

# TRACHEOSTOMY

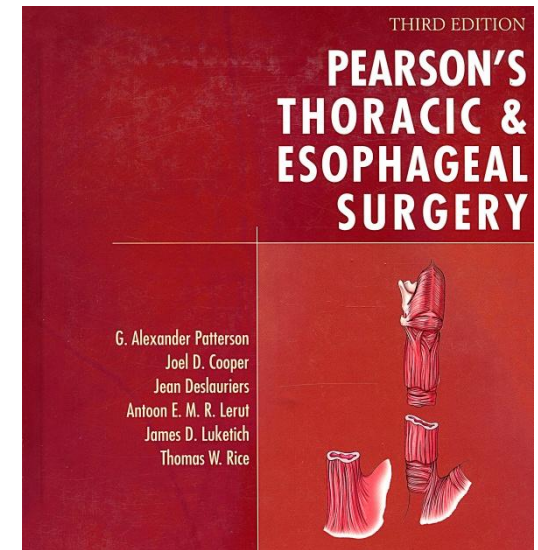
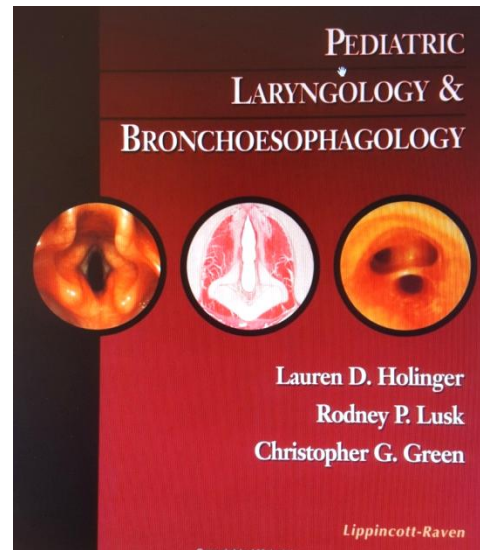
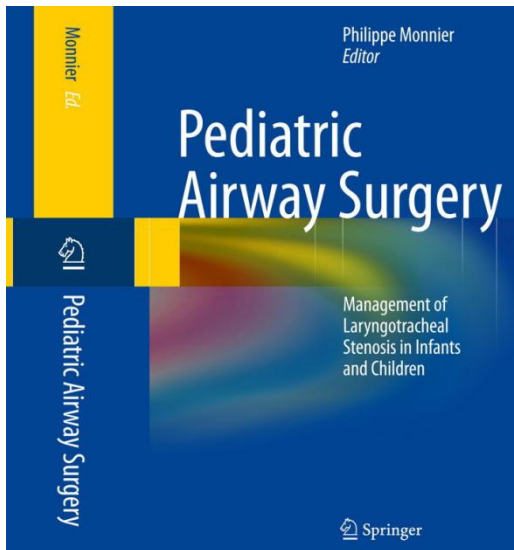
**Kishore SANDU**



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Head - Neck Surgery  
University Hospital  
Lausanne, Switzerland

# DISCLOSURES & CONFLICTING INTERESTS

1. No financial relation with the industry
2. Images taken for CME purposes from:
  - PHOTO BANK ARCHIVES – ORL DEPT, CHUV, **Marion BRUN**
  - REFERENCE BOOKS







- Stress
  - parents
  - doctors
  - hospital staff

## •Death

- Growth retardation
  - speech
  - feeding

## •COSTLY

### Tracheostomy vs T' tomy

≤ 1960's

- treatment of **airway obstructions** (FBs) ,  
**acute infections** (epiglottitis, abscesses, LTBitis)
- currently .....

## SUMMARY OF INDICATIONS

- **Upper airway obstruction**
  - > LTS (including BVFP, UVFP)
  - > OSA-related narrowings  
(including craniofacial deformities)
- **Prolonged ventilator dependence**
  - > cardiopulmonary disease
- **Pulmonary toilet**
  - > neurologic impairment
  - > LTEC, LT-fistula

## BIASES IN INDICATIONS

- Expertise in infant CPAP and BIPAP
- Referral patterns
  - > neurological problems
  - > cardiopulmonary diseases
  - > upper airway obstruction
    - LTS
    - craniofacial anomalies
  - > trauma center

**! GREAT VARIETY AMONG DIFFERENT CENTERS !**

CCH= 12-15/y; GOSH = 50/y(personal comm.); CHUV<2/3yrs



## ALTERNATIVES



- Prolonged intubation  
> premature babies
- Short-term intubation or face-mask with CPAP/BIPAP  
> acute upper airway infections  
> temporary ventilatory support

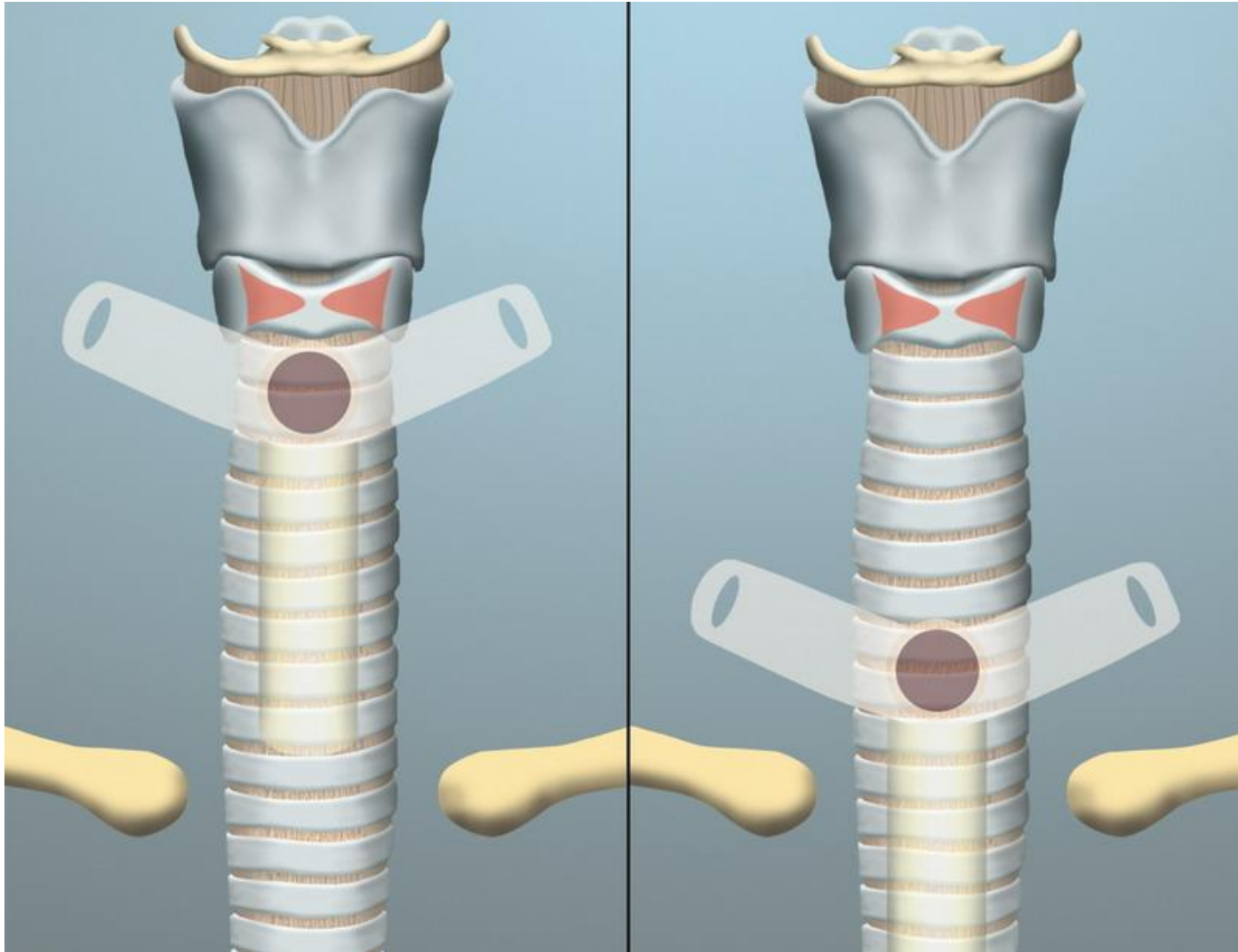
**! DECREASE IN NUMBER OF TRACHEOTOMIES !**

- For **ventilatory support or lung protection**
  - > 3<sup>rd</sup> - 4<sup>th</sup> ring
- For **incipient LTS**
  - > 1st ring or 6<sup>th</sup> - 7<sup>th</sup> ring ( \* anticipated DS procedure in the future  
\* ! risk of stoma - related stenosis! )
- For **(incipient) tracheal stenosis**
  - > through tracheal stenosis ( ! emergency tracheal R&A ! )
- For **intrathoracic tracheal stenosis**
  - > low in the neck with long « stenting » cannula
- For **recurrent tracheostomy stenosis**
  - > through former tracheostomy



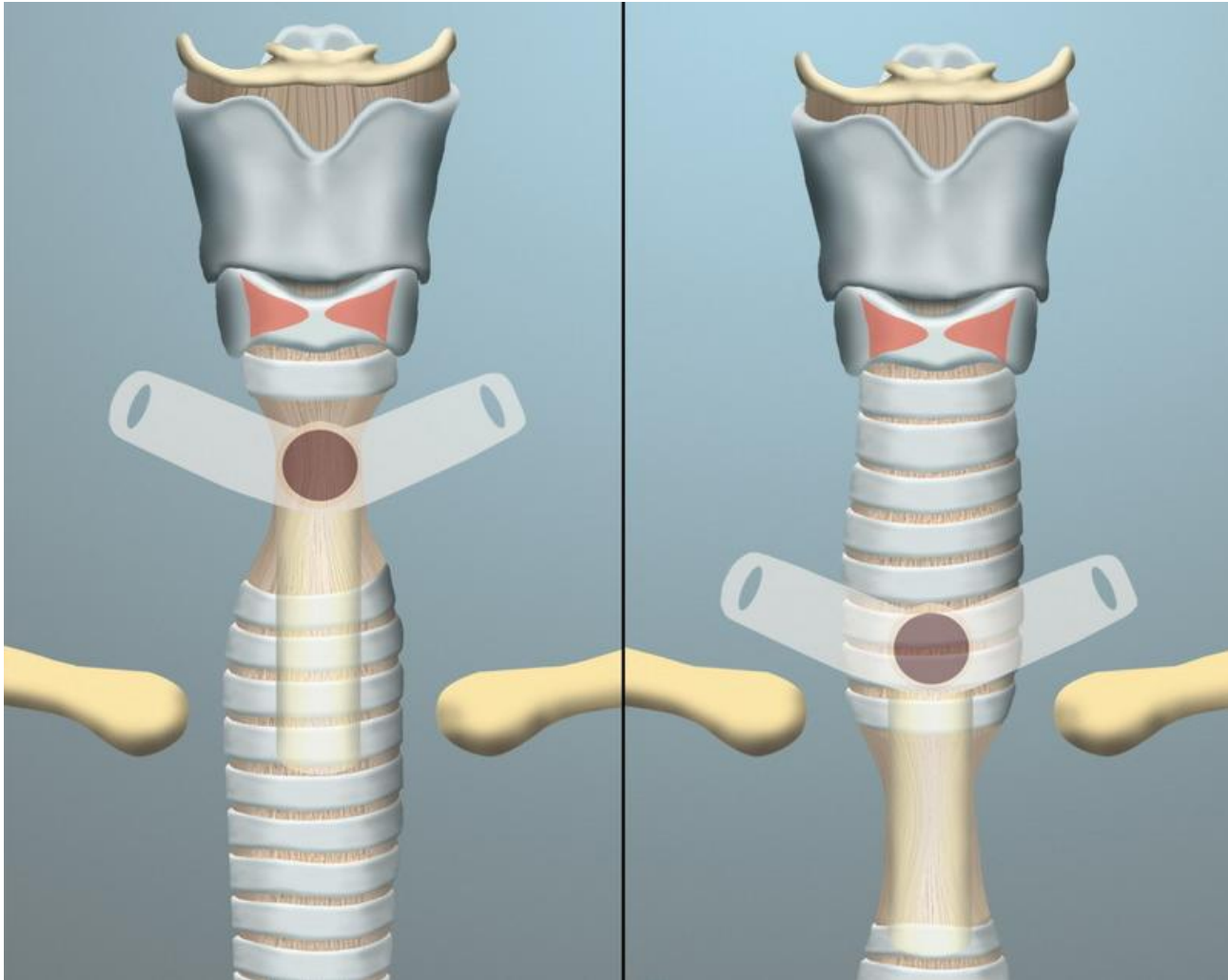
# *Tracheotomy placement*

## FOR INCIPIENT LTS



*Tracheotomy placement*

# FOR TRACHEAL STENOSIS

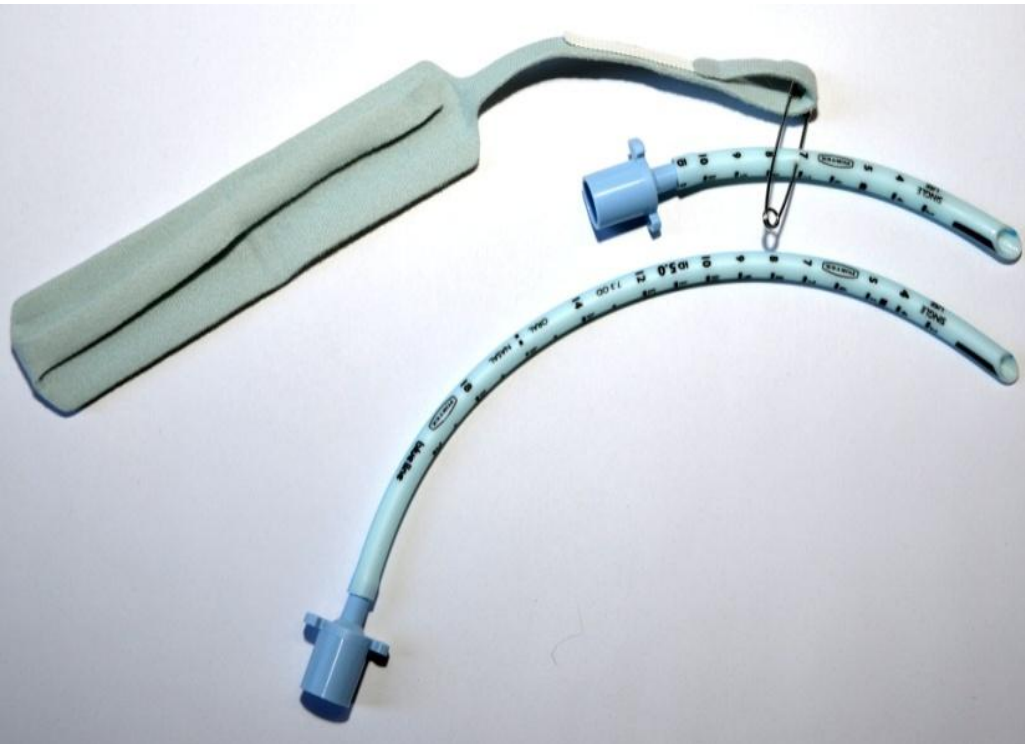


cervical stenosis

thoracic stenosis

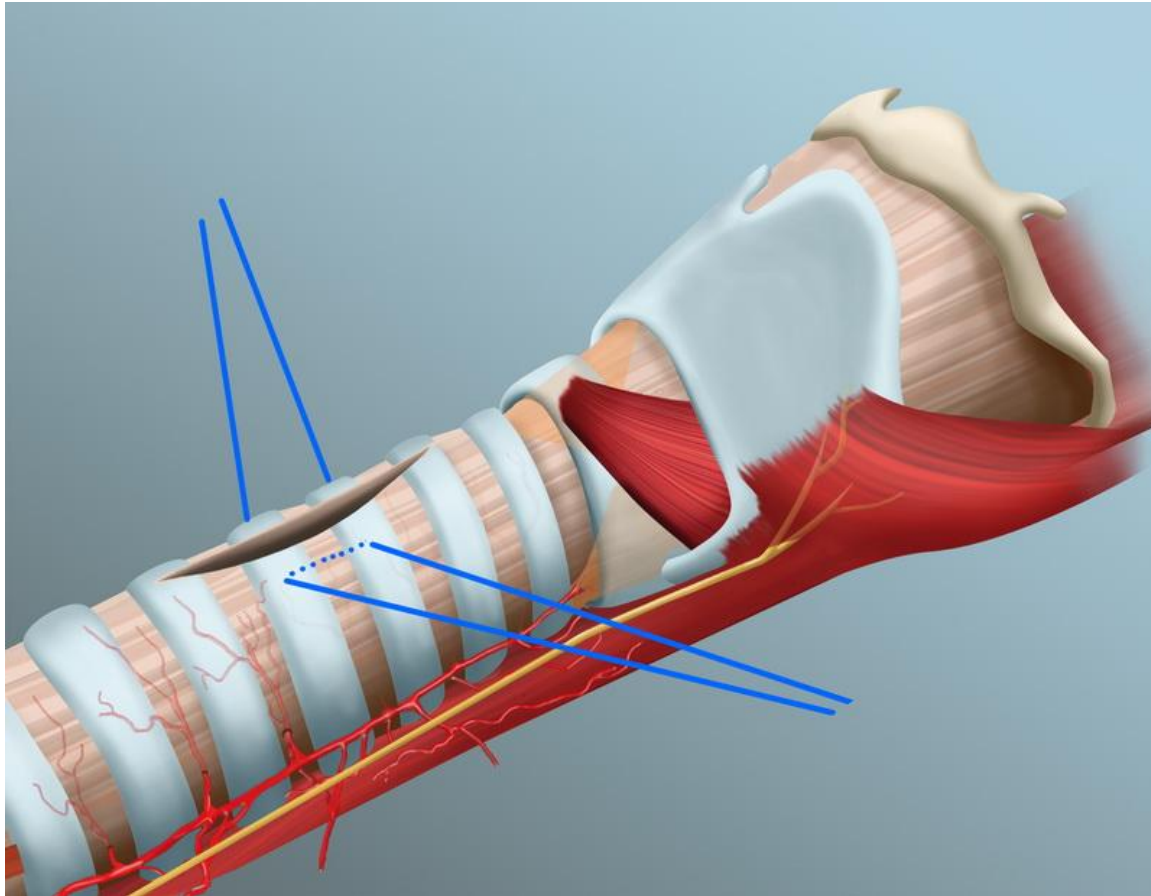
# MODIFIED PORTEX BLUE LINE TUBE

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- Trans tube flexible bronchoscopic control to avoid distal airway trauma
- Distal tracheal stenting

