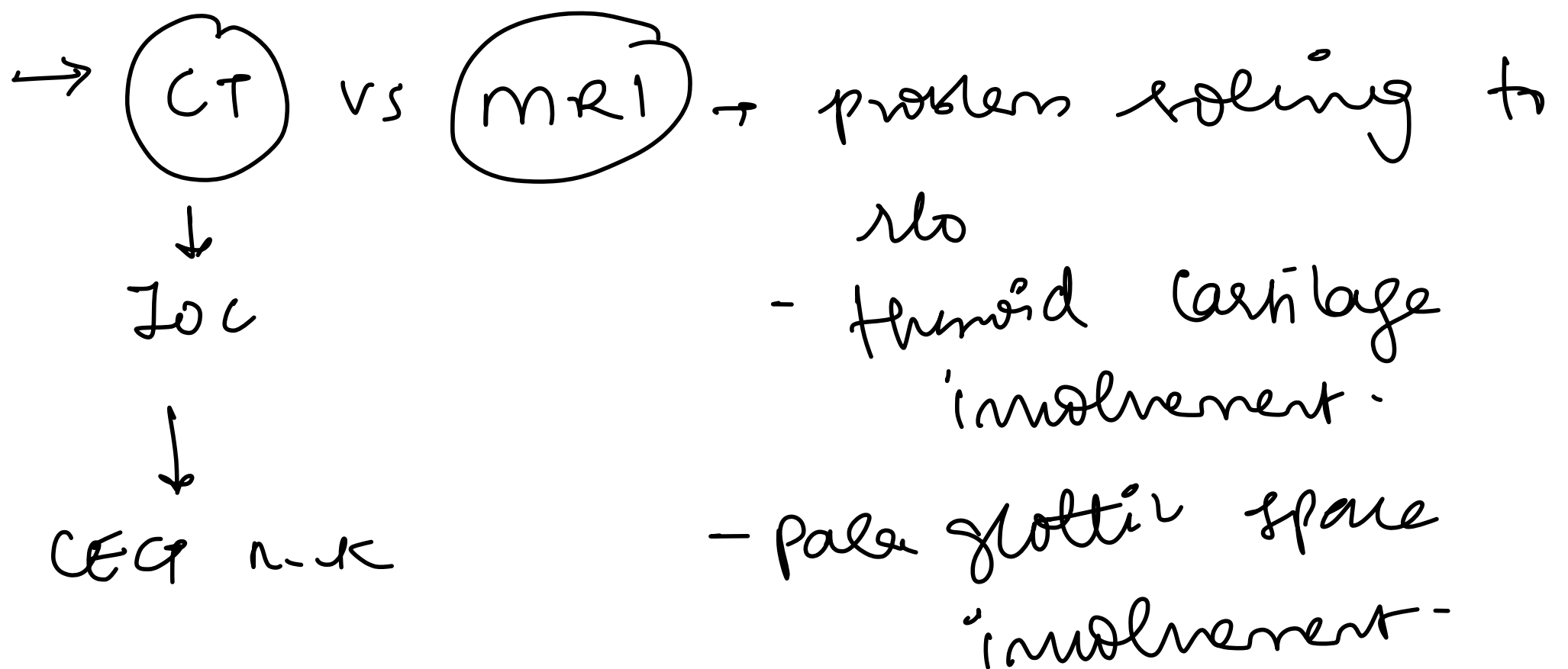
## ② Rigid vs Flexible laryngoscopy

- Visibility is same in both.
- matter of institutional preference.
- Inspection & Bx can be done in same sitting in flexible laryngoscope.

Areas which cannot  
be seen on flexible  
scope

- 
- ① Apex of pyriform
  - ② post cricoid.

- Restricted vocal cord mobility d/t
- ① involvement of thyroarytenoid muscle.
  - ② Bulk of the tumor.



→ specific issues w.r.t Anterior commissure lesions

- \* Thyroid Cartilage involvement
- \* Difficult exposure for laser excisions.
- \* ↑ frequency of post op Synechia formation = poor voice quality.

## → Staging of laryngeal cancer:

| Supraglottis                                                                                                                                                                                                                                                             | glottis                                                                                                                                                                          | Subglottis                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| <p>T<sub>1</sub> - limited to one subsite of supraglottis.</p> <p>T<sub>2</sub> - more than 1 subsite</p> <p>Subsites of supraglottis:</p> <ul style="list-style-type: none"> <li>- Base tongue</li> <li>- vallecula</li> <li>- medial wall of pyriform sinus</li> </ul> | <p>T<sub>1</sub> - 1a - limited to 1 vc<br/>1b - involves both vc with normal mobility</p> <p>T<sub>2</sub> - extension to supraglottis / subglottis / impaired vc mobility.</p> | <p>T<sub>1</sub> - limited to subglottis</p> <p>T<sub>2</sub> - extension to vocal cord &amp; impaired mobility.</p> |

Common to all

T<sub>3</sub> - limited to larynx & vocal cord fixation /  
invasion of paraglottic space /  
invasion of inner cortex of thyroid cartilage

T<sub>4a</sub> - outer cortex thyroid cartilage /  
Trachea / cricoid / tongue / strap muscle / thyroid / esophagus invasion.

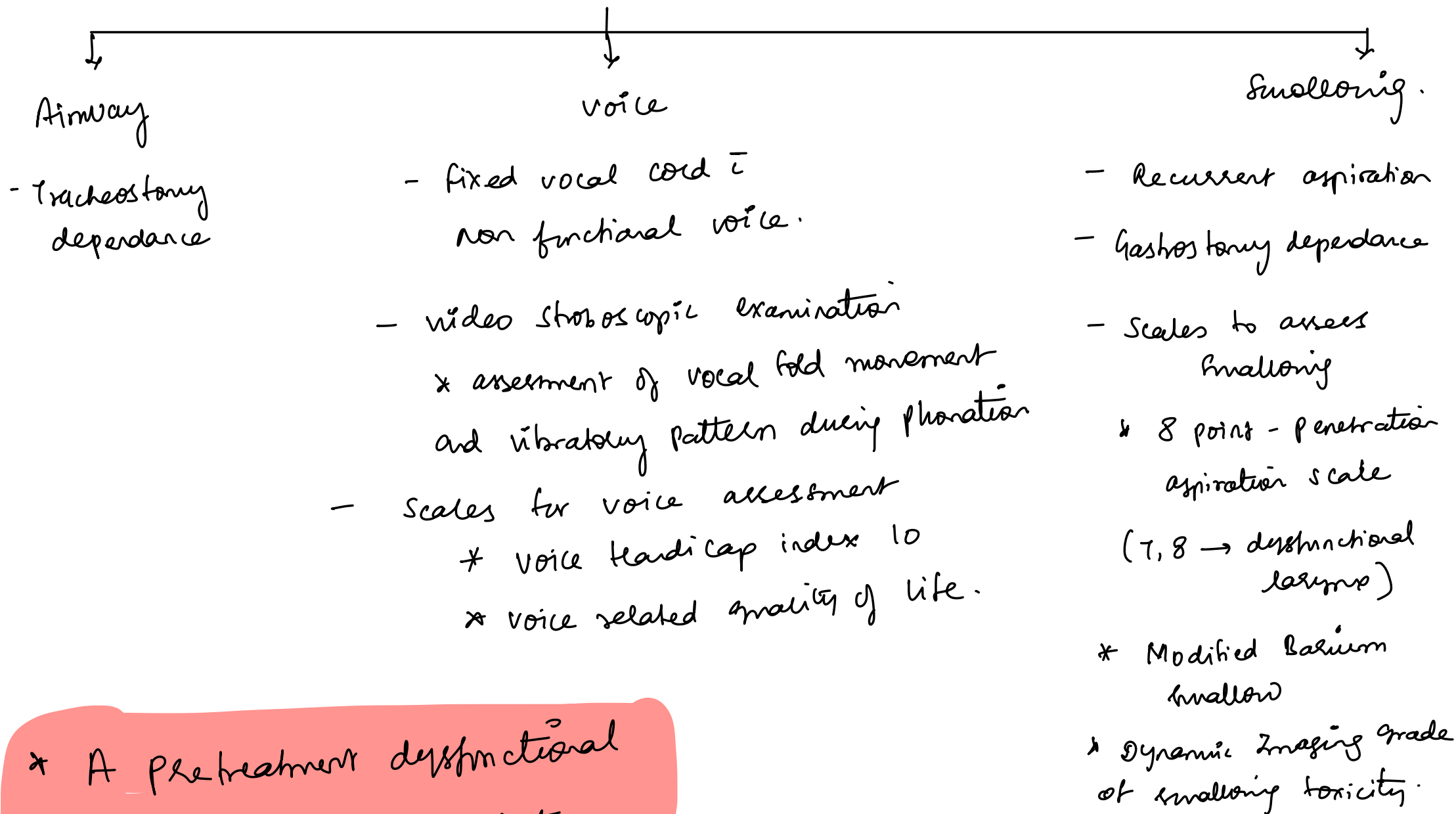
T<sub>4b</sub> - Prevertebral space / Carotid Artery / mediastinum.