# ANGLO-SAXON OPERATIVE TECHNIQUE



## OPERATIVE TECHNIQUE

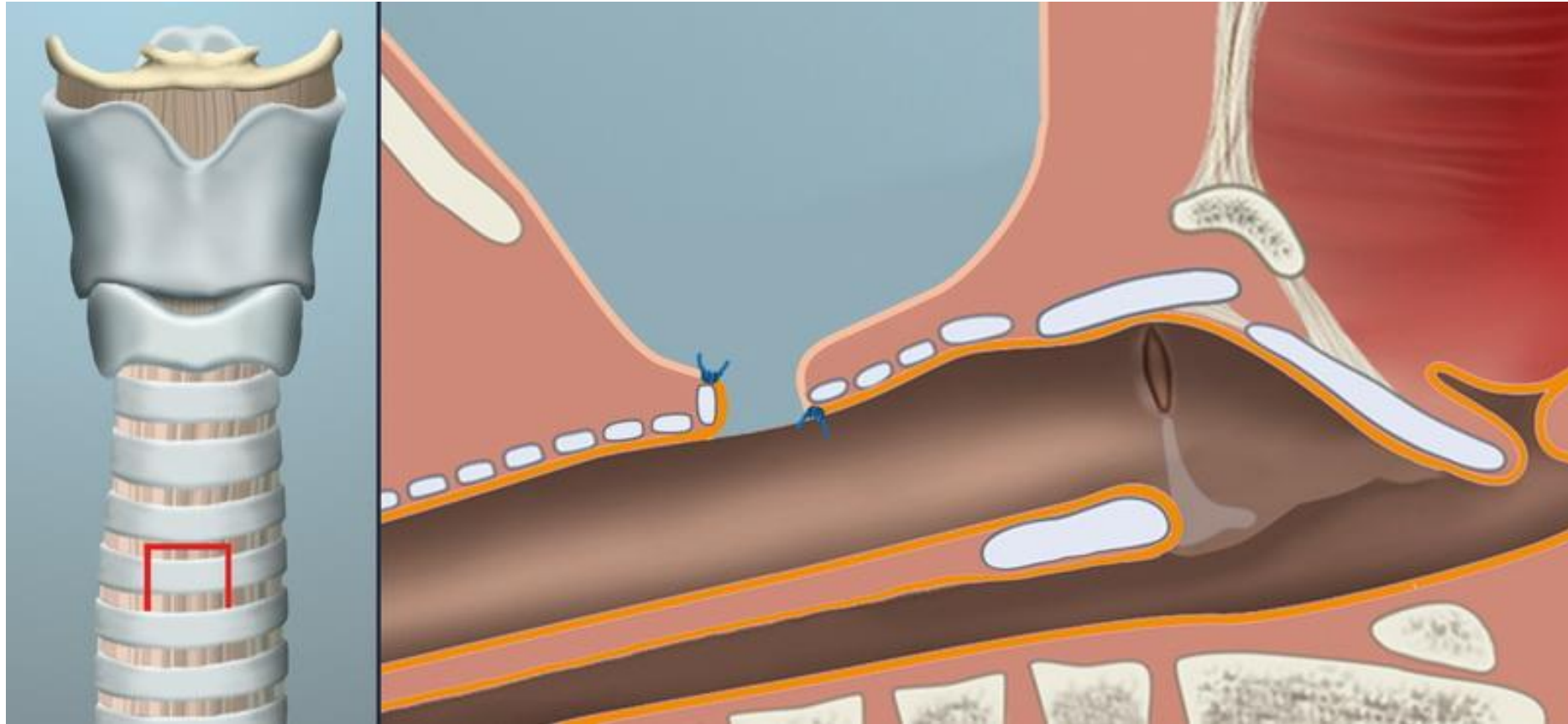
### Lausanne

- Under general anesthesia
- ET tube or rigid bronchoscope or laryngeal mask
- Incision of **ONLY ONE tracheal ring**
- Resection of **subcutaneous fat**
- **Resorbable skin sutures** around stoma opening  
> mature stoma tract
- Cannula used to calibrate tracheal opening

**! CREATE A MATURE STOMA TRACT !**



## OPERATIVE TECHNIQUE



front view

- > Single ring Bjork's flap
- > Width should not be more than the length
- > stomal size calibrated as per cannula size

lateral view

## ADVANTAGES

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- No risk of **false passage** during recannulation
- Prevention of air and mucus leaks
  - > **no subcutaneous emphysema**  
under positive pressure ventilation
- Less **suprastomal collapse and granuloma**

## EARLY COMPLICATIONS

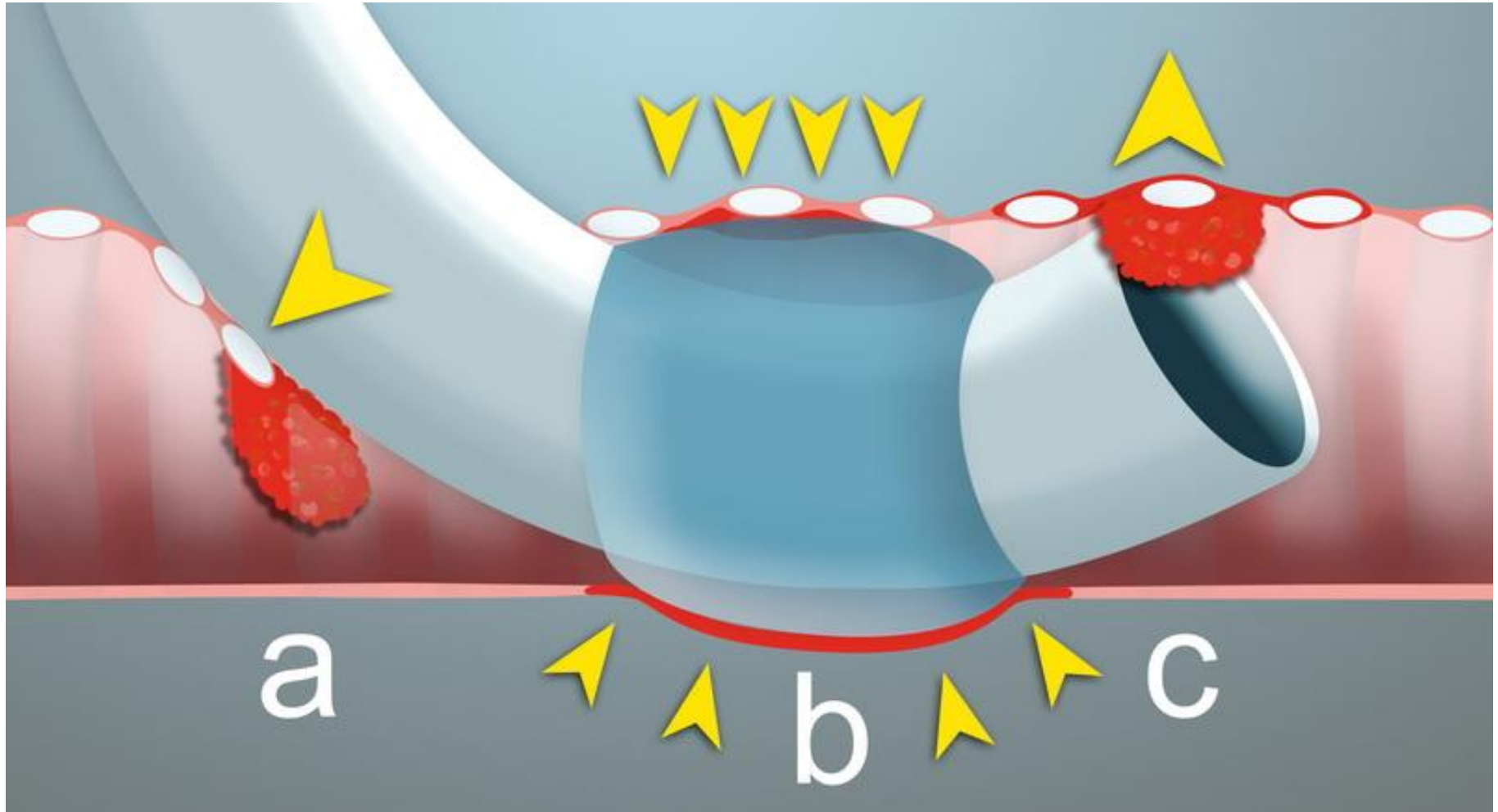
- Within the first postoperative week
  - > hemorrhage
  - > pneumomediastinum
  - > pneumothorax
  - > local infection
  - > accidental decannulation
  - > mucous plugging of cannula

**! TECHNICAL ERRORS or POOR TRACH. CARE !**

## LATE LOCAL COMPLICATIONS

- Suprastomal collapse and granuloma
- Cannula tip granuloma or stenosis
- Granulation tissue along stoma tract
- Double lumen stoma tract
- Lower airway infection, pneumonia
- Accidental decannulation
- Plugged tracheostomy cannula
- Localized tracheomalacia

# CANNULA-RELATED STENOSIS



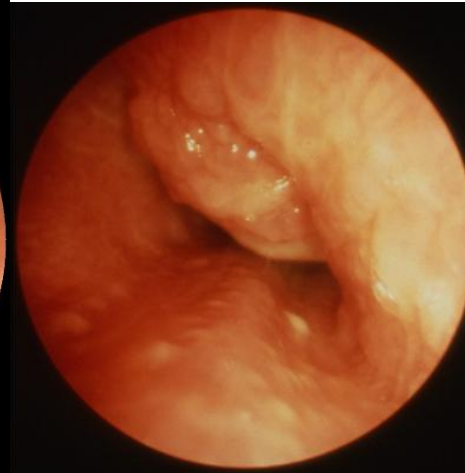




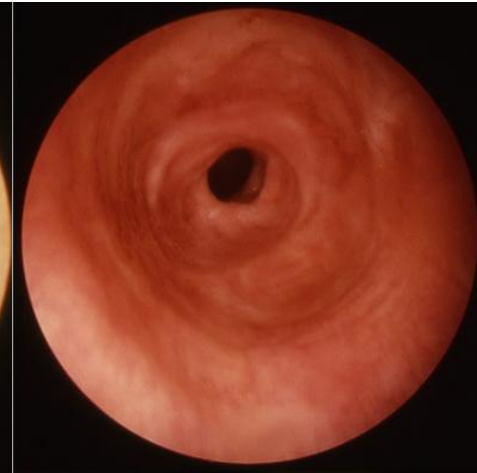
Suprastomal  
collapse +  
granuloma



A-frame  
tracheal  
deformity



Cannula  
tip  
granuloma



Cannula  
tip  
stenosis

- **Poor tracheostomy care**

- > removal of infected granulation tissue
    - bipolar coagulation/biopsy forceps/scissors
  - > Ciproxin HC ear drops/ nebulisations
  - > gentamycin-corticosteroid ointment
- } 3 x /d
- > change of tracheostomy cannula

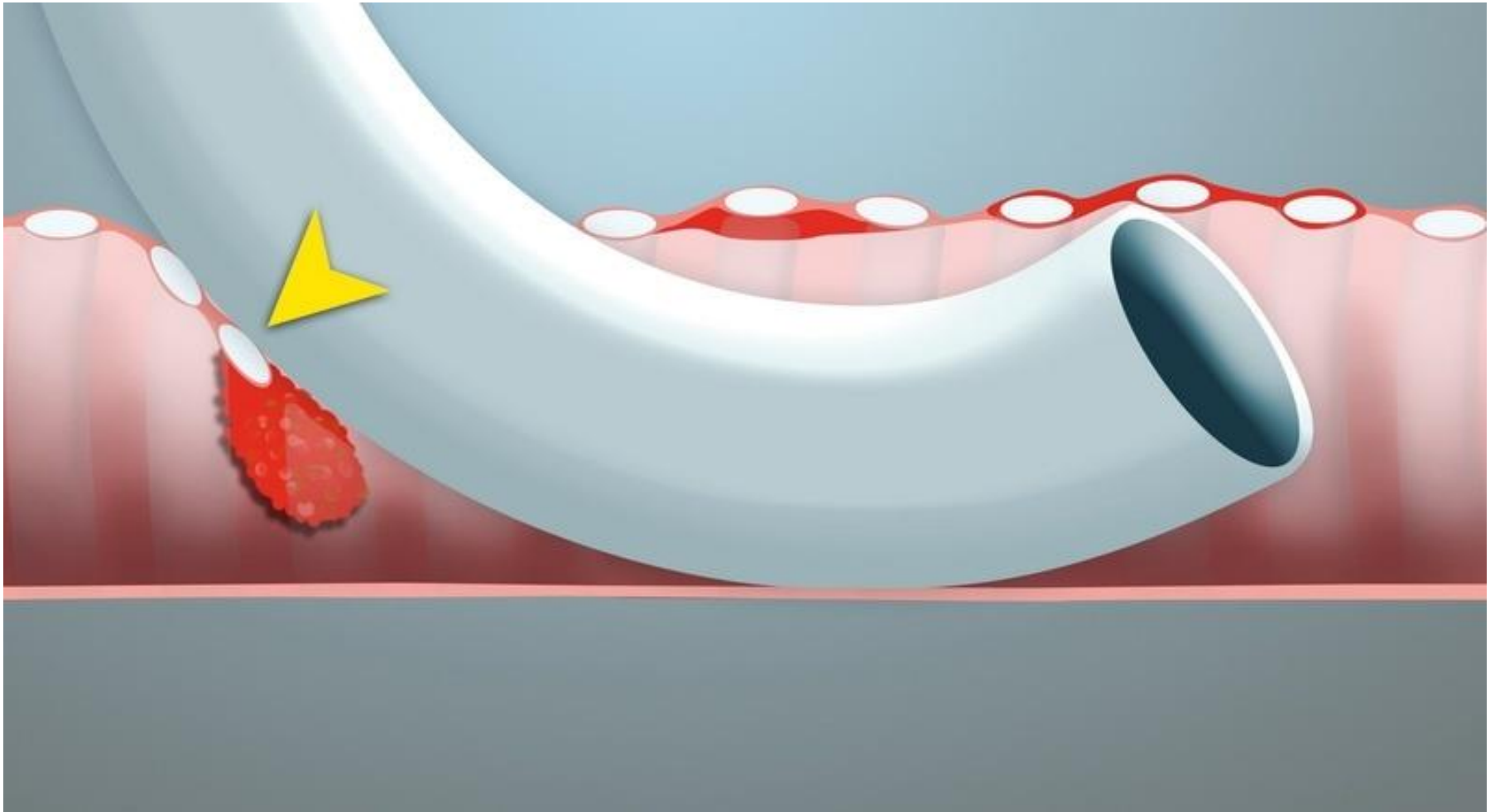
- **Lower airway infection**

- > bacteriological aspirate
- > proper systemic antibiotics

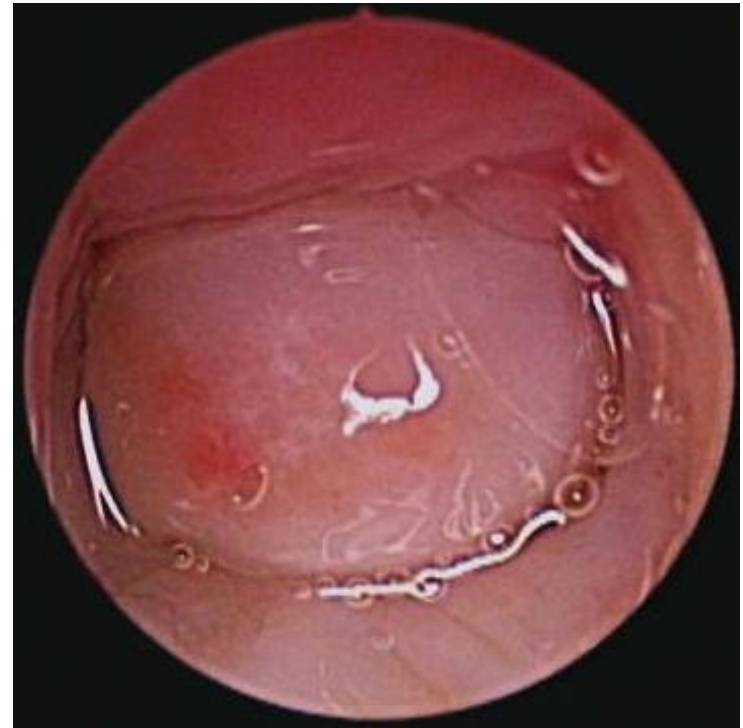
## SUPRASTOMAL COLLAPSE and GRANULOMA

- **Frequently seen in infants and small children**
  - > asymptomatic until capping trials or decannulation
- **CAUSES**
  - soft pliable cartilages in children
  - temporary arrest of tracheal growth
  - convexity of tracheostomy cannula
  - infection
- **Partially avoidable if**
  - > skin sutured around tracheostoma opening
  - > good tracheostomy care

# SUPRASTOMAL COLLAPSE and GRANULOMA

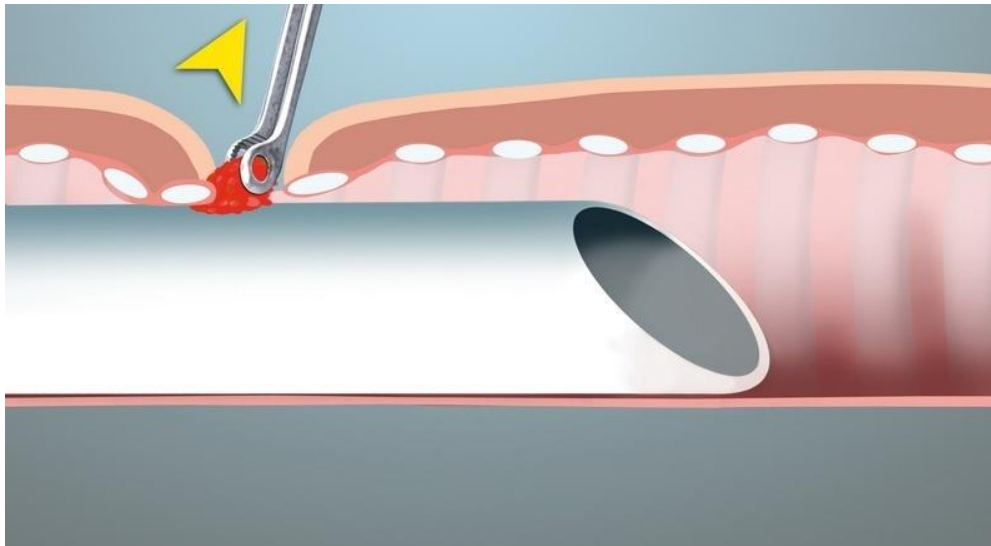
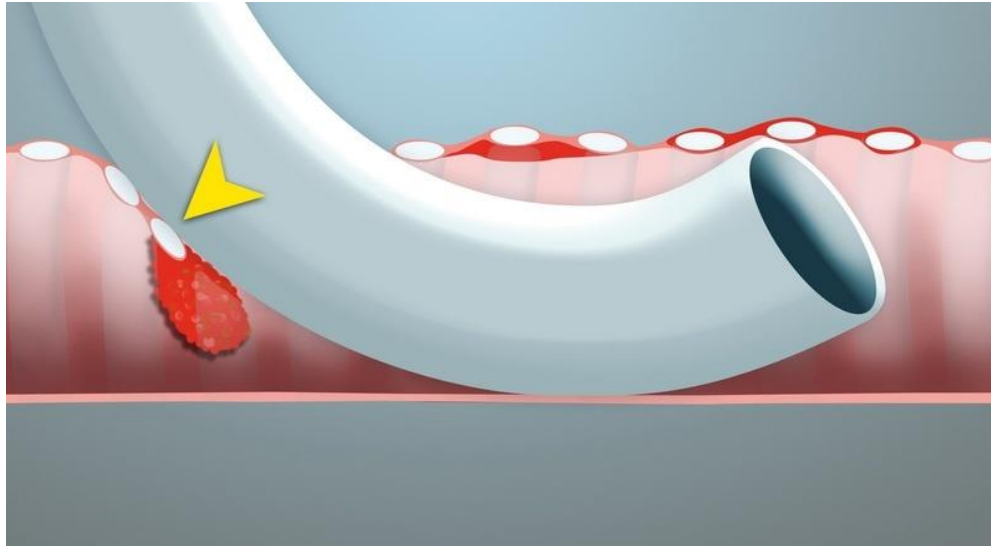


# ENDOSCOPIC FINDINGS



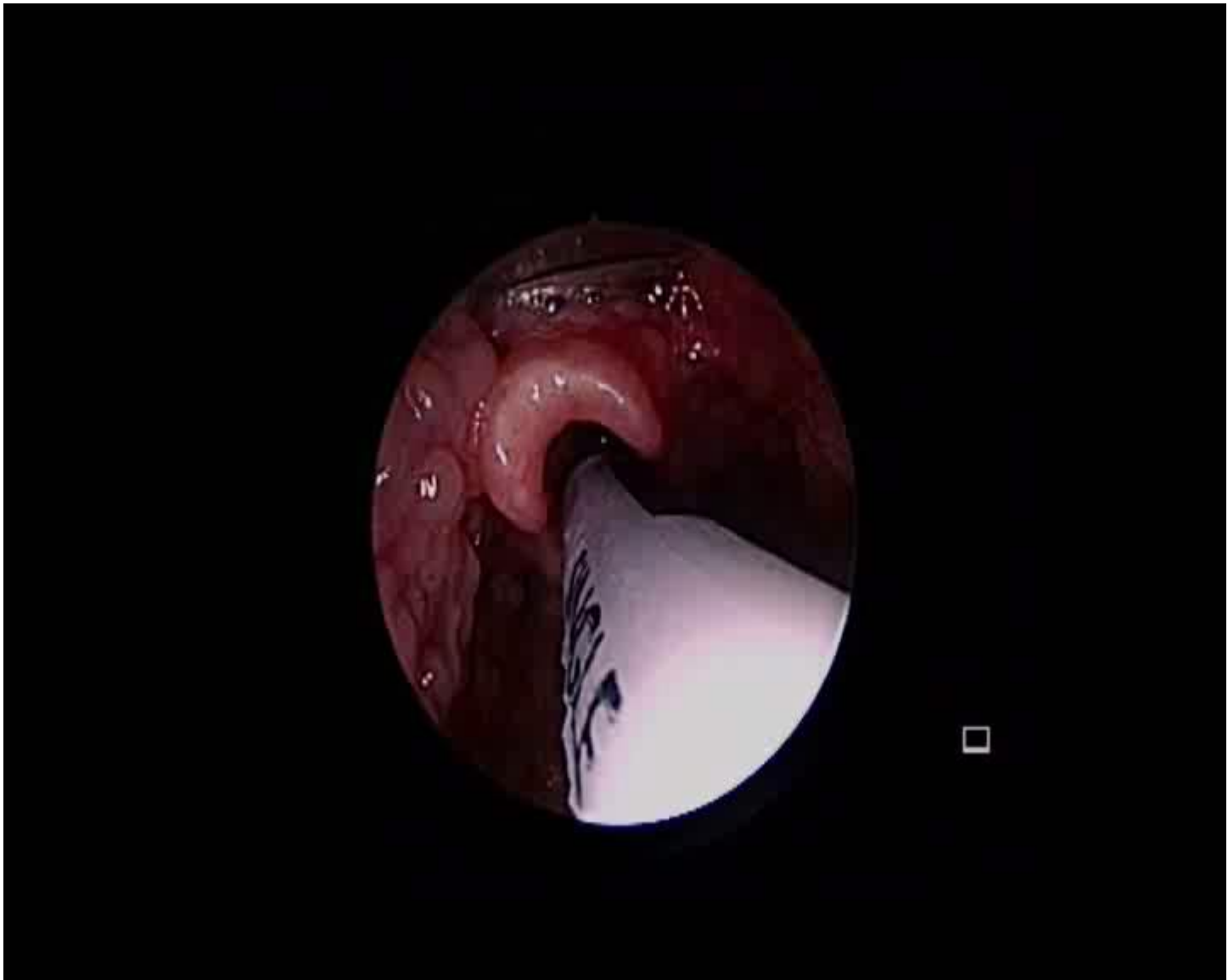


# EFFECT OF ET INTUBATION

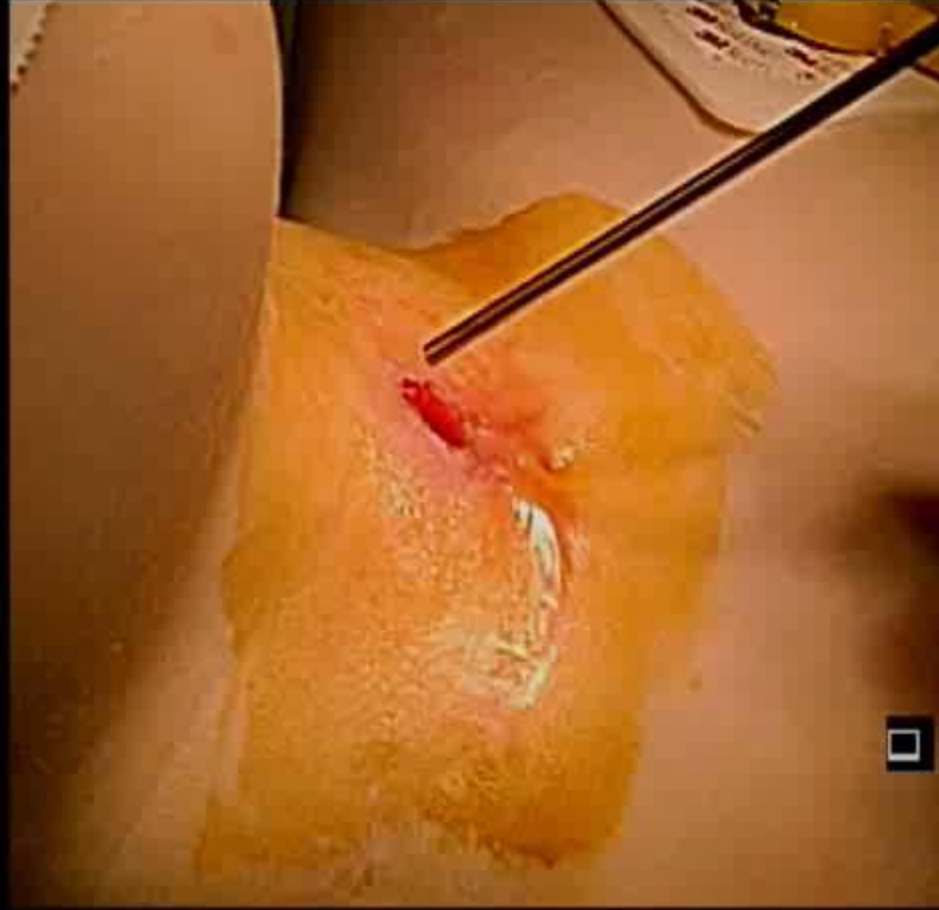




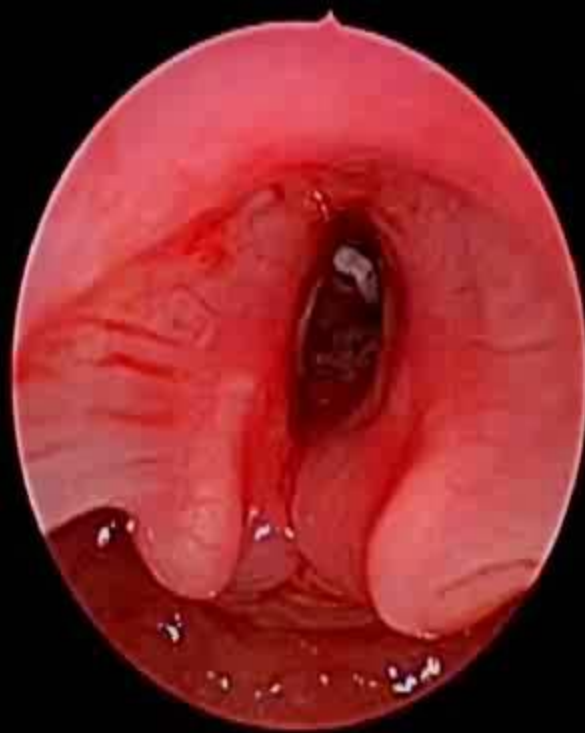








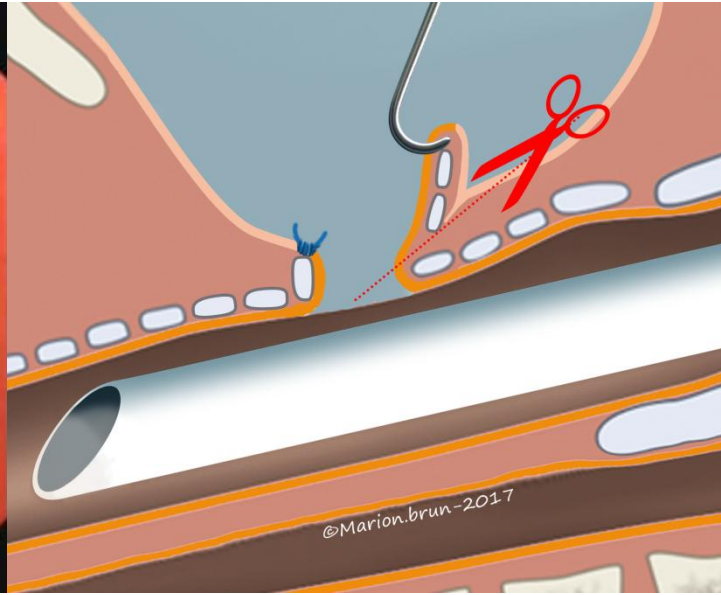




# Suprastomal collapse



Pre op



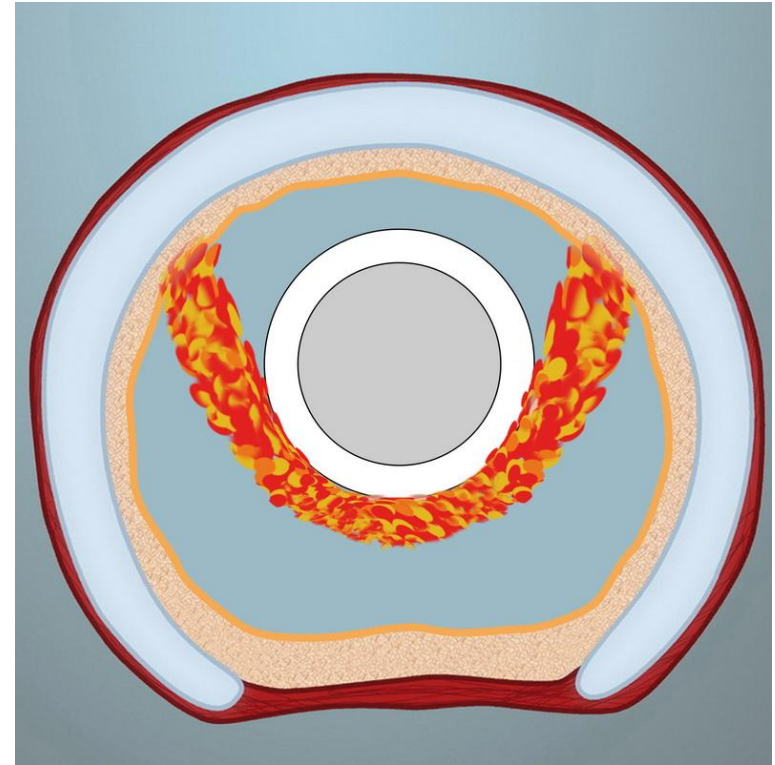
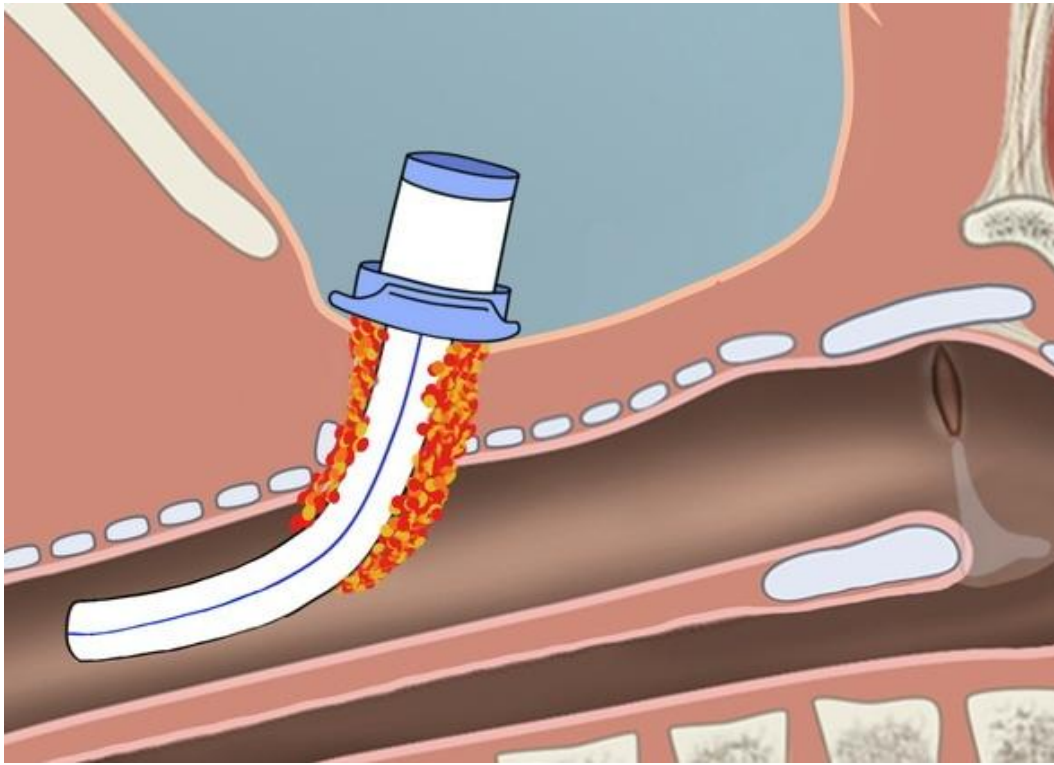
Immediate post op