N Staging → same as HNSCC.

## \* Assess patients and patient selection for laryngeal preservation:

- Imaging before Scopy
- CT - disease extent
  - involvement of cartilage
  - extralaryngeal spread.
- MRI - when CT doubtful.
- DL Scopy - To map the disease and Bx

### - functional assessment of larynx (pretreatment)



\* A pretreatment dysfunctional larynx is a candidate for total laryngectomy.

## → Goals of organ preservation in CA larynx:

- 1) Cure the cancer
- 2) Preserve laryngeal functions
- 3) Maximise quality of life.

\* T<sub>1</sub>/T<sub>2</sub> No tumours of larynx

Single modality organ preserving treatment

RT vs Sx (Transoral laser microsurgery TLM / open partial laryngectomy)

- Better voice quality.

- 5-6 weeks of treatment

- TLM provides single day treatment

- RT may be reserved for recurrence

No RCT Comparing both modalities.

meta analysis suggest both offer

equal oncological outcomes and voice quality.



# Organ preservation options

→ Primarily dysfunctional larynx

↓  
Total Laryngectomy.

↓  
Early Glottic Cancer  
T<sub>1</sub>/T<sub>2</sub> N<sub>0</sub>

- RT
  - Transoral Laser microlaryngectomy (TLM)
  - open partial laryngectomy (vertical)
- } equal outcomes
- Reserved for local recurrence following RT/TLM.

↓  
Early Supraglottic Cancer  
T<sub>1</sub>/T<sub>2</sub> N<sub>0</sub>

- Rate of CN mets - 10-50%
- Neck is to be addressed in any modality.

## options

- RT
- organ preserving Sx
  - i) open supraglottic laryngectomy (horizontal)
  - ii) SCPL - CHEP - Supra Cricoid Partial laryngectomy + Cricohyoidotomy.

↓  
Locally advanced  
T<sub>3</sub>/T<sub>4</sub>

↓  
Concurrent CRT is currently standard of care

↓ F16  
± Salvage laryngectomy



→ organ preservation trials in glottic cancer:

Table 1. Radiotherapy Versus TLS in Stage I Glottic Cancer      TLS - Transoral laser Sx

| Author                | Year | No. of patients | Local control                                   | Larynx preservation                        | Voice quality                                                                                                       |
|-----------------------|------|-----------------|-------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Aaltonen et al [5]    | 2014 | RT 28; TLS 32   | At 2 years, 88% in RT vs. 90% TLS               | Not available                              | Overall voice quality similar in both arms. Voice more breathy in TLS; less hoarseness-related inconvenience in RT. |
| Remmelts et al [7]    | 2013 | RT 159; TLS 89  | At 5 years, 86% in RT vs. 75% in TLS (P = 0.07) | 5-year 83% in RT vs. 93% in TLS (P < 0.05) | VHI 12.4 ± 8.9 in TLS vs. 8.3 ± 7.7 in RT (P < 0.05) suggestive of poor outcome of TLS                              |
| Milovanovic et al [8] | 2013 | RT 74; TLS 72   | Equal in both arms                              | Equal in both arms                         | Shimmer score mean 3.75 in TLS; 4.07 in RT                                                                          |
| van Gogh et al [9]    | 2012 | RT 39; TLS 67   | At 2 years, 95% in RT vs. 97% in TLS            | At 2 years, 95% in RT vs. 100% in TLS      | Shimmer score mean 5.06 in TLS vs. 5.39 in RT; voice outcome recovery earlier in TLS.                               |
| Dinapoli et al [6]    | 2010 | RT 70; TLS 73   | Equal oncological outcome                       |                                            | Median VHI 18 in TLS vs. 4 in RT (P < 0.0001)                                                                       |

① → RT in all studies - EBRT 66 Gy | 2 Gy per # over 6.5 weeks.

② → Transoral laser microsurgery:

- KTP (Potassium Titanyl phosphate) LASER
  - CO<sub>2</sub> LASER → minimal scatter, minimal Reflection
- Surrounding neurons < 0.5µm  
absorption depth - 0.2mm

Procedure

- Patient position → 35° neck flexion 15° head extension.
- Laser safe double cuff ET tube

↓  
operating laryngoscope introduced  
↓

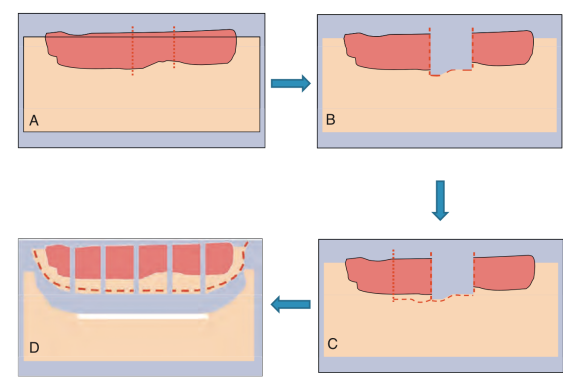
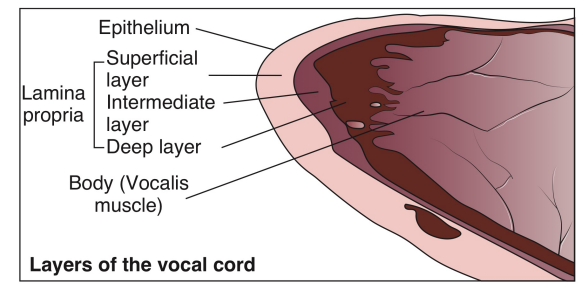


Figure 10.67 Technique for transoral endoscopic resection by sequential transection and excision of laryngeal cancer. A, Initial parallel vertical cuts through tumor to assess depth of invasion. B, Resect a small piece and identify the deep margin of tumor. C, Follow the deep margin of the tumor and systematically resect in pieces. D, Accurate orientation of the specimen is crucial.

↓  
Defect heals by secondary intention.

\* European Laryngological Society classification of Tcm based on layers of vocal cord.



- for glottic cancers:
- Type 1 - Subepithelial
- 2 - Subligamentar
- 3 - Transmuscular
- 4 - Total
- 5 - extended - Anterior Com.  
- Arytenoid  
- Subglottis
- 6 - Anterior BIC cordectomy  
or commissurectomy.