> 3 months



# Tracheostomy

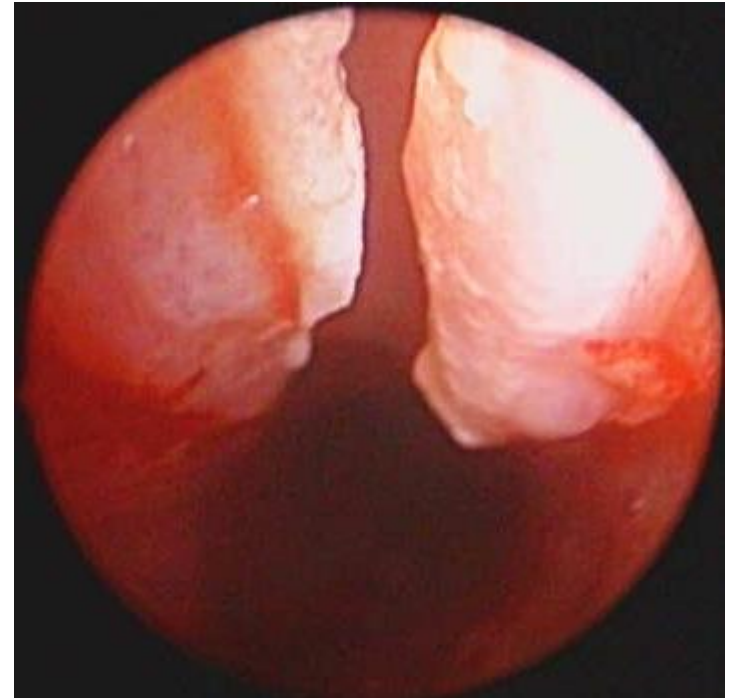
## DOUBLE TRACHEAL LUMEN



## DOUBLE TRACHEAL LUMEN



Granulation tissue arising  
from lateral aspect  
of tracheotomy

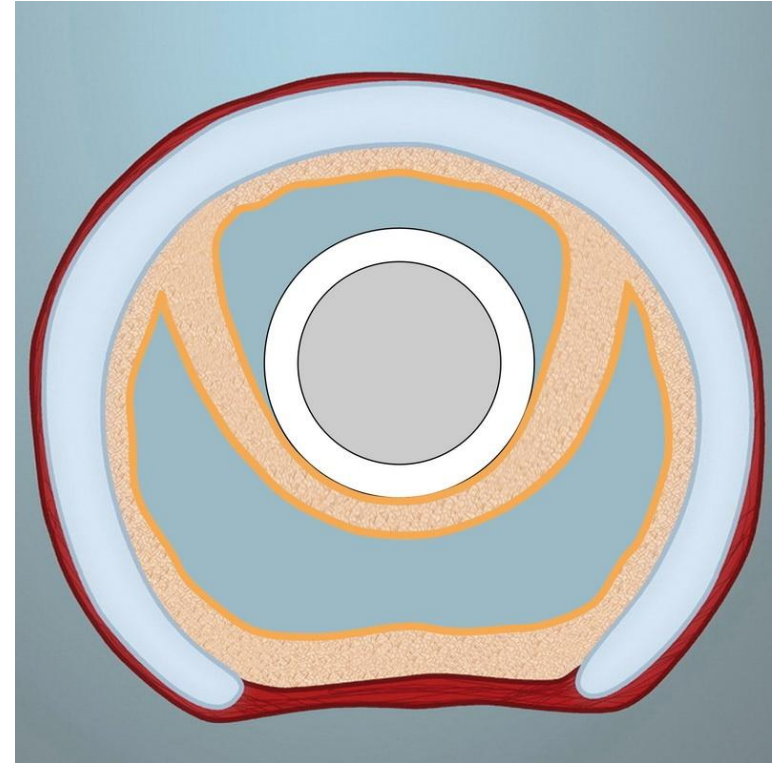
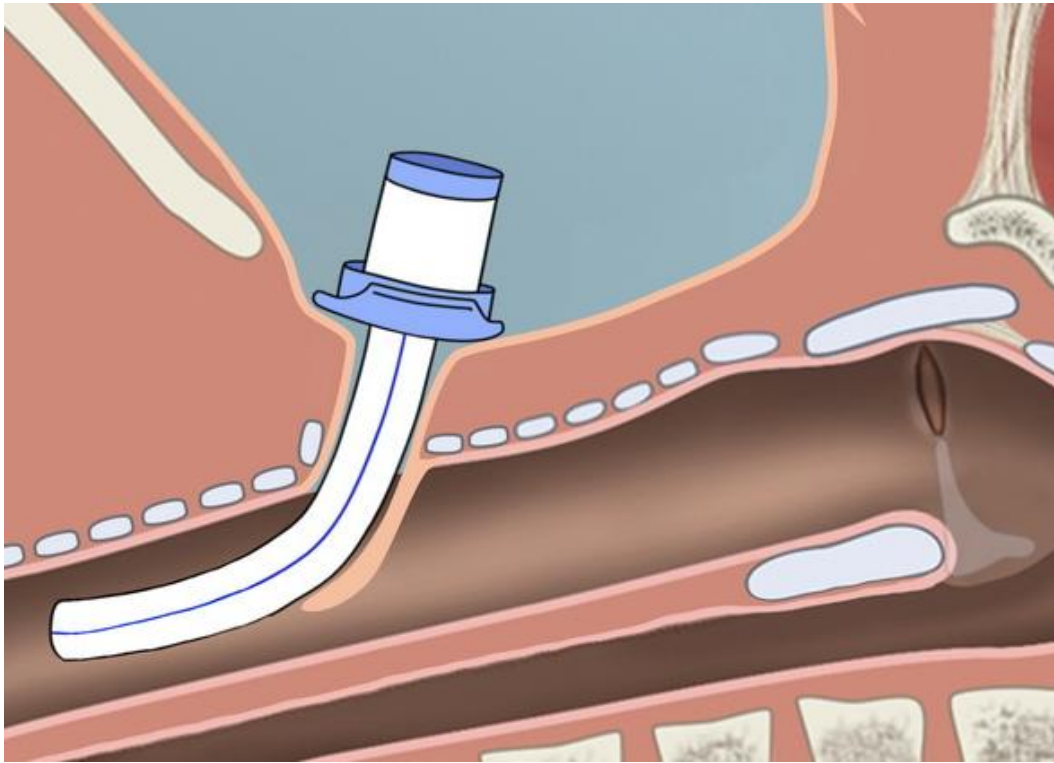


Granulation tissue about  
to merge in the midline



# *Tracheostomy*

## DOUBLE TRACHEAL LUMEN



AT THE STAGE OF MATURE CICATRICIAL TISSUE

*Tracheostomy*

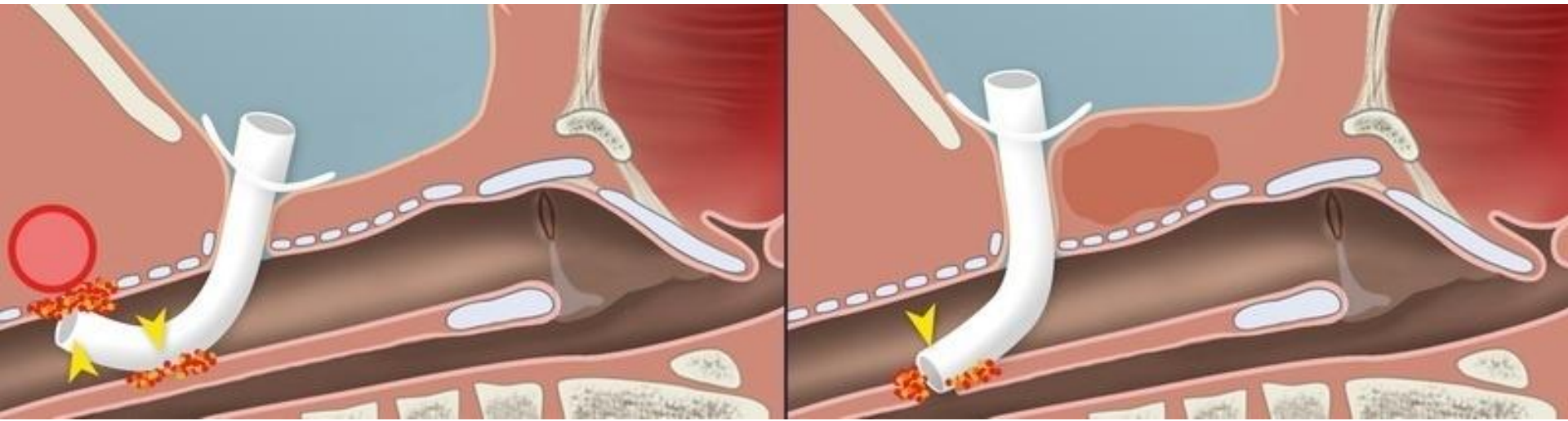
# DOUBLE TRACHEAL LUMEN





# Tracheostomy

## RARE PEDIATRIC COMPLICATIONS

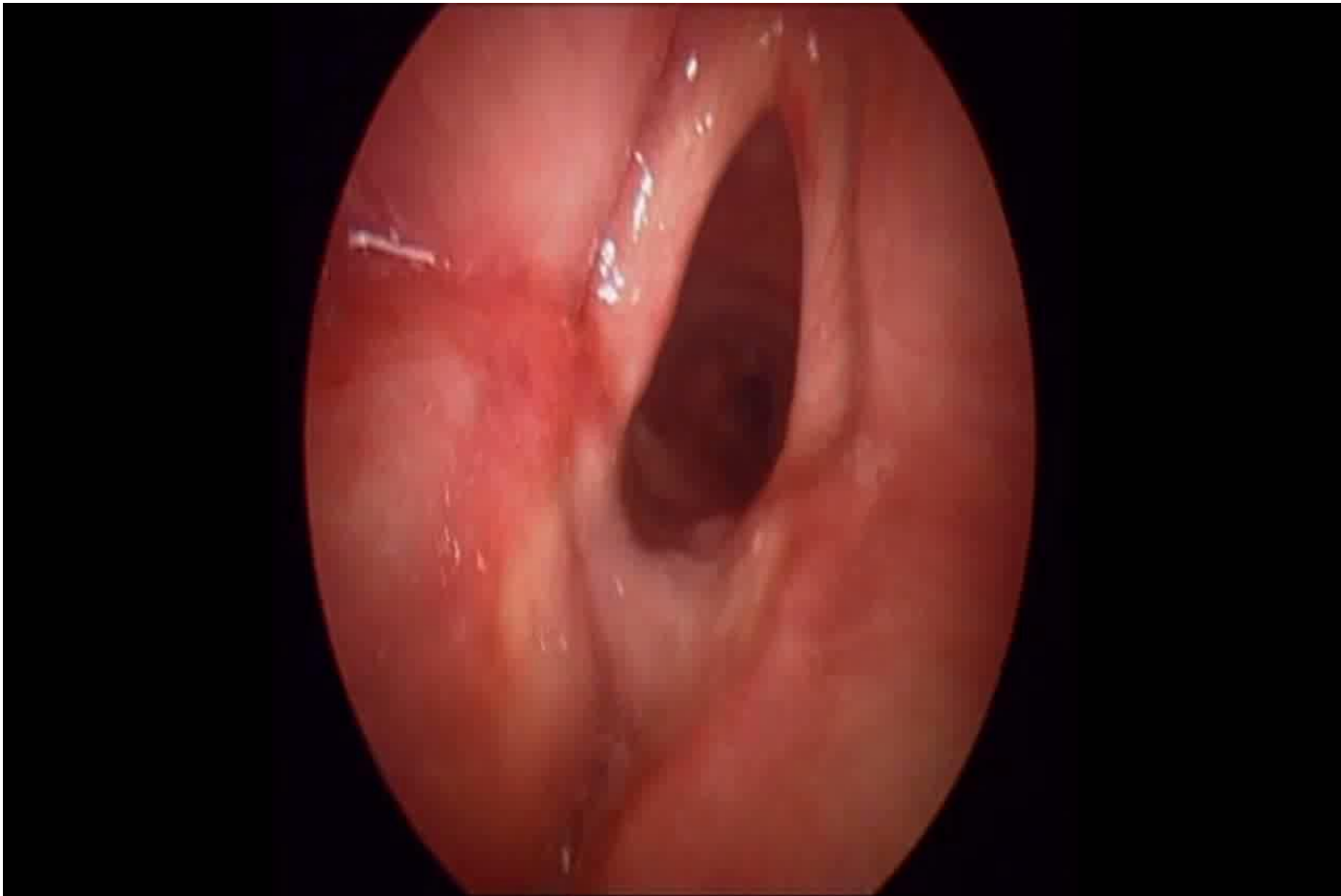


Tracheo-innominate  
artery fistula  
*PULSATING CANNULA*  
BLEEDING GRANULATIONS

Tracheo-esophageal  
fistula

## Pre op endoscopy

- >Tracheocutaneous fistula
- >Stomal malacia
- >1.5 cms ETF



## POST-DECANNULATION COMPLICATIONS

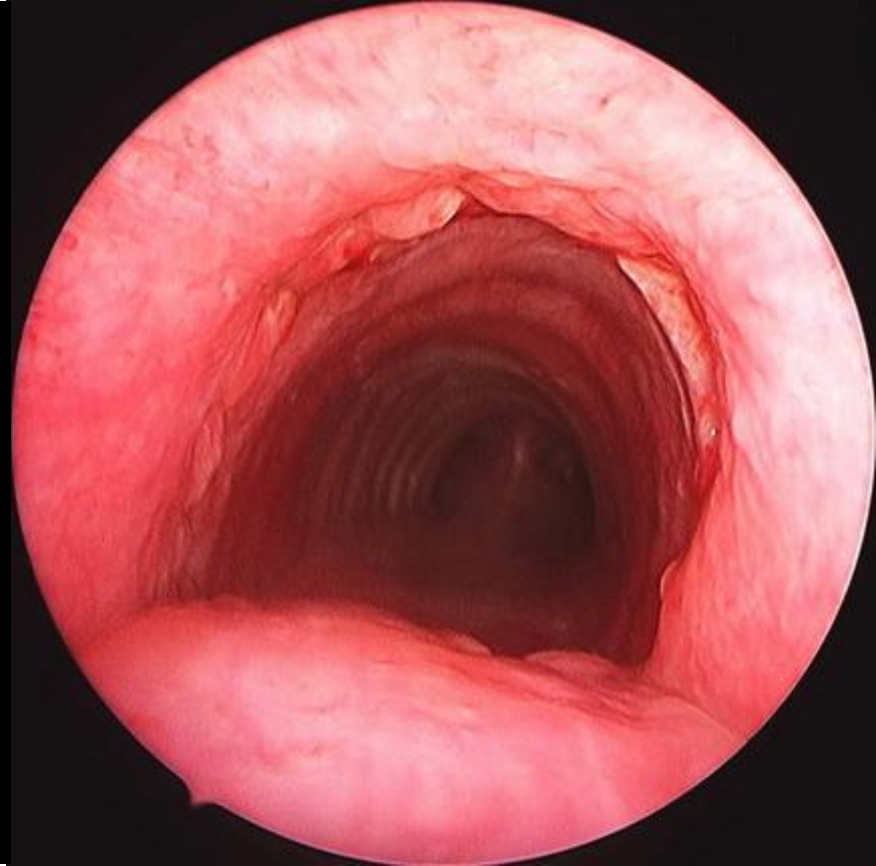
- Localized tracheomalacia /  
A-frame deformity /  
Suprastomal collapse
- Distal tracheal stenosis

# *Localized tracheomalacia*

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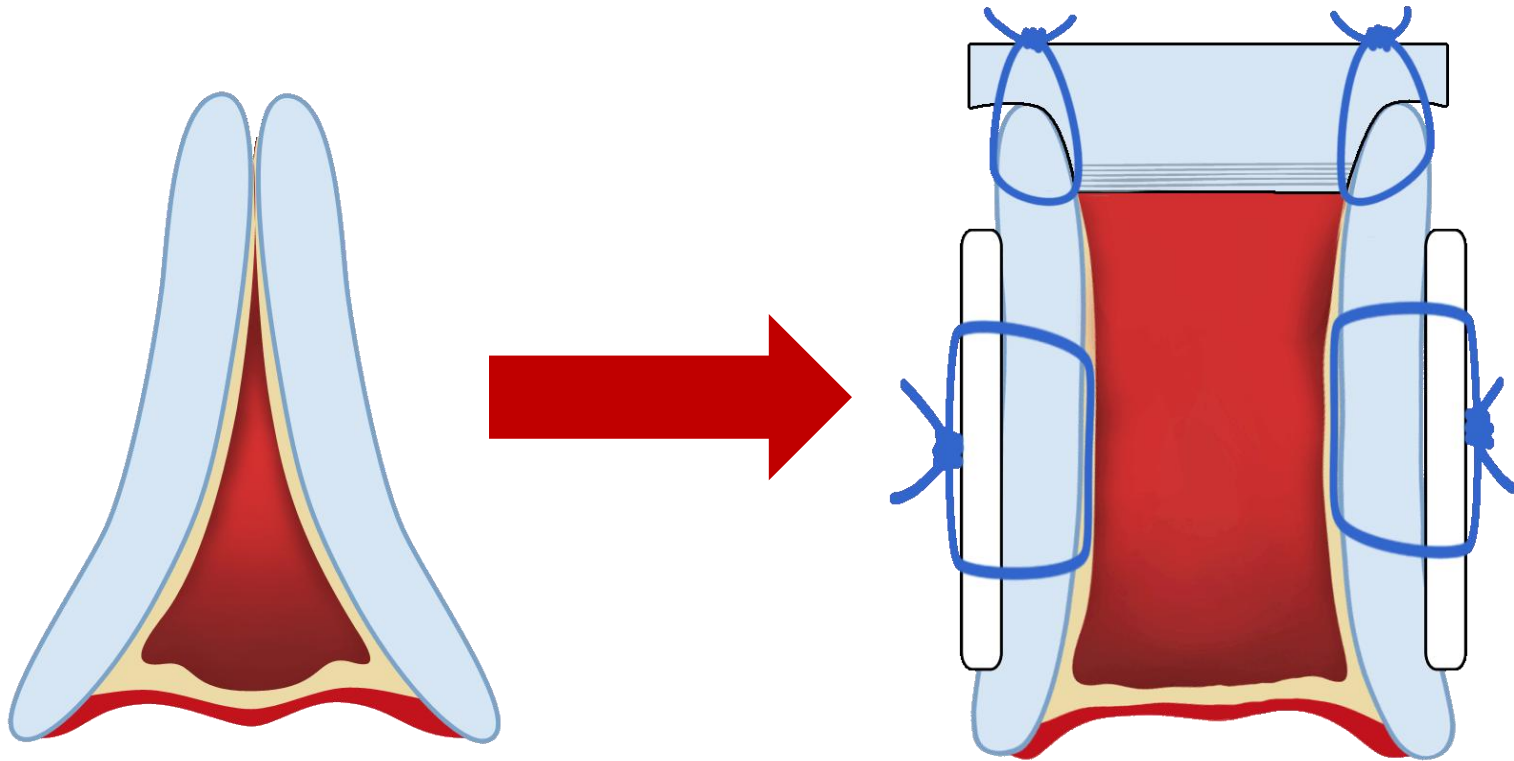


Former tracheostoma  
dynamic airway exam



10 days post-resection  
anastomosis

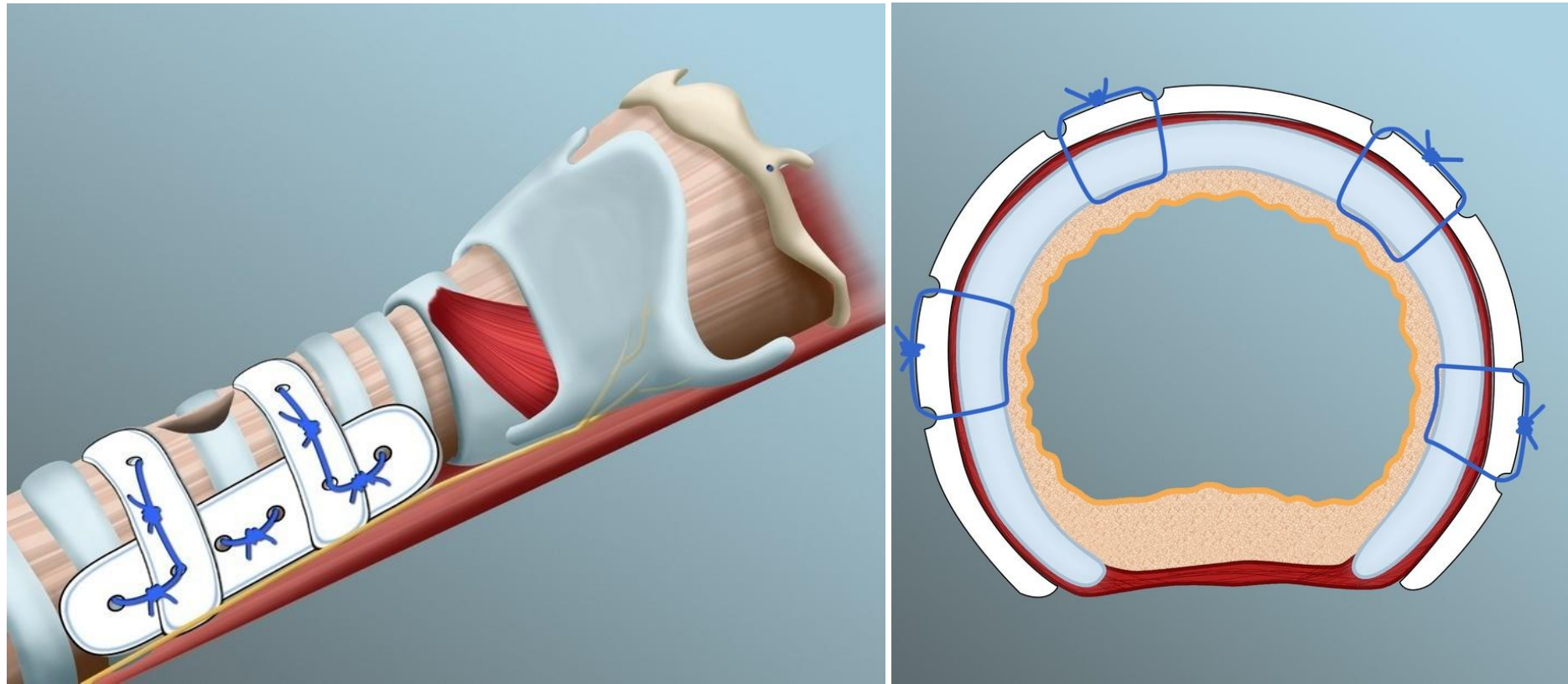
# A-FRAME TRACHEAL DEFORMITY



Anterior cartilage graft  
± PDS miniplates

**! WHEN RESECTION-ANASTOMOSIS IS IMPOSSIBLE !**

# TRACHEAL REINFORCEMENT



Transfixiant 4.0 PDS sutures



# TRACHEAL REINFORCEMENT

Preoperative view



Postoperative view



PDS miniplates  $\pm$  anterior costal cartilage graft

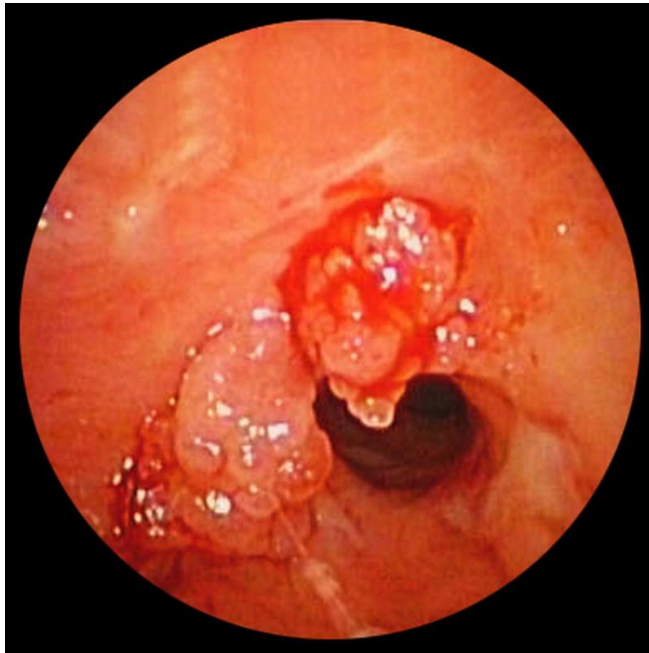
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# LOWER AIRWAY INFECTION

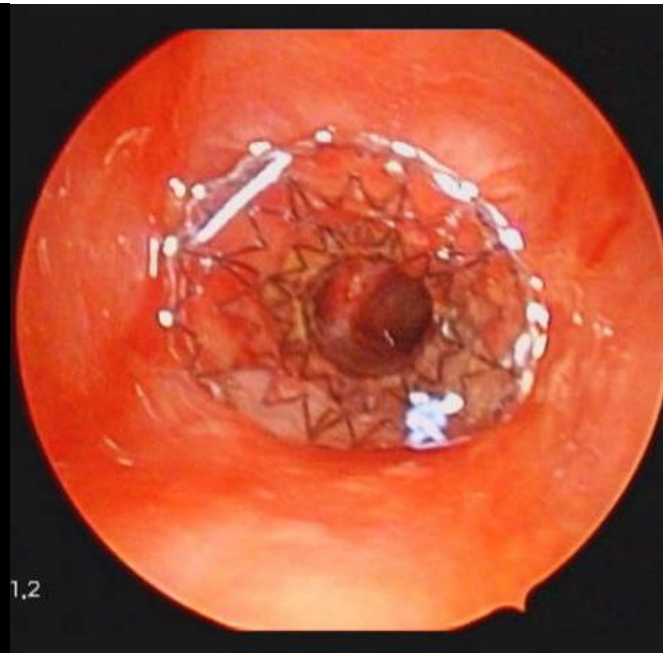
**! A TRACHEOSTOMIZED PATIENT SHOULD ALWAYS HAVE A BACTERIOLOGICAL ASPIRATE UPON ARRIVAL AT THE HOSPITAL !**

*Distal tracheal stenosis*

# INTRATHORACIC STENOSIS



Preoperative  
view



Stenting



Final result

**!LASER, DILATATION, SHORT-TERM STENTING!**

## DISTAL AIRWAY STENTING

- Long cannula bypassing stenosis
- Non-cuffed endotracheal tube passed through tracheostoma
- Temporary short-term stenting



**PROPER TUBE POSITIONING MAY BE DIFFICULT**

**—  
NEED FOR FIBEROPTIC CONTROL**

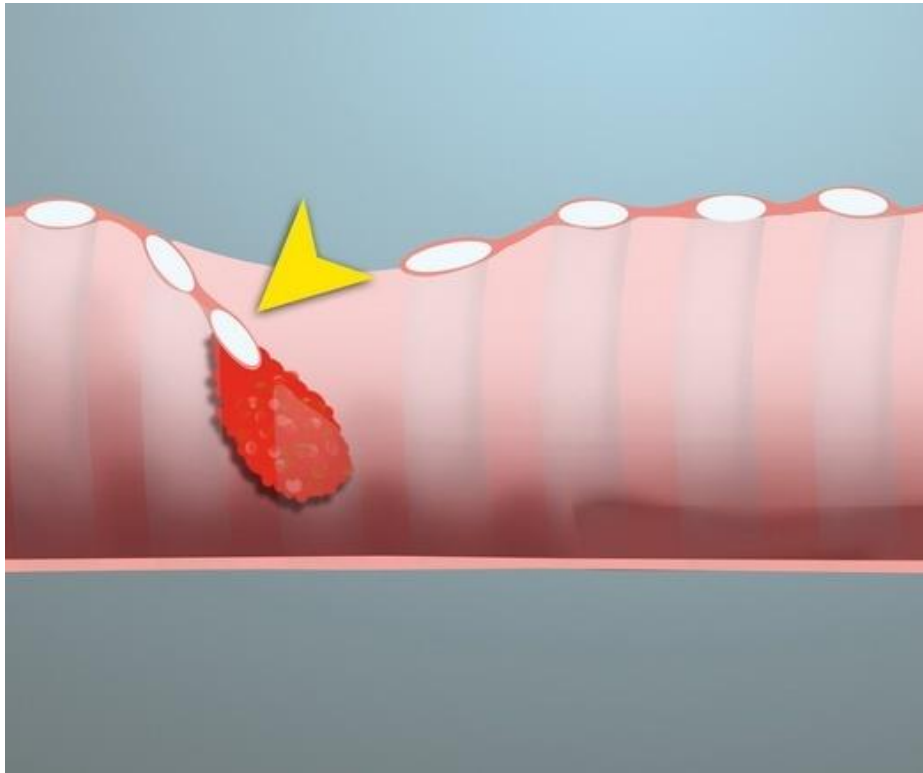
- Only when the initial cause to do tracheostomy has resolved / been corrected
- Thorough airway evaluation (flexible / rigid)
  - > under spontaneous respiration
  - > with temporary removal of cannula
- Down-sizing of tracheostomy tube
- Successful capping trials of tracheostomy tube
  - > during the day
  - > Polysomnography (OSA-related obstruction)

## SURGICAL CLOSURE

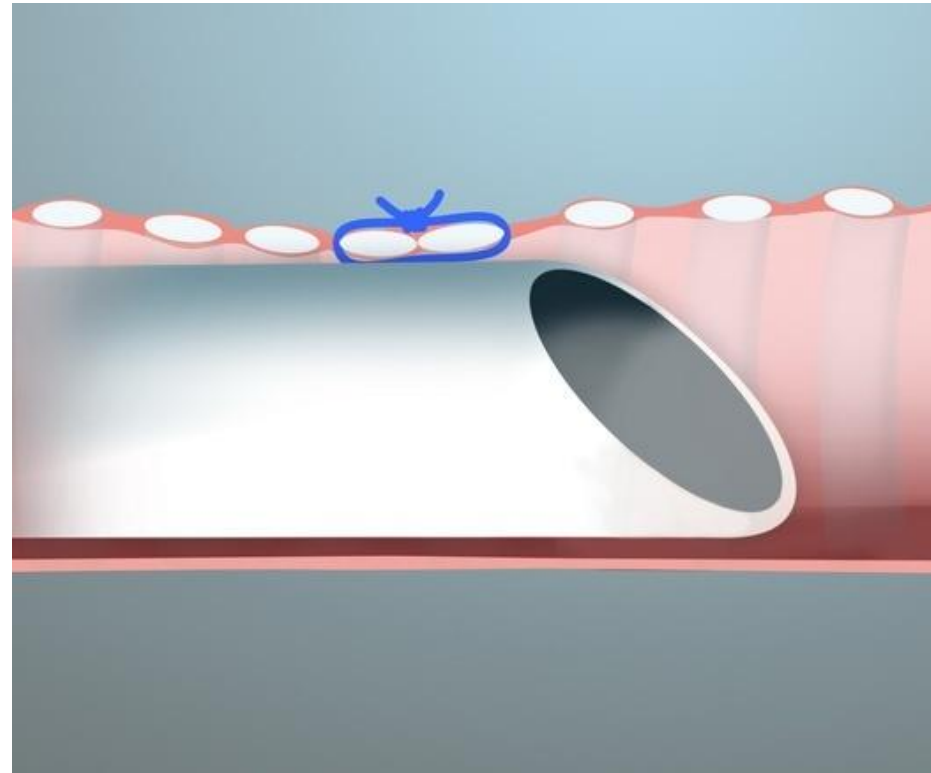
- After successful airway reconstruction
  - > improves local situation at stoma site
  - > avoids tracheocutaneous fistula
  - > eliminates unsightly scar
- Transoral intubation
  - > ET tube passed beyond tracheostoma
  - > removal of granuloma pushed inside the tracheostomy opening
- Removal of ellipse of skin around stoma
- Excision of skin pit down to trachea
- Closure with stitches placed in cranio-caudal axis



## SURGICAL CLOSURE

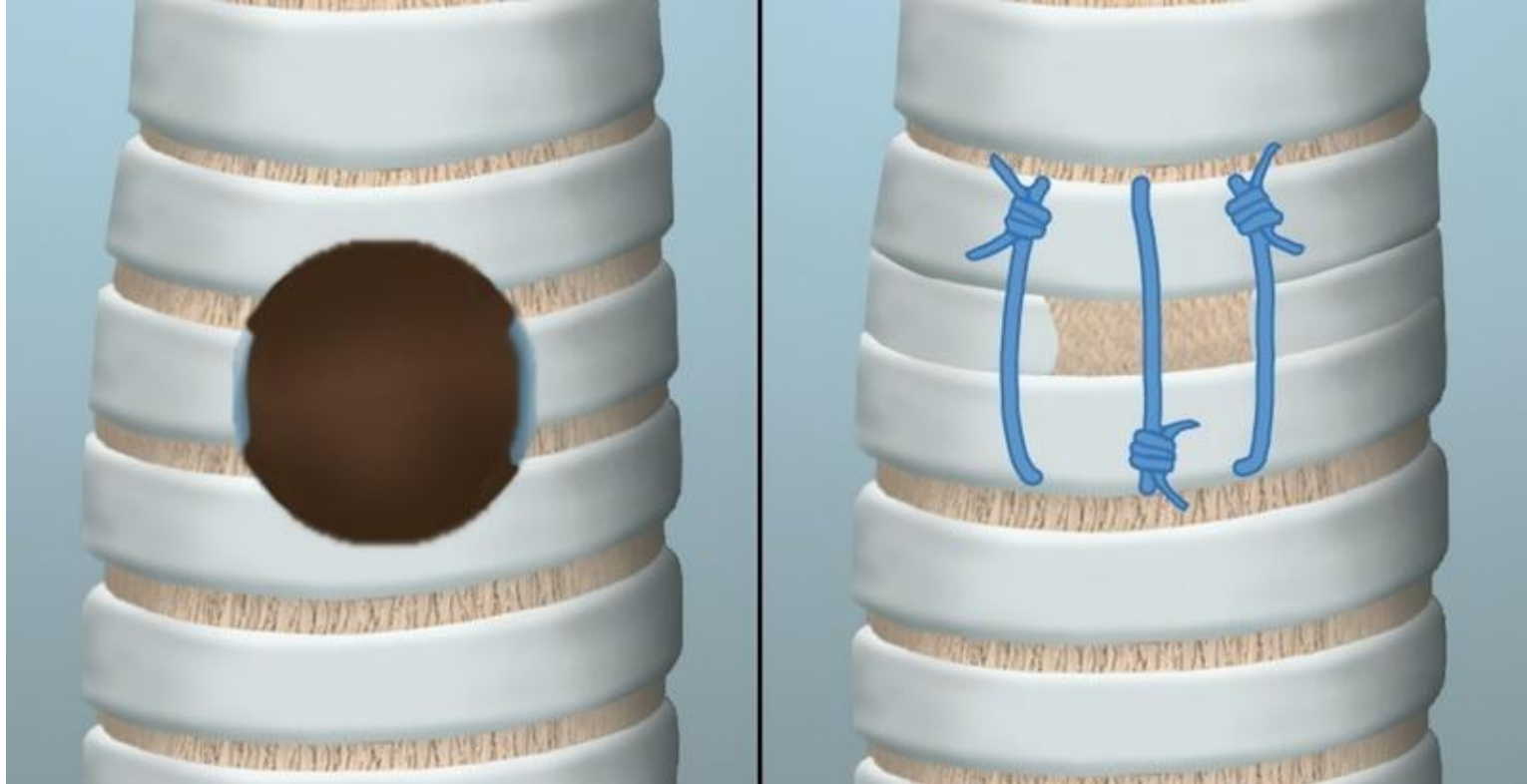


Suprastomal collapse



Removal of granuloma  
+ closure

## SURGICAL CLOSURE



Complete resection  
of cutaneous stoma



Stitches in cranio-caudal axis  
*Restores a steady Roman vault  
at the stoma site*

- **Current indications**
  - > upper airway obstruction
  - > prolonged ventilatory support
  - > pulmonary toilet
- Great inter-institutional **variations in indications**
- **Tracheotomy location**
  - > dependent on indication