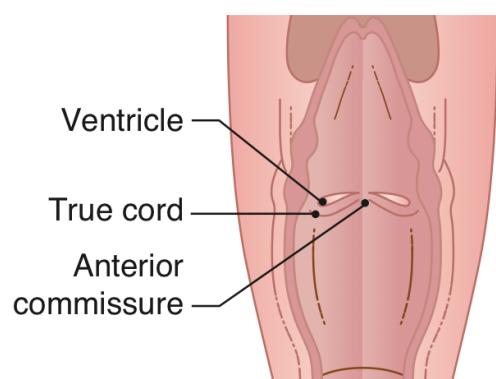


→ voice preserving laryngeal surgeries:

## Fundamental Fact

### All Partial Laryngectomies:

- Are variable amounts of resection
  - Of some but not all of swallowing elements
  - Of some or most of speech elements
- Which preserve
  - The cricoid arch
  - At least one functioning C-A joint
  - Lung-powered airflow and naso-tracheal airway



1. Lesion of mobile cord extending to anterior commissure.
2. Lesion of mobile cord involving vocal process and antero-superior portion of arytenoid.
3. Subglottic extension should not be more than 5 mm.
4. Select patients with fixed vocal cord lesion not extending across the midline.
5. A unilateral transglottic lesion not violating the above criteria.
6. True cord/anterior commissure lesion not involving more than anterior third of opposite cord.

**Figure 10.83** Criteria for the selection of a lesion suitable for a vertical partial laryngectomy.

Structures which can be sacrificed.

### Permissible (partial) Loss

#### Variable extents of

- Swallowing elements
  - Epiglottis, AEF
  - False cords
  - True cords
  - Hyoid in Base tongue-hyoid complex
  - One arytenoid
- Speech elements
  - Vocal folds
  - Vocalis muscle (thyro-arytenoideus) unilateral
  - One arytenoid

\* Structures which have to be preserved

1. Complete Cricoid Cartilage with at least one crico-arytenoid joint
2. Base tongue in base tongue-hyoid complex.

## → Candidates for voice preserving laryngectomy.

### Patient factors

- good pulmonary function
- Neuromuscular competent.

### Tumour factors

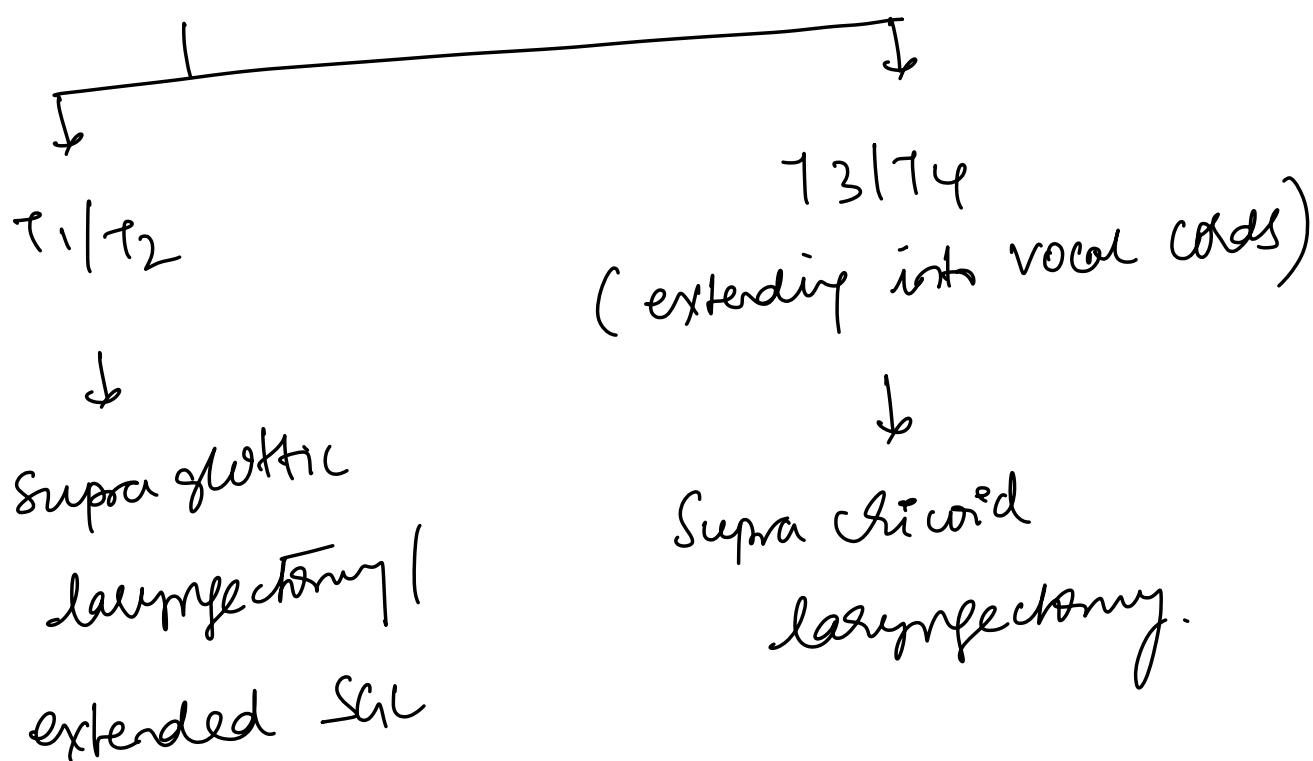
- Cricoid
- Subglottis
- Posterior midline
- at least 1 cricoarytenoid joint
- No extralaryngeal spread.

If All are preserved, then voice preserving laryngectomy.

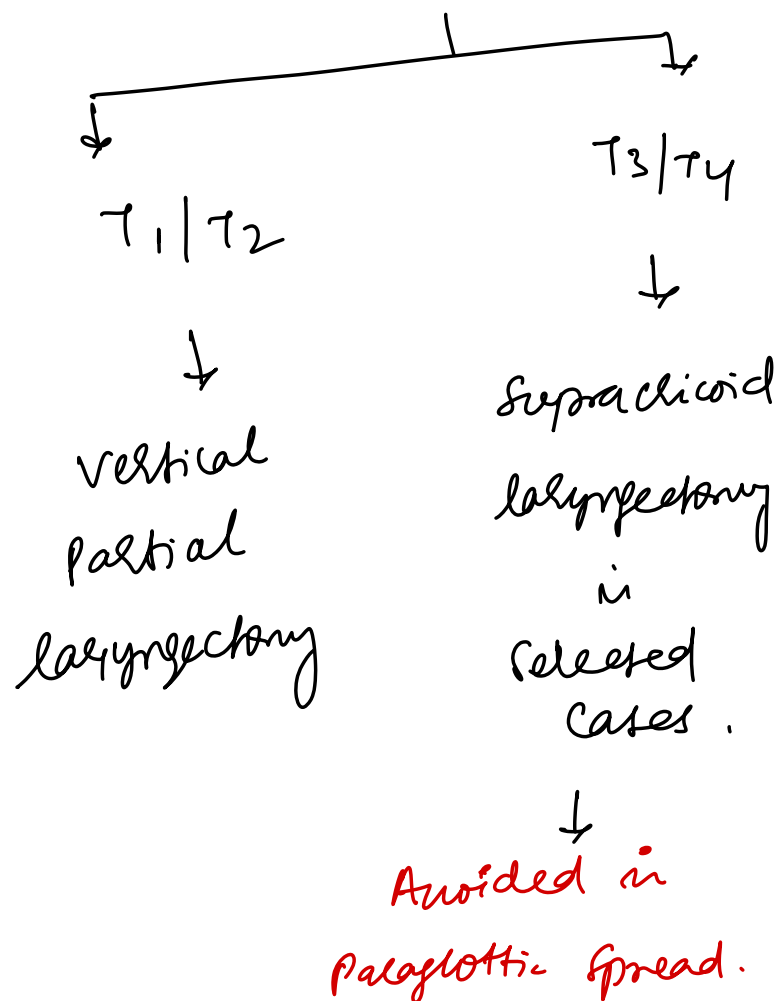
## → Techniques of voice preserving laryngeal Sp

### Location of primary

#### Supraglottic



#### Glottic



All voice preserving laryngectomies will need temporary tracheostomy.

①

## Horizontal Supraglottic Laryngectomy



\* Decannulation  
after 6 weeks  
only.