- **Mortality** ~ 1-3%
  - > accidental decannulation
  - > plugging of tracheostomy tube
- **Complications (under-reported)**
  - > early
  - > late
  - > post-decannulation
- **Tracheotomy management at home**
  - > full parental training
  - > caregiver support

# MANAGEMENT OF SUBGLOTTIC STENOSIS

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& Head - Neck Surgery  
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Lausanne, Switzerland**



**Centre hospitalier  
universitaire vaudois**



# Endoscopic vs Open & .... *COMBINED APPROACHES*

## 1. CONGENITAL

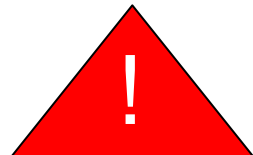
- Cricoid malformation
- Web

## 2. ACQUIRED

- Fresh incipient post intubation stenosis
- Established stenosis



...Complimenting each other, & for result optimisation  
**AIRWAY SURGEON MUST BE TRAINED IN BOTH**



# MODIFIED MYER-COTTON AIRWAY GRADING SYSTEM

Myer-Cotton grade		Isolated SGS	Isolated SGS + <b>comorbidities</b>	SGS + <b>glottic</b> <b>involvement</b>	SGS + <b>glottic</b> <b>involvement +</b> <b>comorbidities</b>
		a	b	c	d
I	0% - 50%	I a	I b	I c	I d
II	51% - 70%	II a	II b	II c	II d
III	71% - 99%	III a	III b	III c	III d
IV	No lumen	IV a	IV b	IV c	IV d



## PARAMETERS INFLUENCING OUTCOME

- STENOSIS
  - > Fresh, incipient vs mature, cicatricial LTS
  - > Low grade vs high grade LTS
  - > Short vs long stenosis
  - > Subglottic vs glotto-subglottic vs transglottic LTS
  - > Pan-mural vs purely intrinsic stenosis
  - > Malacic vs non-malacic stenosis
- PATIENT
  - > Infants vs children vs adolescents
  - > Secondary airway lesions
  - > comorbidities, congenital anomalies



**PRECISE PREOPERATIVE ASSESSMENT IS CRITICAL**



# ENDOSCOPIC TREATMENTS

## INDICATIONS

- > Post-intubation stenosis
- > Select group of cicatricial stenoses
  - Grade I - III acquired SGS
    - \* Thin diaphragm
  - PGS
- > Adjunct to open surgery/ *result optimisation*
  - dilation
  - (partial) arytenoidectomy
  - glottic or supraglottic webs

# CONTRAINDICATIONS

- Congenital stenosis
- Loss of cartilage support
- Vertical scar > 1cm
- Posterior scarring with arytenoid fixation
- Circumferential scarring

*Simpson GT. et al.: Ann.Otol.Rhinol.Laryngol.1982*



No additional endoscopic treatment

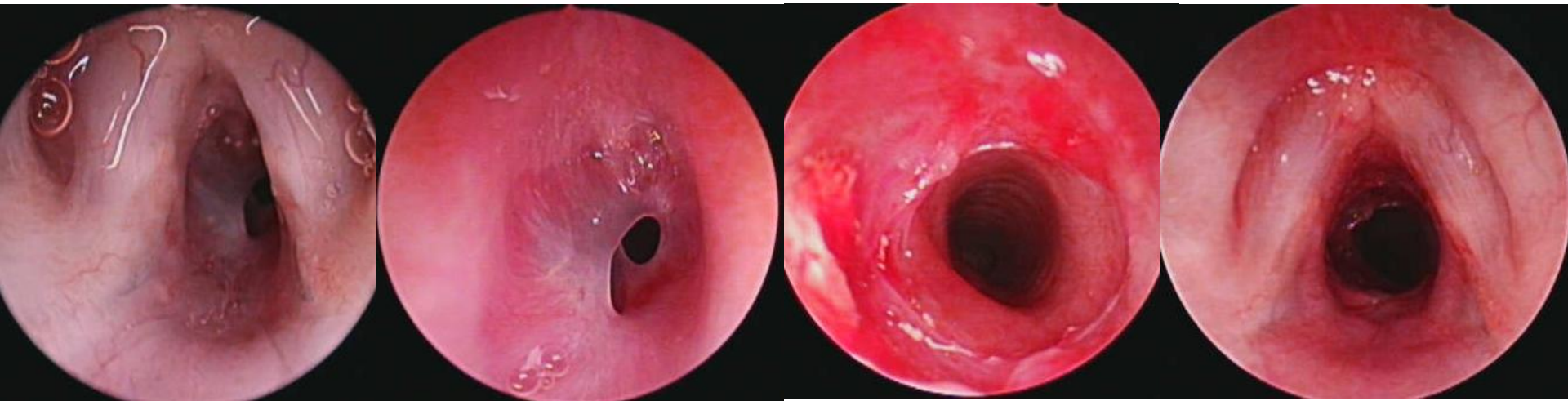
if stenosis recurs to its initial grade after a primary treatment

## TYPE OF ENDOSCOPIC TREATMENTS

- CO<sub>2</sub> laser resection / radial incisions
  - > ultrapulse technology
- Dilatation
  - > tapered bougies or balloons
- Cricoid split + balloon dilatation
- CO<sub>2</sub> laser + dilatation + stent
- Mitomycin-C : 2 mg/ml topically

# ENDOSCOPIC TREATMENT

Incipient, diaphragm- like SGS



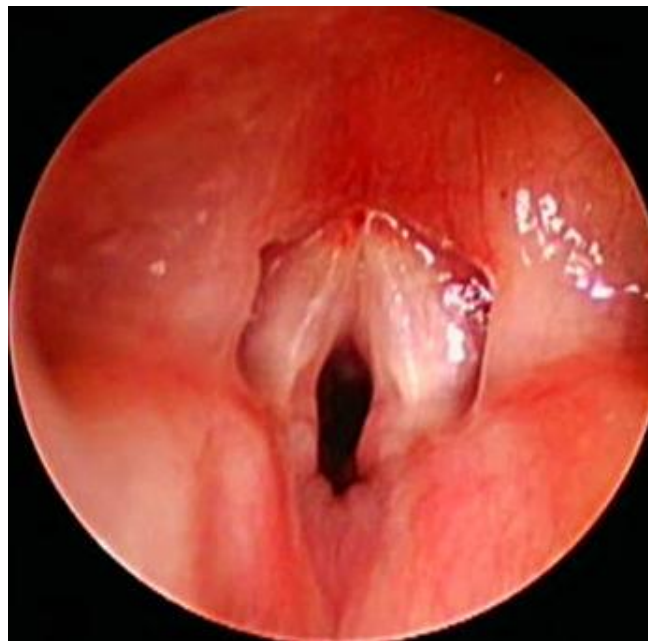
6 weeks

Cardiac surgery on d 18  
Multiple extubation failures  
CPAP 24h since 5 days

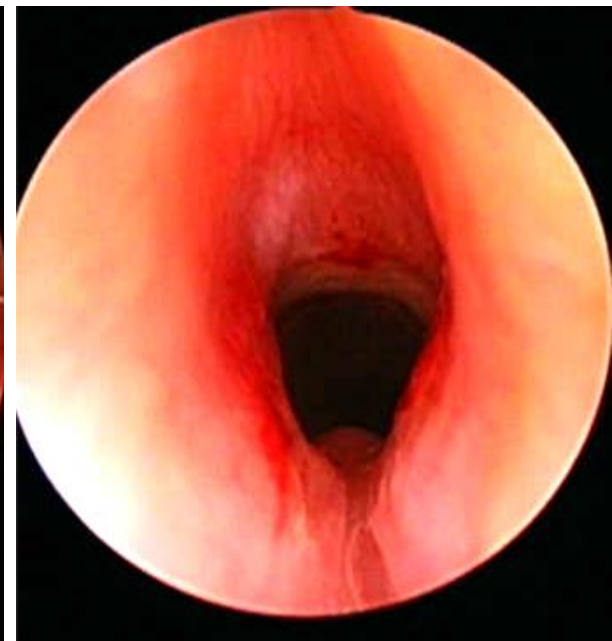
# EVOLUTION / MANAGEMENT OF MIXED STENOSIS



Pre op



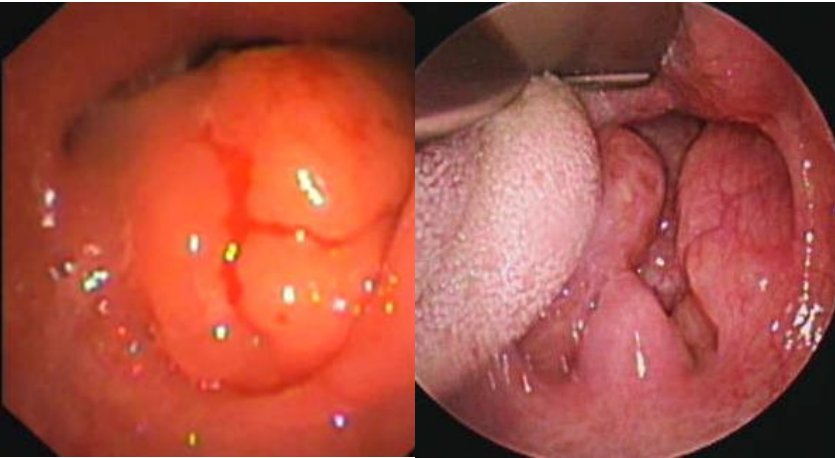
Imm.  
Post op  
Suboptimal airway



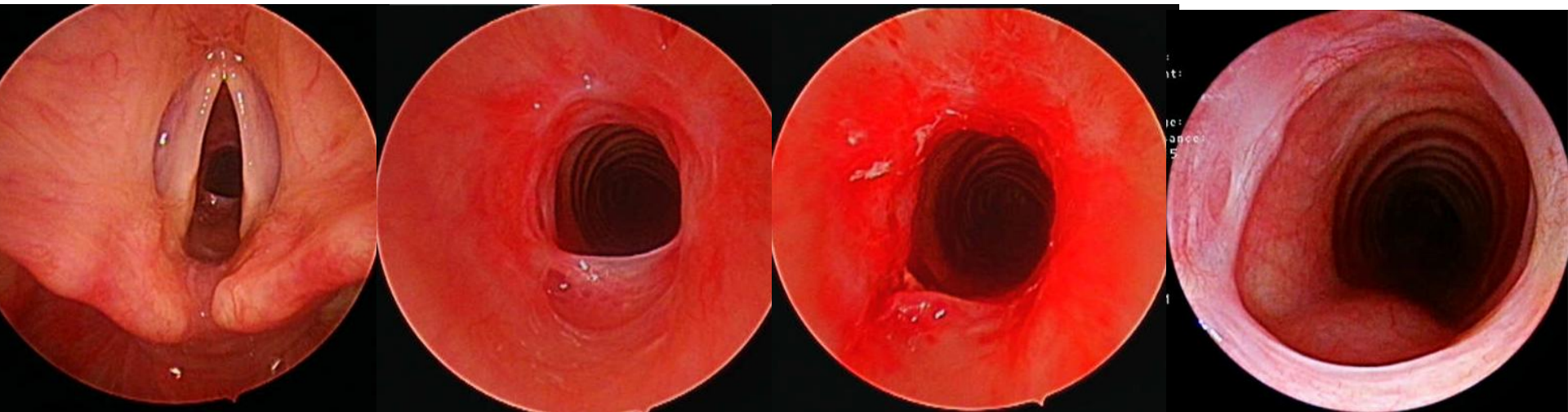
4 weeks  
V - shaped cricoid



# Grade I SGS



Adeno-tonsillar  
hypertrophy



- Kenacort
- Mercedes Benz* incision
- Balloon dilation

4 months



# OPEN APPROACHES FOR SGS

....Outcome influencing parameters

## 1. CONGENITAL

- **Cricoid involvement**
  - Anterior / Posterior / Both
  - Small- hypoplastic- / Flattened

## 2. ACQUIRED

- **Site of the tracheostomy**
  - > +/- stoma static
  - > close to the stenosis / reconstruction site
- **Special situations**
  - associated secondary airway anomalies
  - multi- operated

# OPEN AIRWAY RECLAIMING SURGERIES

**LTR**

**PCTR**

**Extended PCTR**

- Always DS

SS

- isolated SGS

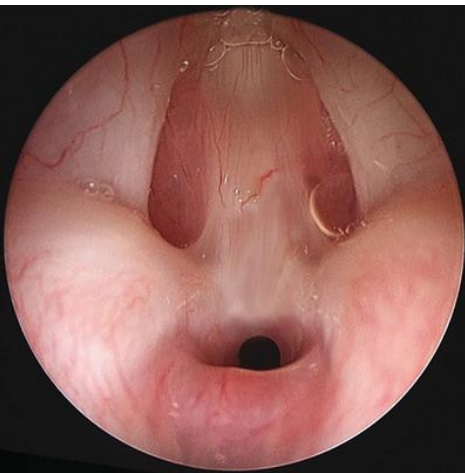
DS

- Comorbidities
- Glottic involvement

# INDICATIONS FOR LTRs

CONGENITAL

ACQUIRED



Glottic  
web



Elliptical  
cricoid



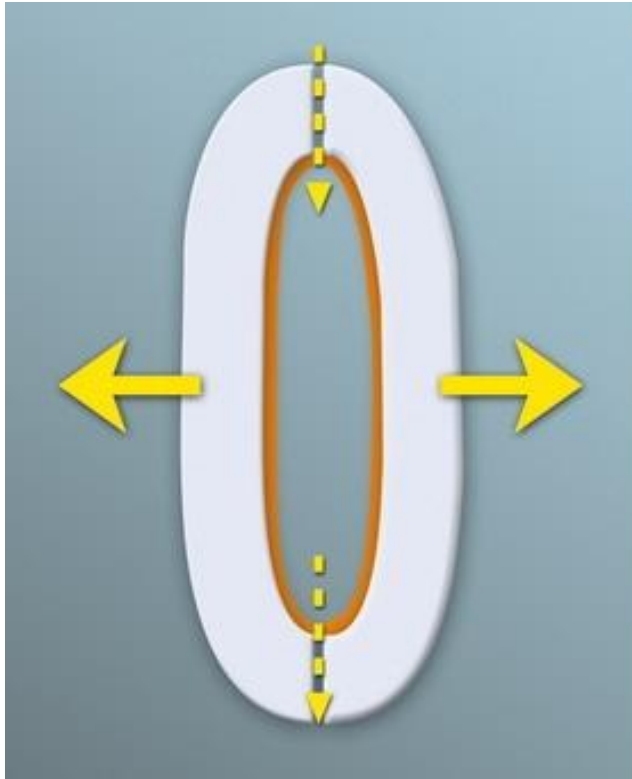
Purely  
PGS



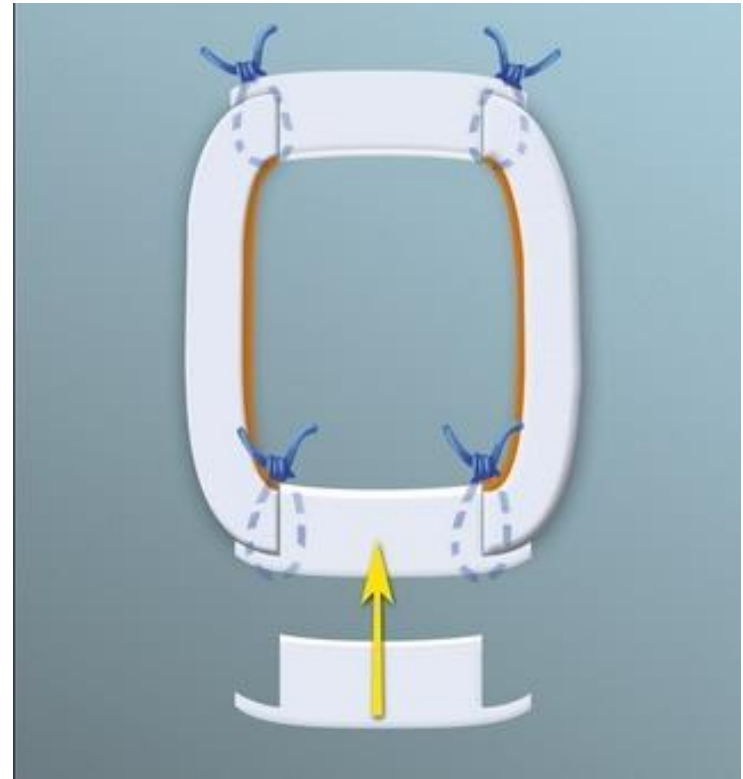
PGS + minor  
grade SGS

*Elliptical cricoid ring*

# LARYNGOTRACHEAL RECONSTRUCTION

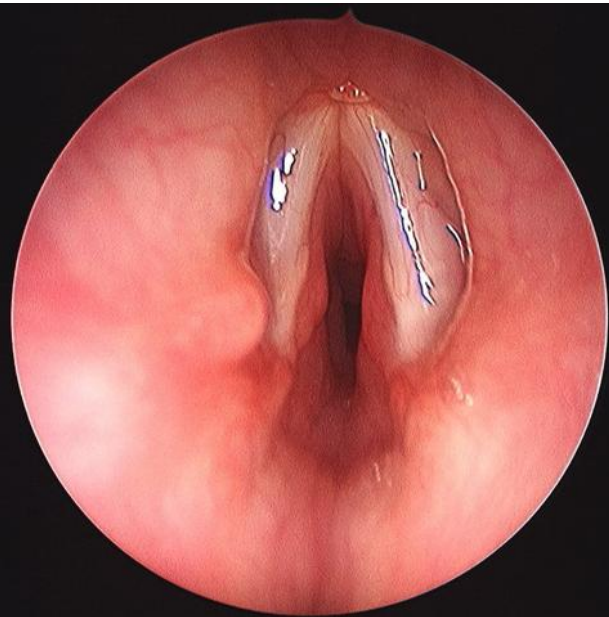


ANT + POST  
CRICOID SPLIT

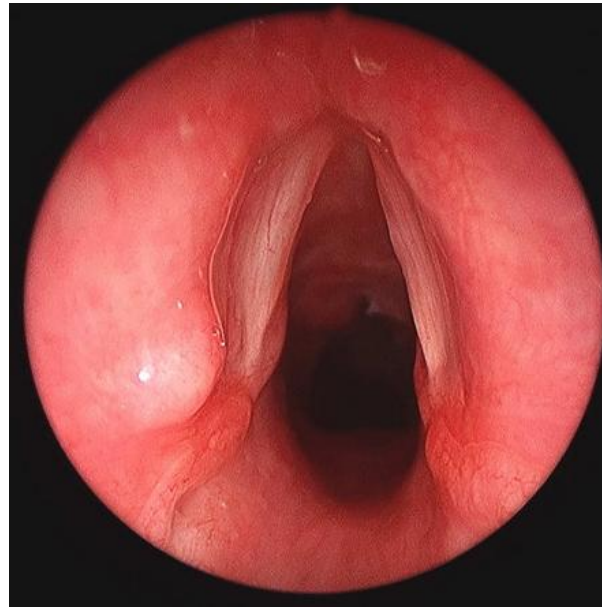


DOUBLE COSTAL  
CARTILAGE GRAFT

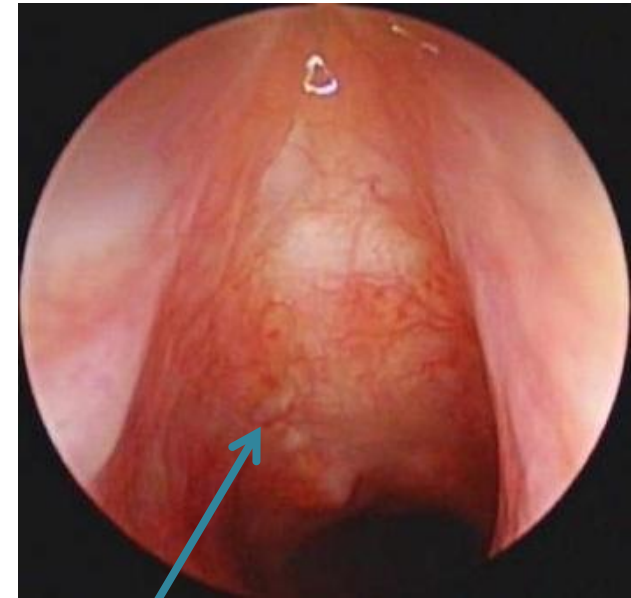
# EXAMPLE



Preoperative view

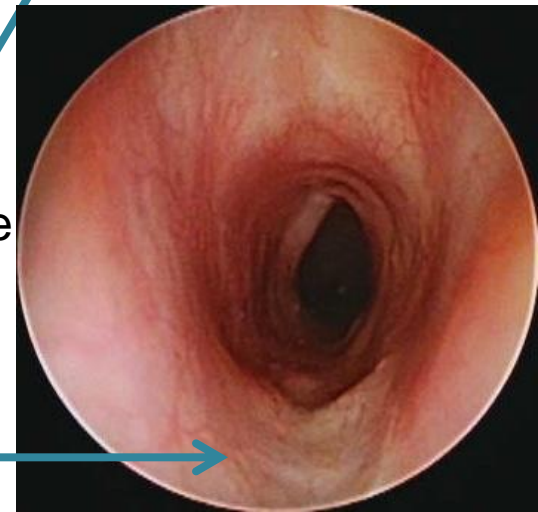


Postoperative view

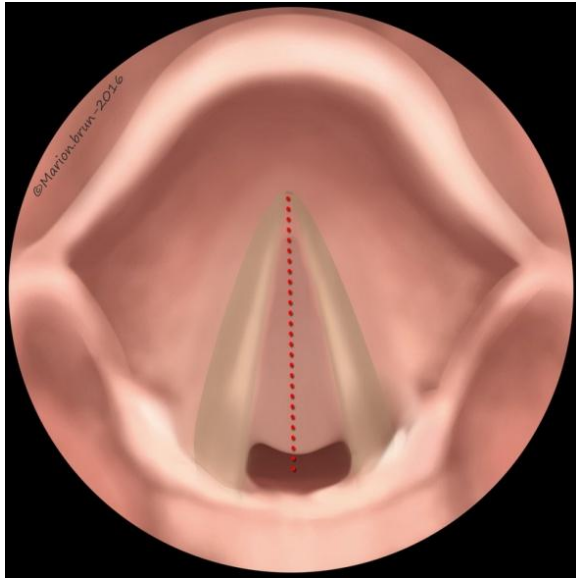


Anterior Costal Cartilage

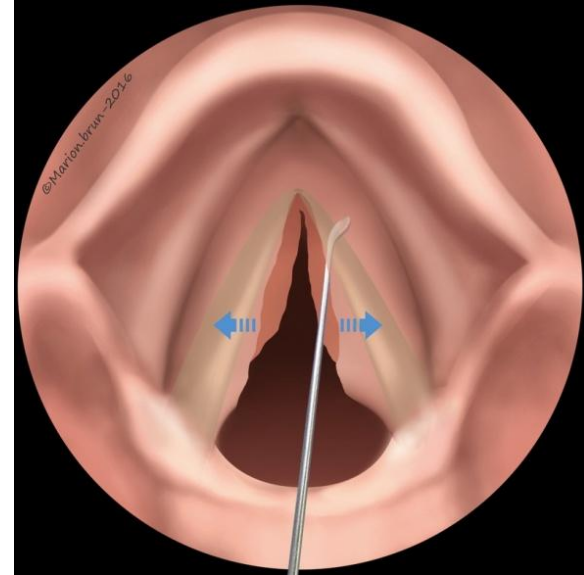
Posterior Costal Cartilage Graft



# Combined approach for treating dense laryngeal webs



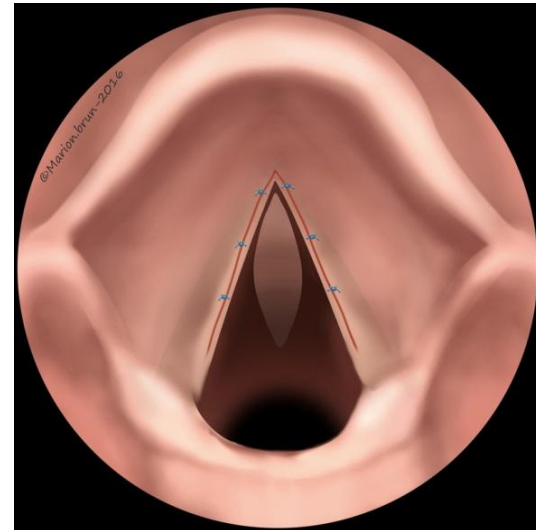
MLS: CO2 laser division of the web



Complete LF: Lateral mucosal dissection up to the Morgagni's ventricle



Mucosal mobilisation

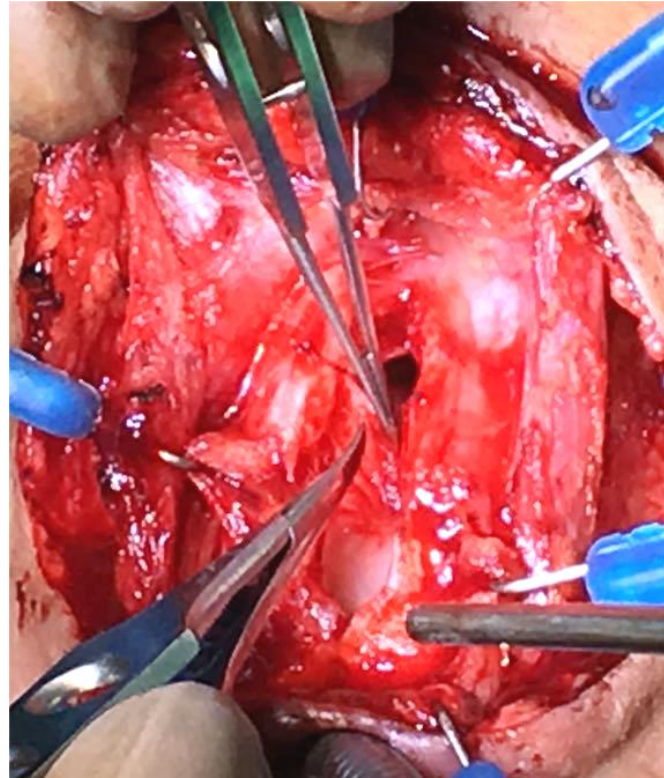


7.0 PDS, + ACCG + LT mold



## Reclaiming glottic mucosa from the Morgagni's ventricle

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- 7.0 PDS
- Complete glottic mucosalisation



## Combined approach for treating dense laryngeal webs



preoperative  
view



postoperative view

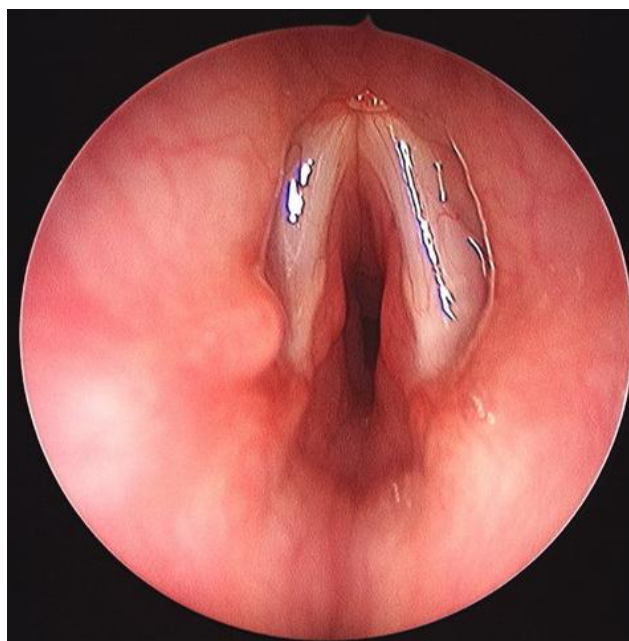
Time to decannulation: 76 d

## EXAMPLES



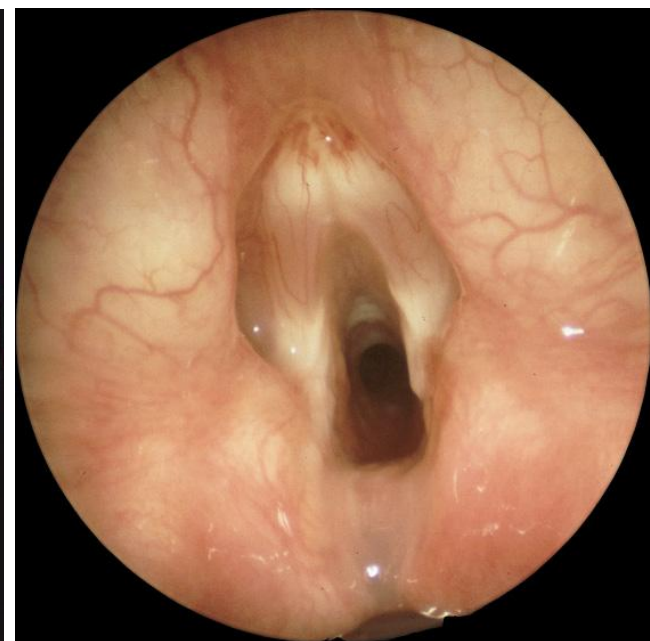
thick anterior  
lamina

ACCG



elliptical  
shape

A+PCCG

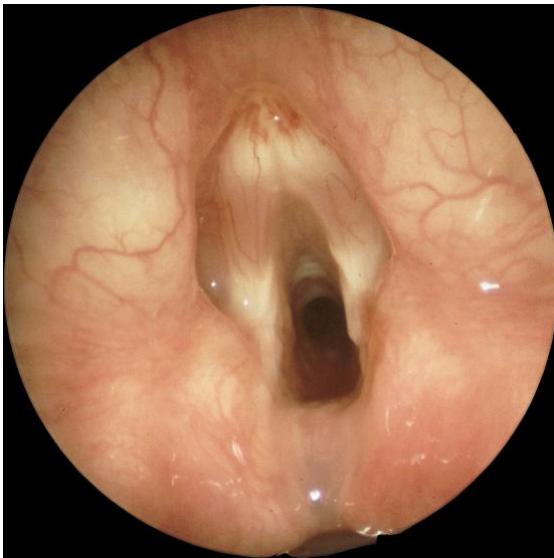


generalized  
thickening

PCTR

# INDICATIONS FOR PCTRs

CONGENITAL



Generalized  
thickening

ACQUIRED

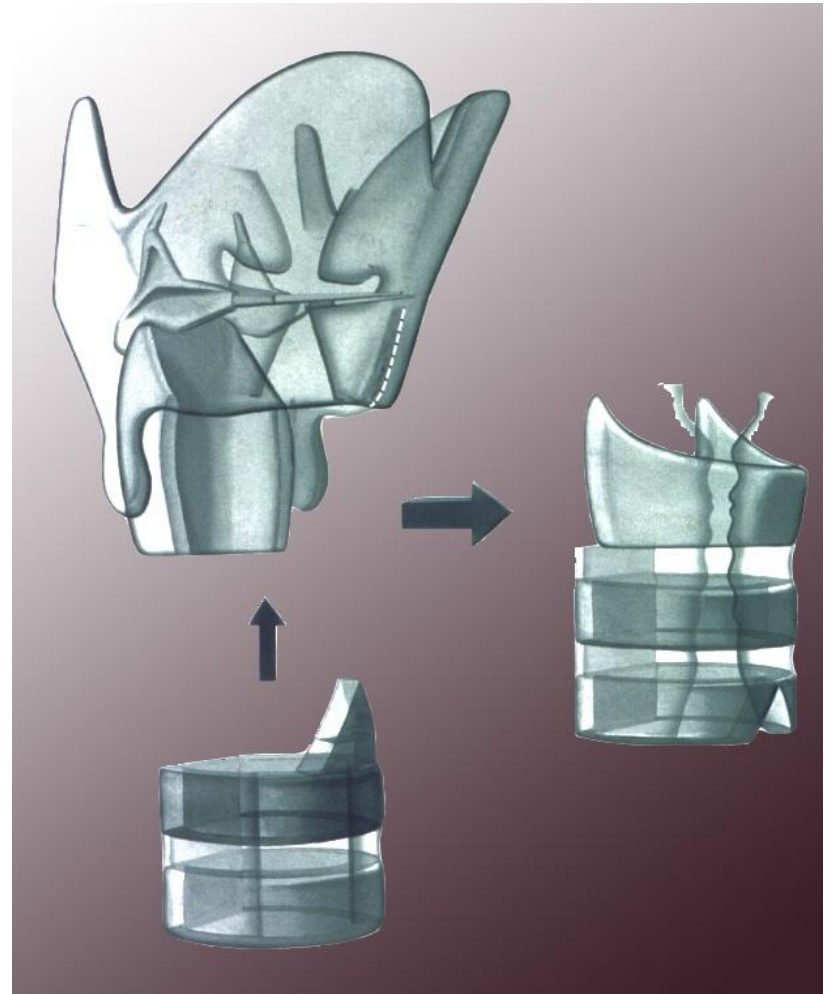
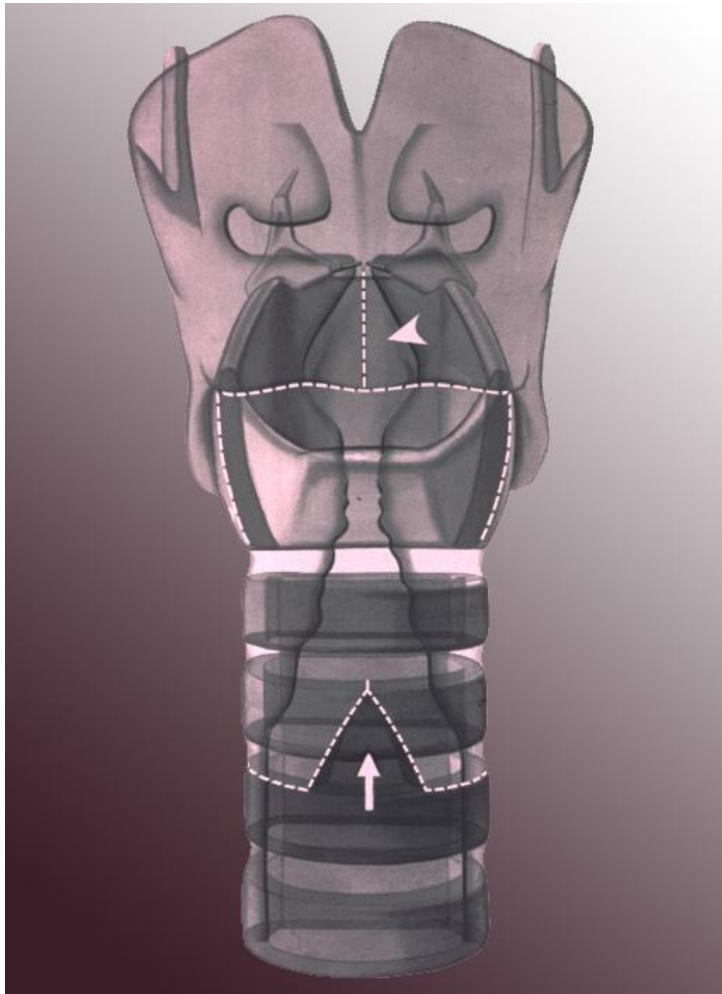