Can remove entire Pre-epiglottic space  
Done for T1-T3 Supraglottic cancers

Cuts across Paraglottic space  
Not suitable for Transglottic

Removes swallowing elements :Ep, AEF, False cords; (Thy)  
Main Morbidity: Swallowing disorder  
Functional restoration: laryngeal elevation/suspension

## 2. Vertical Partial Laryngectomy

Removes lateral/anterior/anterolat. glottis  
One arytenoid can be removed  
Indicated for T1-T2 Glottic cancer

Cuts through Paraglottic space

Contra-indications:

Post. Comm./Inter-aryt/ T3 (PGS)

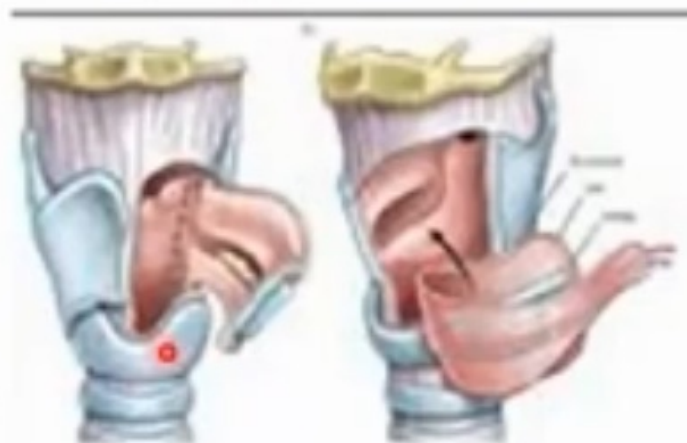
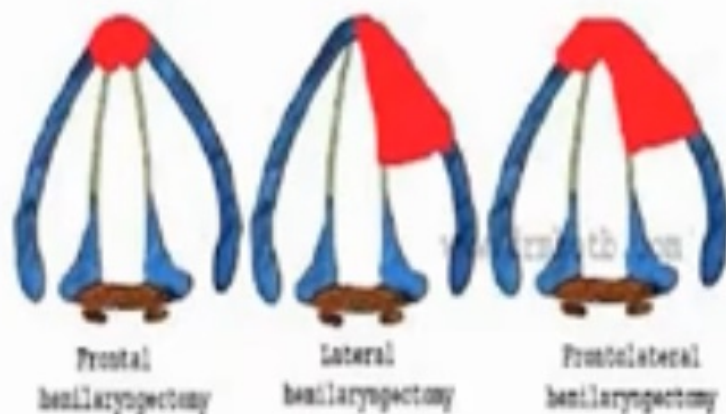
Significant subglottic involvement

Removes speech elements

Main morbidity: voice quality +/- aspiration

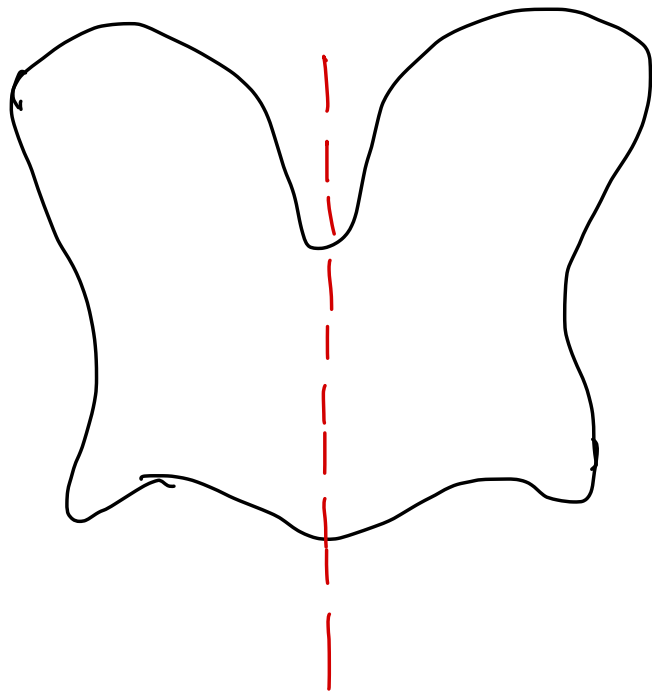
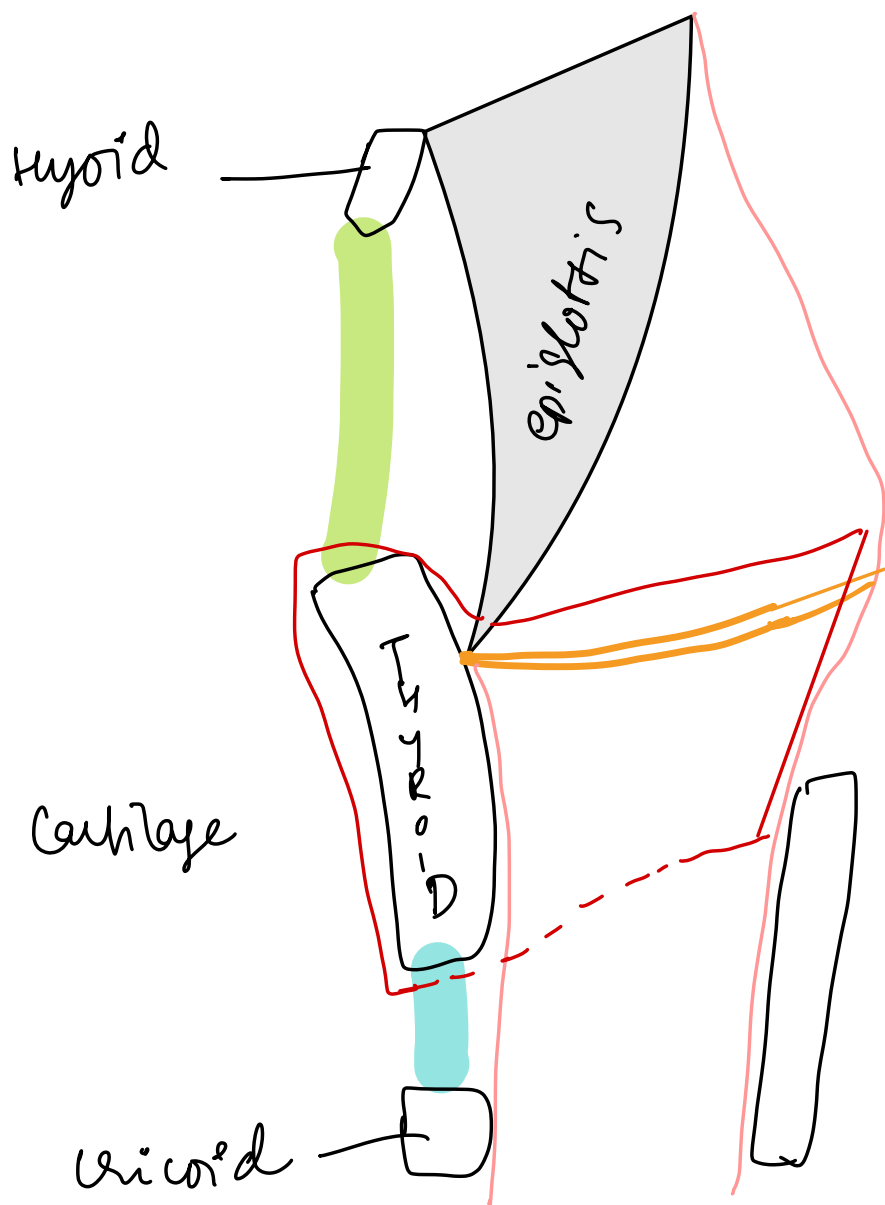
Functional restoration:

-glottic reconstruction; arytenoid replacement



Earliest  
Decannulation  
of  
laryngectomy  
Can be  
done in  
vertical  
partial  
laryngectomy

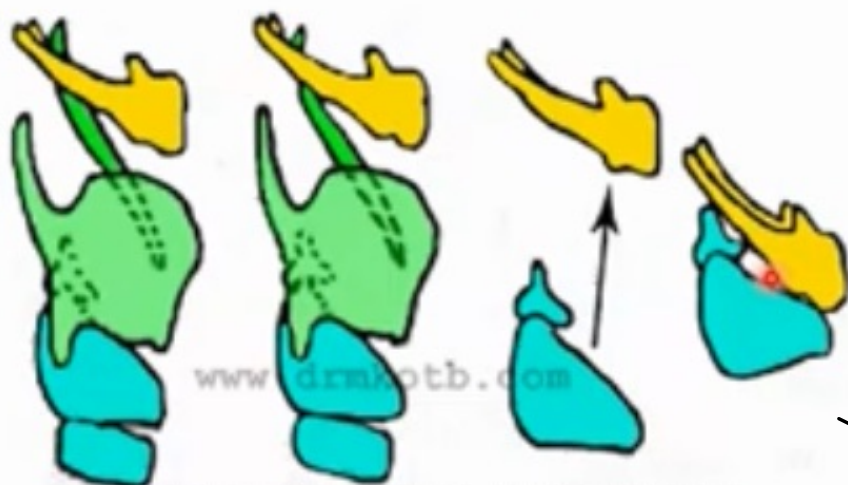
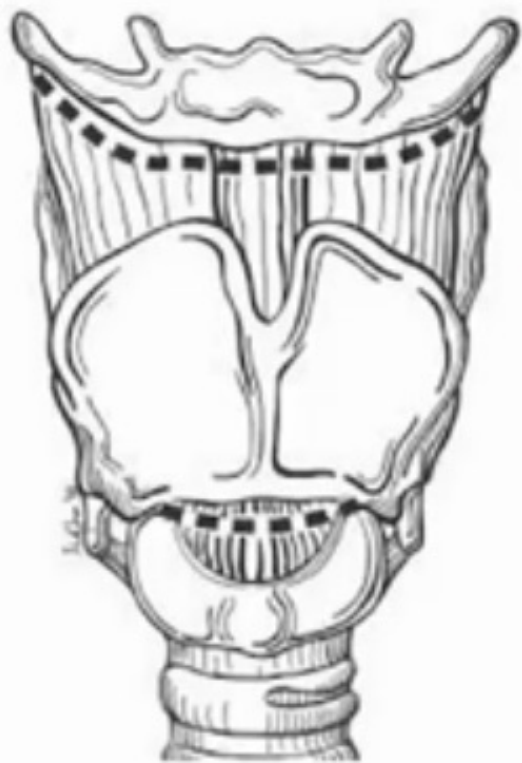
→ open vertical partial laryngectomy :



\* Perichondrium on the diseased side is elevated off the cartilage. water tight defect closure is done with the perichondrium.



### 3. Supracricoid Laryngectomy



Structures preserved  
1) cricoarytenoid complex

2) hyoid - base tongue complex.

vibratory movements of arytenoids produces phonation even without vocal cords.

\* Decannulation after 6 weeks only.

5-1. may need permanent tracheostomy.  
d/t persistent edema of cricoid (complete ring)

↑  
d/t post op radiation in nodal positivity.

Cricohyoidopexy  
- fills the gap and maintains swallowing pattern.

- hyoid base tongue complex prevents aspiration.

#### Supracricoid Laryngectomy

- Removes entire thyroid ala, both para-glottic spaces, partial/total pre-epiglottic space, anterior membranous subglottis, +/- one arytenoid
- Indication:
  - T1b-T2, selected T3, limited T4 Glottic
  - T1-T3 Supraglottic
- Contra-indication: BOT/hyoid/Subglottic involvement
- Swallowing and speech elements resected
- Morbidity: swallowing (aspiration), voice quality, (subglottic edema & airway compromise)
- Functional restoration: laryngeal elevation

# 4. Near-Total Laryngectomy (Pearson's) with TPSS

Tracheo-pharyngeal Speaking Structure

- Removes:
  - PES, Ipsilateral PGS, nearly all of thyroid ala, one CA joint, ipsilateral subglottis, half of cricoid lamina & most of cricoid arch
- Indication: T3-T4 laryngeal, T3-T4 PF
- Contraindication
  - Posterior midline involved
- Management/Restoration of function
  - Create TPSS
- Functional deficit
  - Loss of nasal breathing in all
  - Phonation in 20-30% (dysfunctional shunt)
  - Voice quality
  - Minor aspiration

→ Open partial laryngectomy vs Transoral Robotic / Laser excisions:

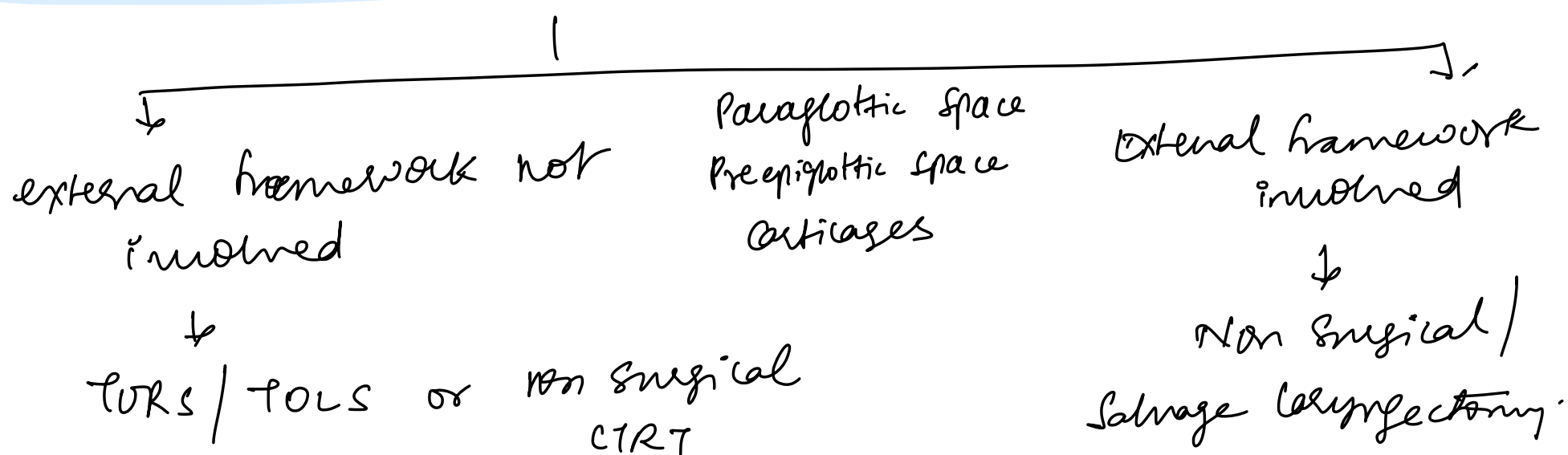
## Advantages of OPL

- Highest local control rates
  - (Larger margins excised)
- Can effectively deal with moderately advanced lesions
- Specimen evaluations and margin assessment easier and simpler
- No immediate repeat assessments are needed
- Adjuvant radiotherapy possible
- Limited mouth opening is not a barrier
- Widely practicable

## Disadvantages of Open Partial Laryngectomy

- Results in greater surgical trauma with greater inflammation, edema and time to complete healing with more fibrosis
- Results in temporary disturbance of swallowing (in supraglottic) and inferior speech quality (in glottic) due to disassembly
- Carries a risk of pharyngocutaneous fistula
- Longer hospitalisation, temporary tracheostomy
- Larger margins excised

→ Alternatives to OPL



## VPL in Current Era

|                        | VPL | TOLS | RT  |
|------------------------|-----|------|-----|
| Local control          | +++ | ++   | ++  |
| Laryngeal Preservation | +++ | ++-  | ++  |
| Voice quality          | +   | ++   | ++- |
| As salvage after RT    | ++  | +    | NA  |

## SGL/SCL in Current Era

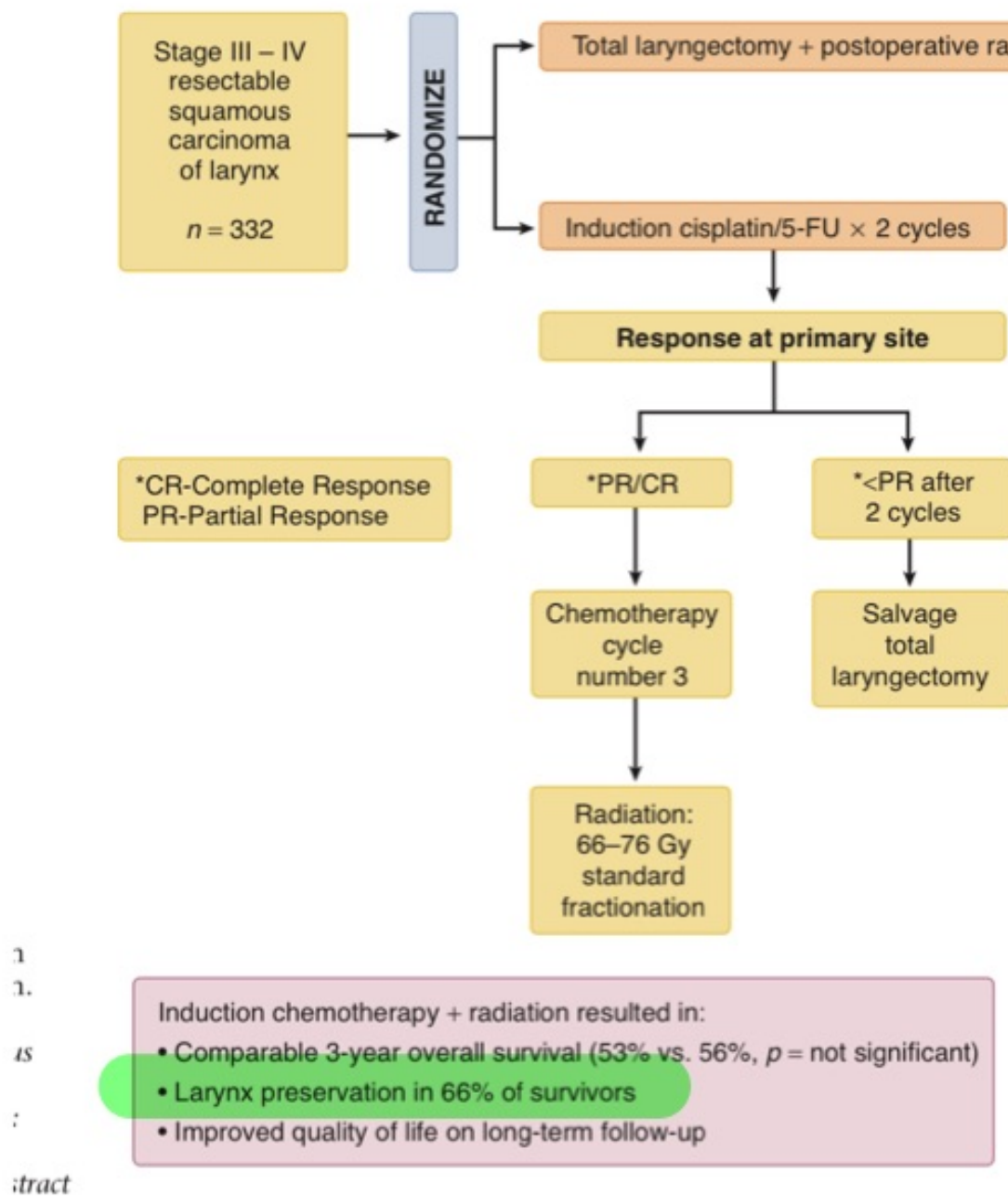
|                        | SGL | SCL | TOLS/TORS | RT  |
|------------------------|-----|-----|-----------|-----|
| Local control          | +++ | +++ | ++        | ++  |
| Laryngeal Preservation | +++ | +++ | ++-       | ++  |
| Voice quality          | +++ | +-  | +++       | +++ |
| As salvage after RT    | ?   | ++  | +         | NA  |



→ Organ Preservation in laryngeal cancer.

1. Veterans affairs trial for laryngeal cancer:

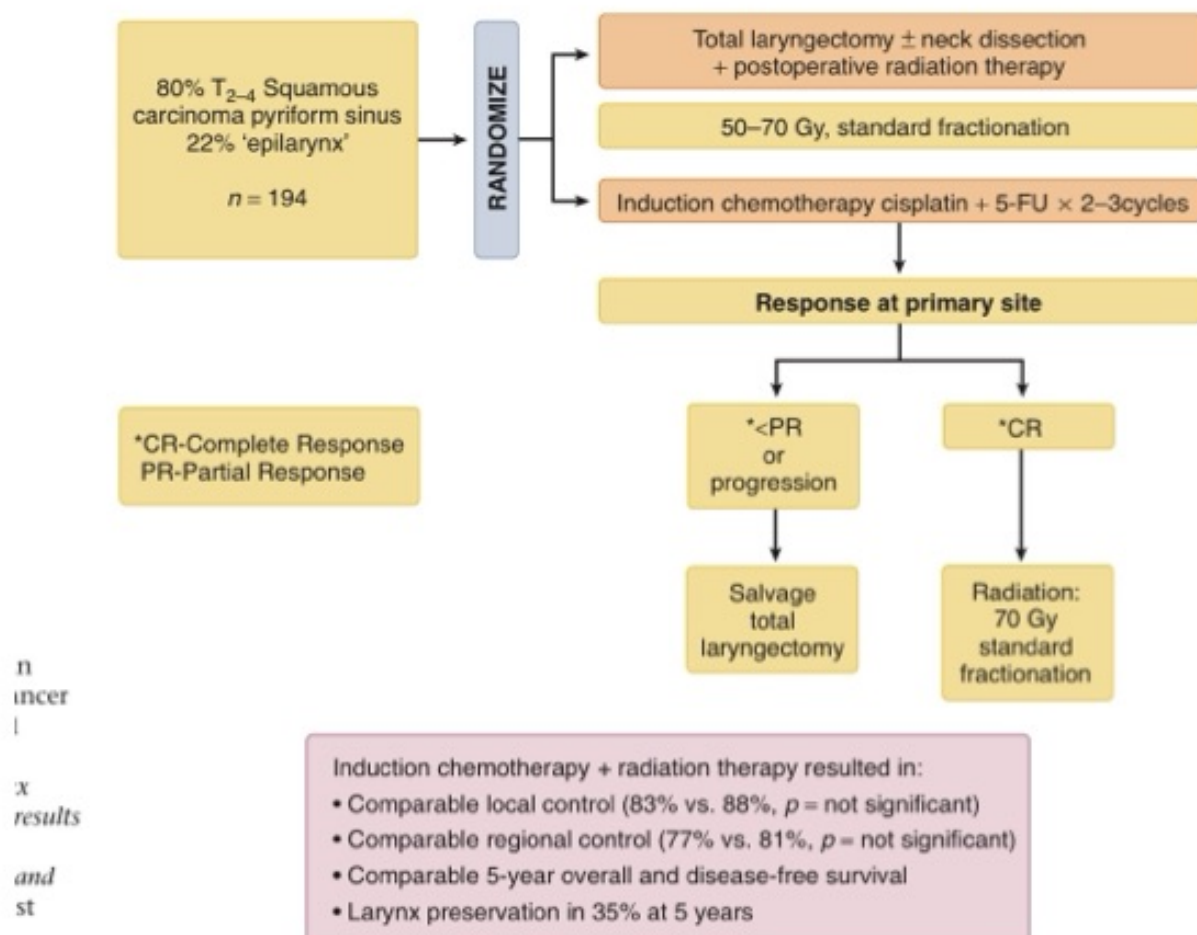
(Induction chemo)



Trial was designed to study rate of larynx preservation & not overall survival.

- LR was more in patients = extra laryngeal extension.

2. EORTC trial for induction chemotherapy in larynx & hypopharynx:



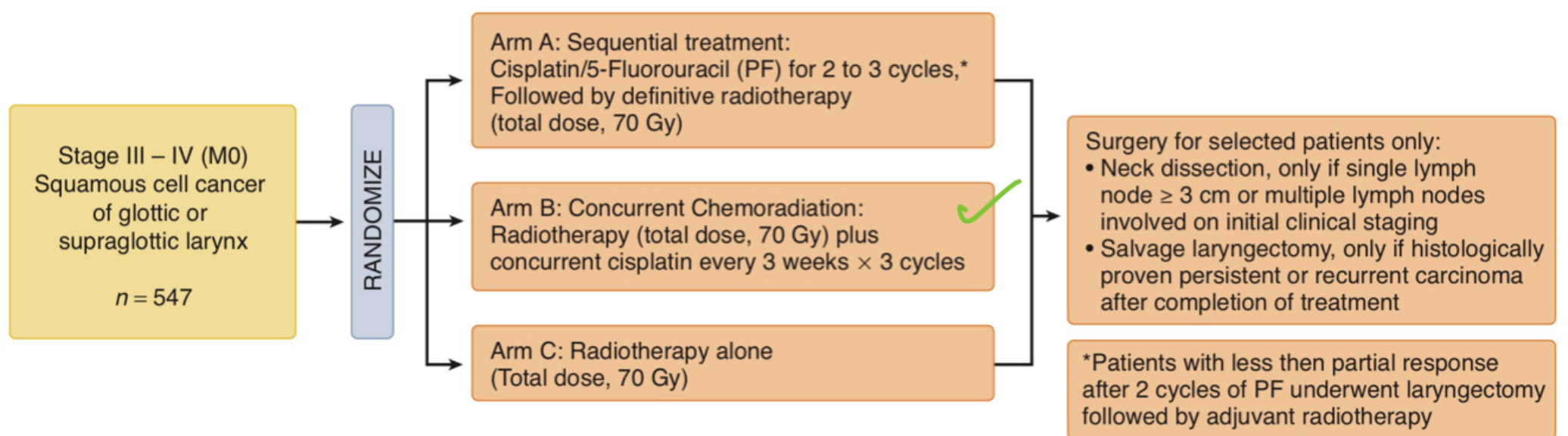
### 3. HORTEC trial (Induction chemo = 3 drugs vs 2 drugs)

Induction CT = PF  
vs  
Induction CT = TPF

→ R1 for responders

3 drug induction CT improved  
5y & 10y larynx preservation rates and LDFS (larynx dysfunction free survival)

### 4. RTOG 91-11 CRT for glottic & supraglottic CA larynx



At median follow up of 3.8 years, concurrent chemoradiation (Arm B) was associated with:

- Higher rate of laryngeal preservation (72% Arm A vs. 84% Arm B vs. 67% Arm C)
- No significant differences in overall survival between the three arms
- Higher rates of  $\geq$  grade 3 toxicities in the chemotherapy-based arms (Arms A and B)

standard of care for stage III/IV (M0)  
glottic & supraglottic laryngeal cancer.

5. DECIDE trial  
PARADIGM Trial

4

$$\left[ \begin{array}{c} \text{ } \\ \text{ } \\ \text{ } \end{array} \right]$$

## 6. Bonner et al approach

Cetuximab + RT  $\rightarrow$  Best results in oropharyngeal CA.

→ later subgroup analysis is

laryngeal cancers showed 87.9-1.

annual preservation rate @ 2 years.

\* No head to head comparison btw concurrent CRT vs Cefiximal + RT.

CTRT VS Letuximat + RT.  
Hence concurrent CRT still remains the standard of care.



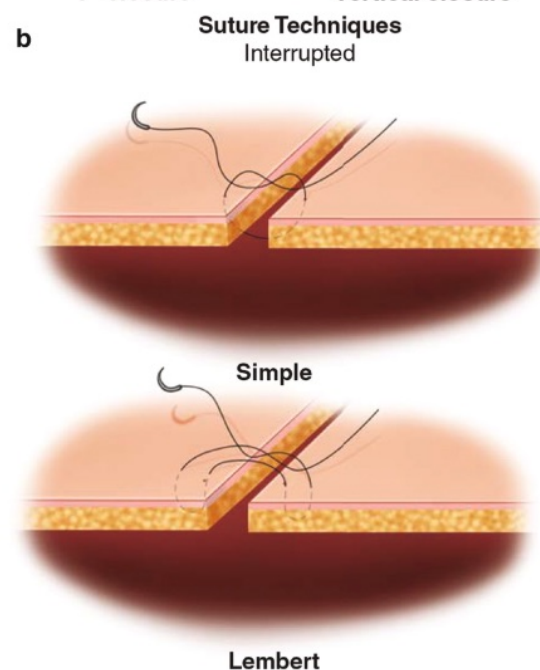
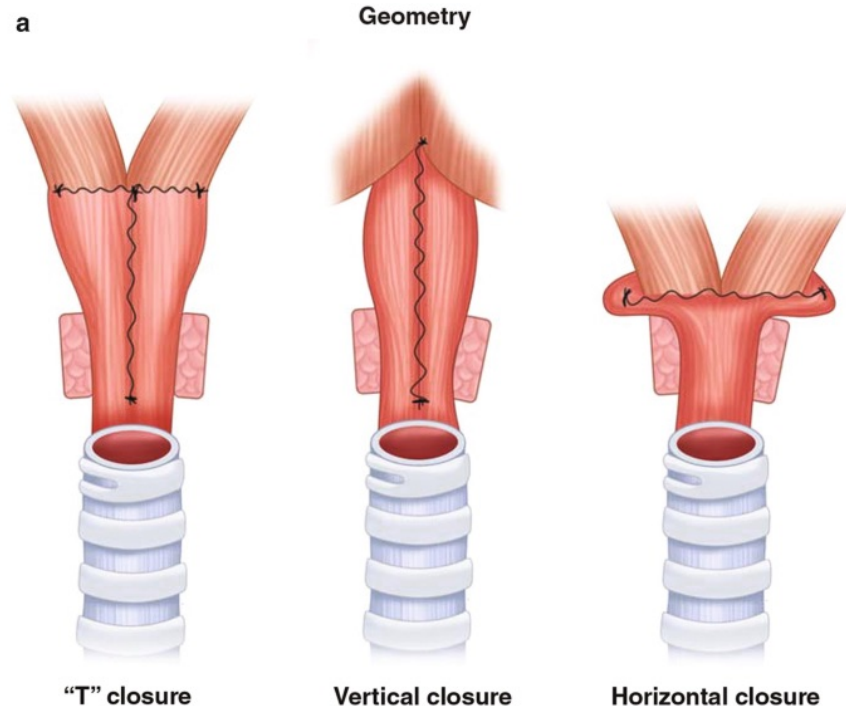
# Rehabilitation after total laryngectomy:

## Total Laryngectomy

- Indication
- Contra-indication
- Loss of function: all
- Rehab:
  - Swallowing: Prevent Pharyngostoma (leak), Stricture
    - Pharyngeal closure principles
  - Breathing: Create Tracheostoma
    - Stoma siting, size and suturing
  - Phonation: Create Vibratory element connected to vocal tract: Mechanical or lung-powered
    - Speech rehabilitation

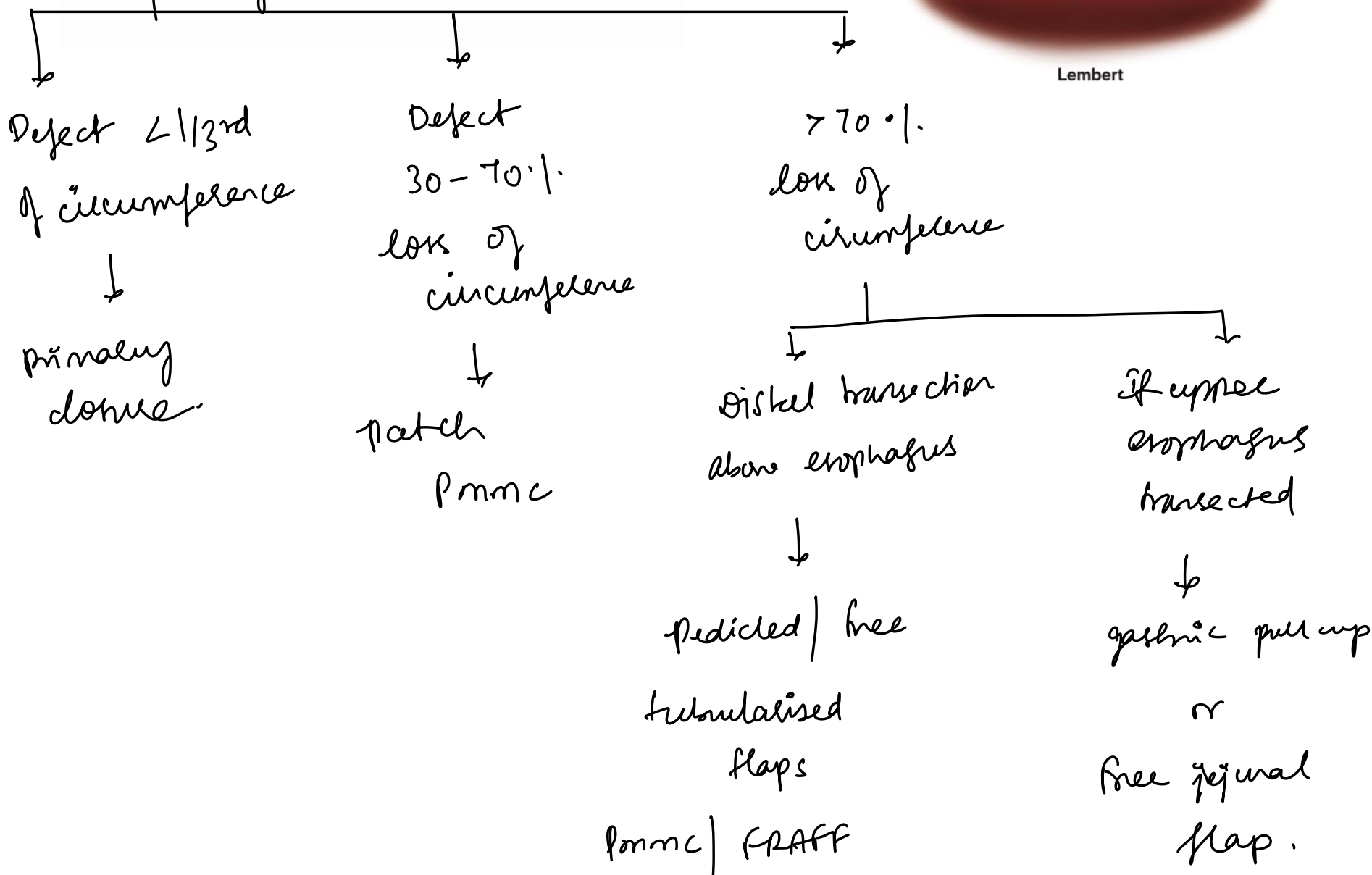
## Pharyngeal closure

- Tensionless
- T- or horizontal closure
- Extrinsic muscles of tongue incorporated
- Salvage post-CRT: supplement primary closure with soft tissue cover
- Adequacy:



Horizontal closure  
→ superior swallowing function, but no longer performed

By Tatin Shah



# Tracheostoma

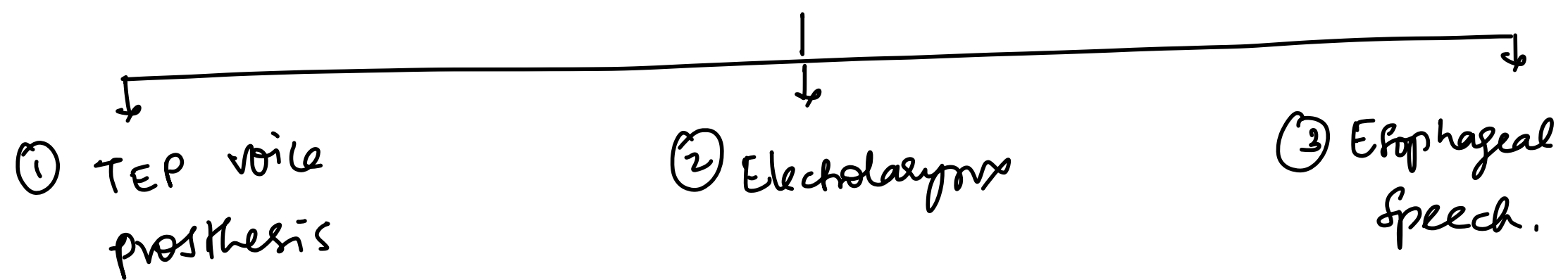
- Shape — cut inbetween tracheal rings.
- Size — "Thumb rule". Not too wide (Not too narrow).
- Site — Ideally separate button hole in inferior flap.
- Suturing — Tracheal ring should not be exposed.  
Skin → trachea → reverse site through skin again.

## Speech Rehabilitation

- Essential requirements
  - Driver
    - Air flow: lung-powered, esophageal, pharyngeal
  - Vibrator:
    - Pharyngoesophageal
    - FOM (floor of mouth)
  - Resonator
    - Vocal tract (tube formed by larynx, pharynx, oral cavity)
  - Articulator
    - Tongue, palate, lips



# Alaryngeal voice restoration following total laryngectomy



## (1) TEP voice prosthesis (Tracheo esophageal Puncture)

- Mechanism of voice - lung powered speech by driving air from lungs into pharynx through a 1 way valve
- Has a better voice quality. minimal training needed.
- As a [secondary TEP - if wound complication are expected.  
primary TEP.
- 2 commercially available TEP prosthesis
  - \* PROVOX VEGA (17 Fr 8mm)
  - \* Blom SINGER
    - ↓  
smaller diameter  
produces lesser  
complications, but  
poorer voice.
- Tracheostome has to be occluded by a finger for phonation.
  - \* Hands free prosthesis available. Has 1 way valve. Air directed into trachea on inspiration & into esophagus on expiration.

## - Complications:

- Acute laryngectomy PISTONING
- TEP puncture site infection
- Granulation tissue
- large stoma.
- Valve leaks.

## \* Essential requirements for successful TEP:

1. Tissue condition — pliable, Not hyper / hypo tonic

2. Neurovascular skills

3. Motivated patient.

T

N

M

## ② Electrolarynx

- mechanism of voice production

A Transcervical / Transoral device  
- produces vibrations of set frequency in the neopharynx

↓

Converted into electronic voice.

- produces sound by mechanical resonance of pharyngeal air column.

- Requires prolonged training.

- produces a monotonic / robotic voice.

## ③ Esophageal speech

- trained technique in which air is swallowed into the esophagus & regurgitated through the neopharynx in a controlled manner to produce sounds.

- Requires prolonged training.

- poor voice quality.

### Comparison

| PHYSICAL REQUIREMENTS | LARYNGEAL SPEECH  | ESOPHAGEAL SPEECH | TO PUNCTURE SPEECH  |
|-----------------------|-------------------|-------------------|---------------------|
| Driver                | Lungs (TV) direct | Upper eso air     | Lungs (TV) indirect |
| Vibrator              | TVC               | PE segment        | PE segment          |
| Resonator             | Normal            | Oropharynx        | Oropharynx          |