Grade III  
SGS



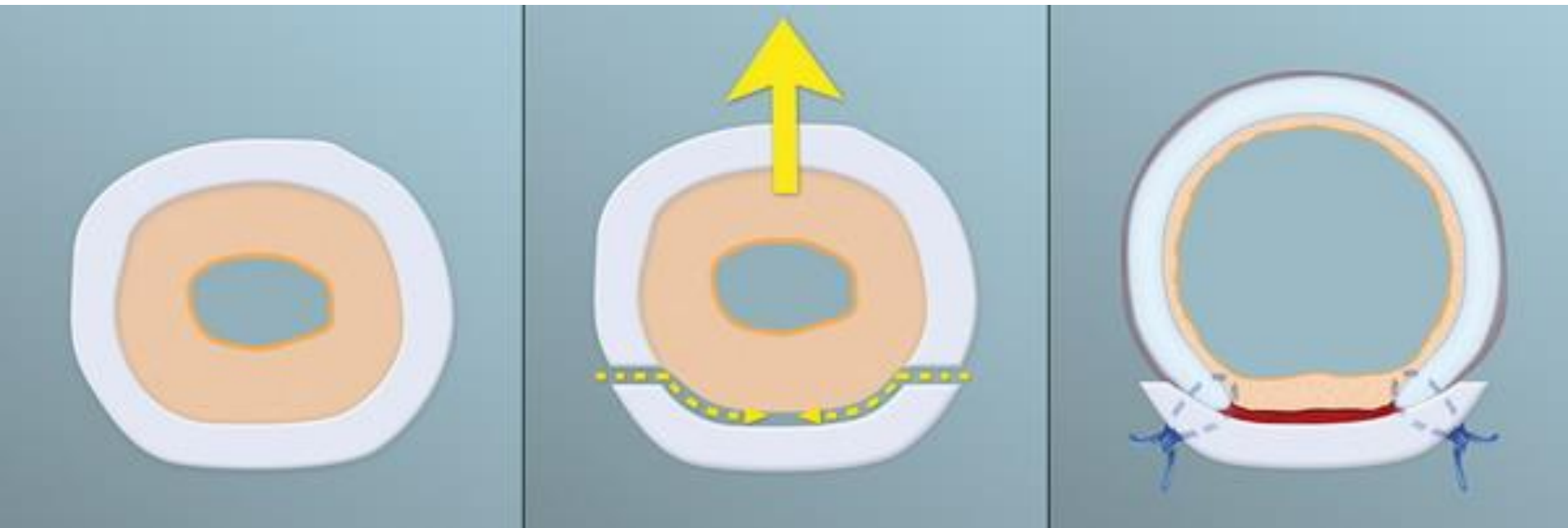
Grade IV  
SGS

# PRINCIPLE



*FLATTENED CRICOID RING + SUBMUCOSAL HYPERPLASIA*

# CRICOTRACHEAL RESECTION



flattened / small cricoid  
+  
submucosal hyperplasia

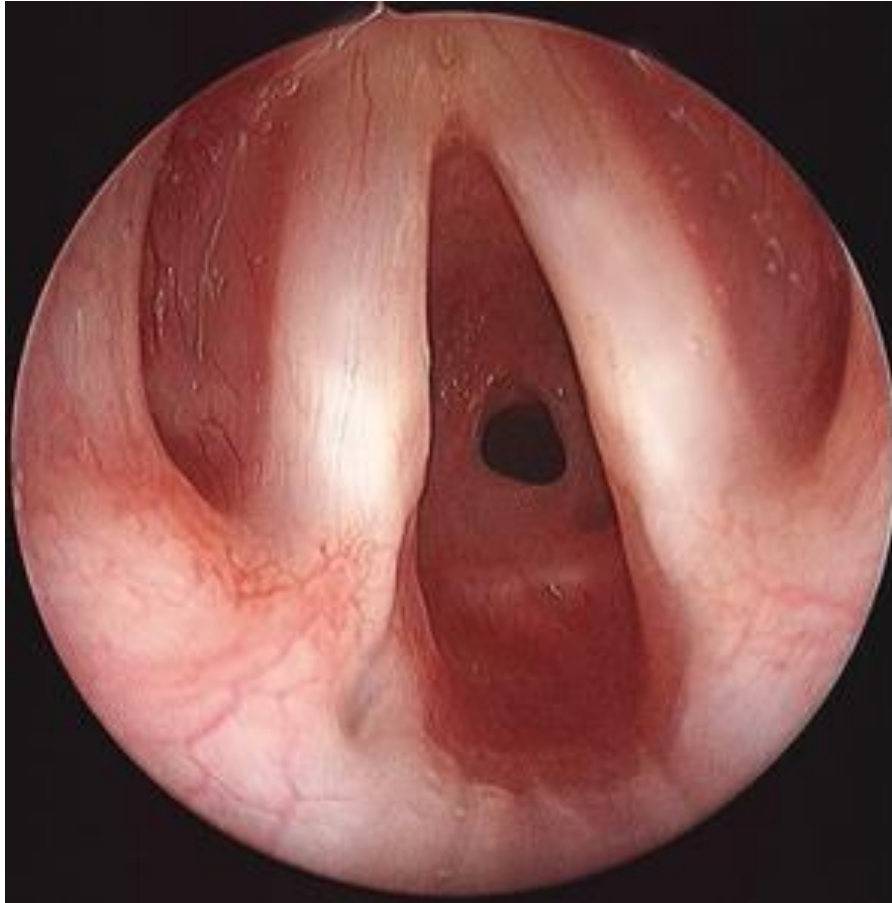
CTR

result post-thyro-  
tracheal  
anastomosis

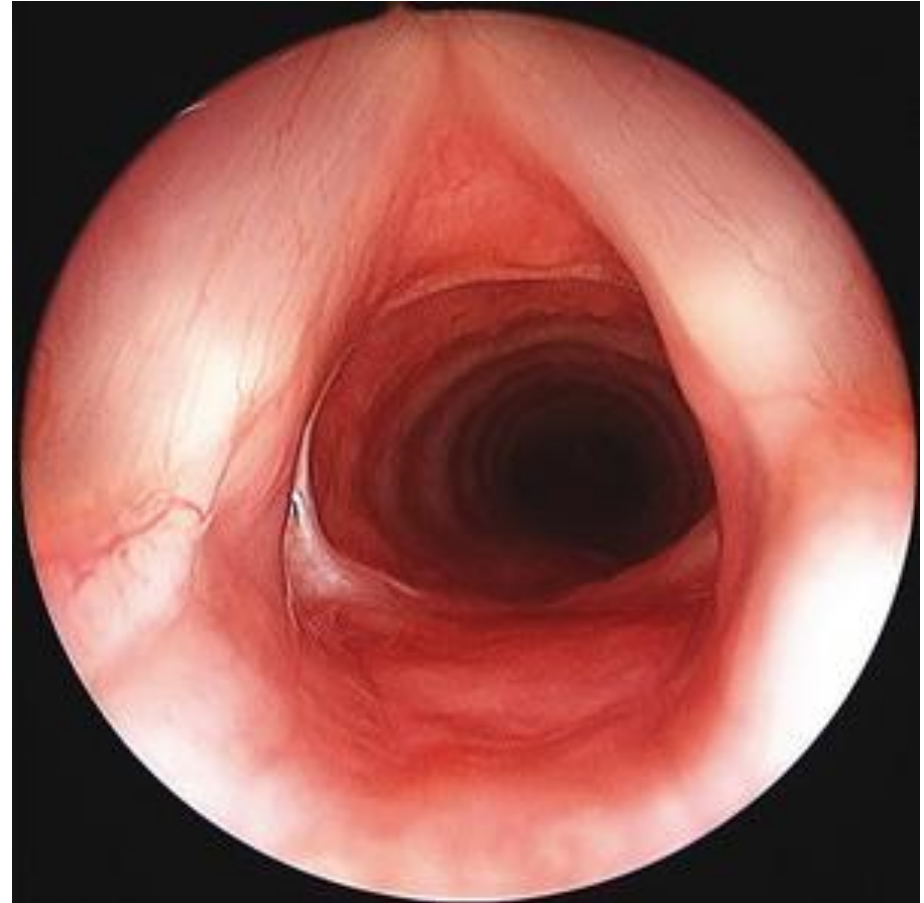
*Generalised thickening*



# SINGLE-STAGE SURGERY



preoperative view



postoperative view  
at 18 months

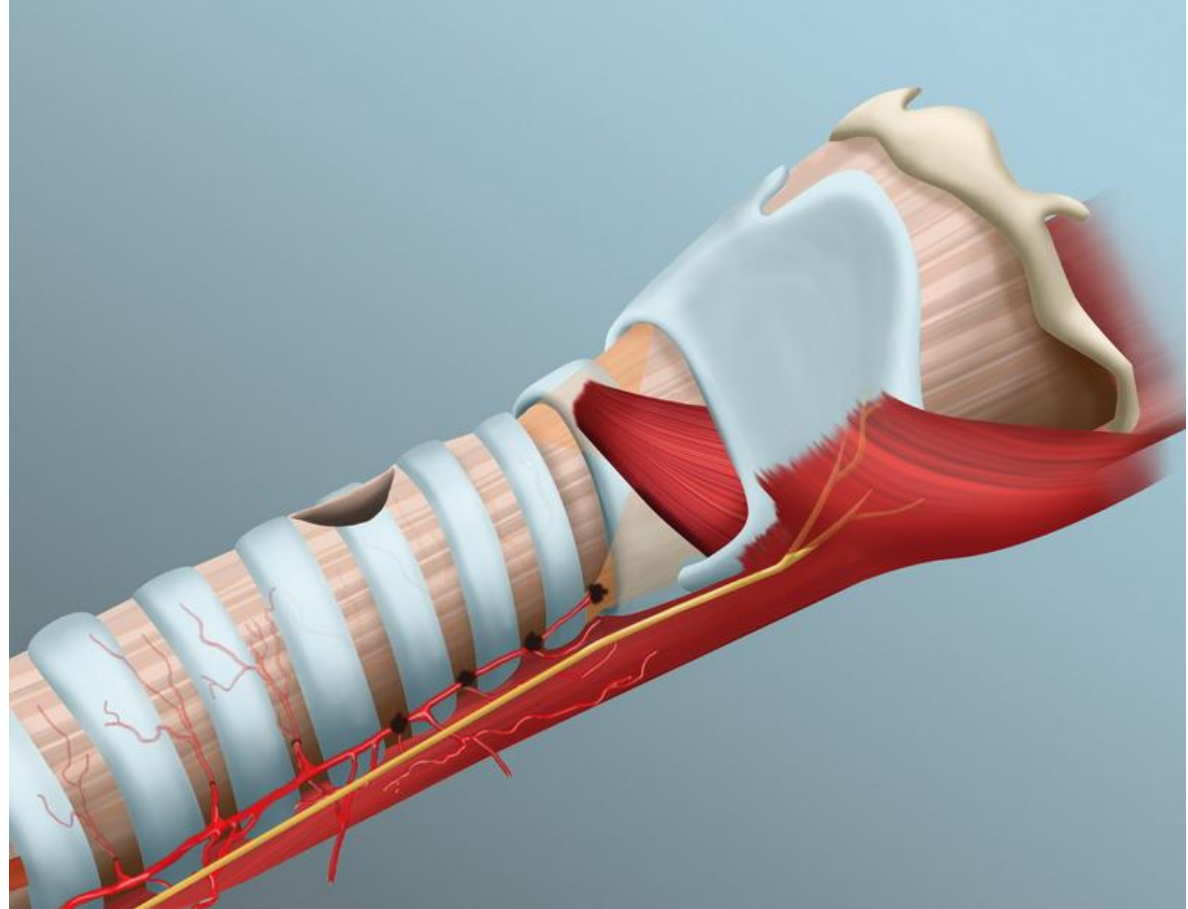
- > Collar incision
- > Crescent-Shape excision around tracheostoma
- > Midline division of strap muscles and thyroid gland





# LARYNGOTRACHEAL DISSECTION

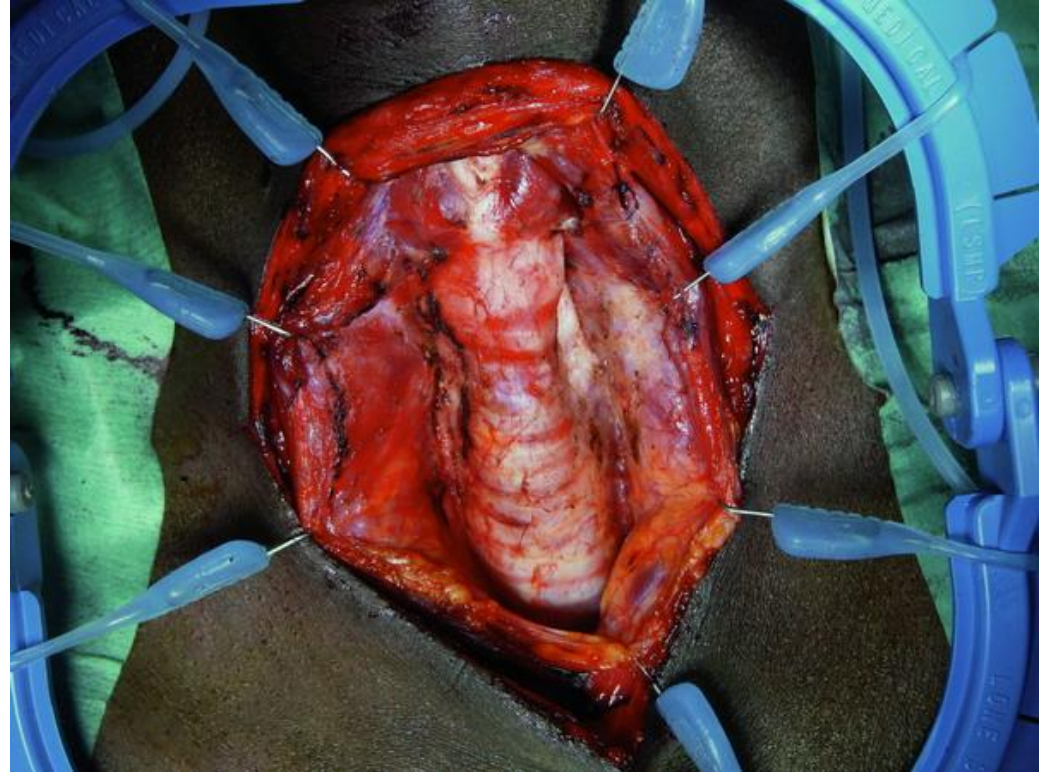
- > hyoid bone  
→ sternal notch
- > close contact  
with tracheal rings
- > no identification  
of RLNs
- > preservation  
of blood supply



# LARYNGOTRACHEAL DISSECTION



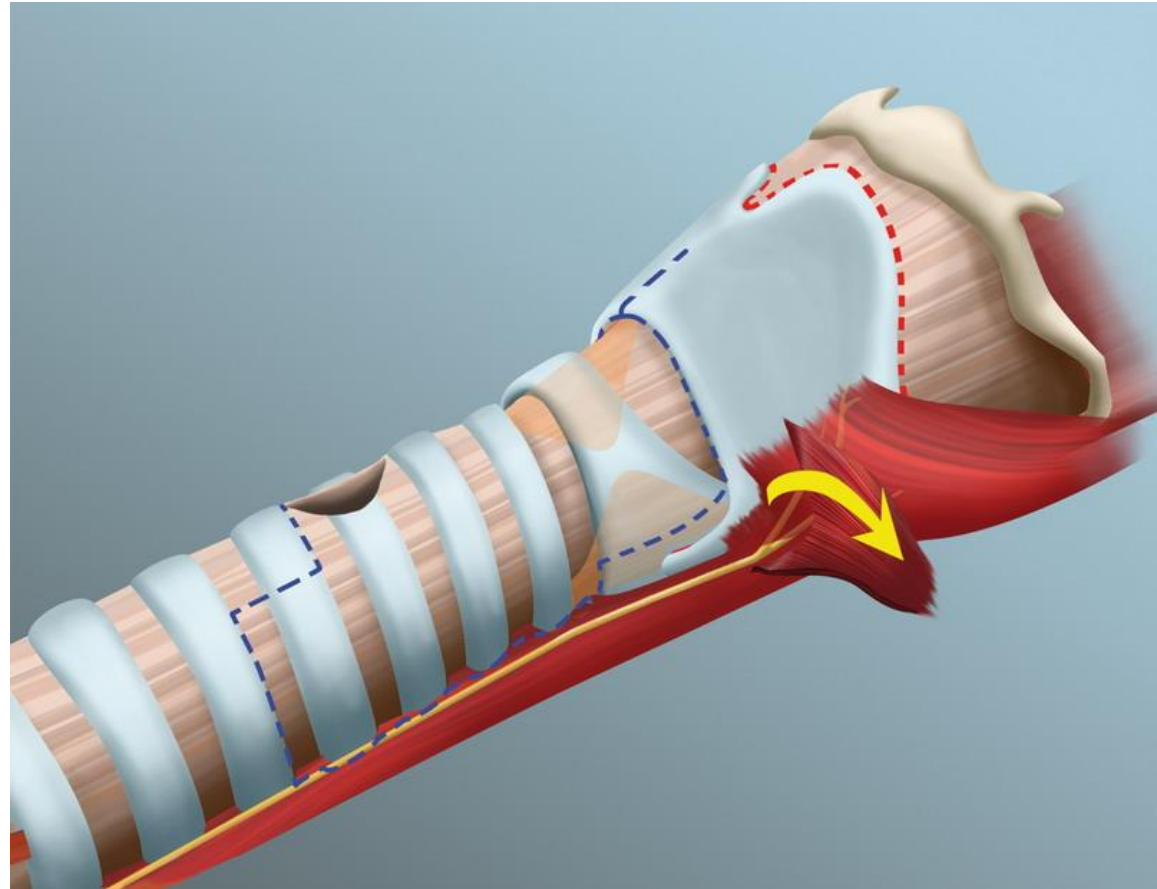
Kocher clamp  
to facilitate  
tracheal dissection



Retractor ring  
with  
elastic stay hooks

## RESECTION LINES

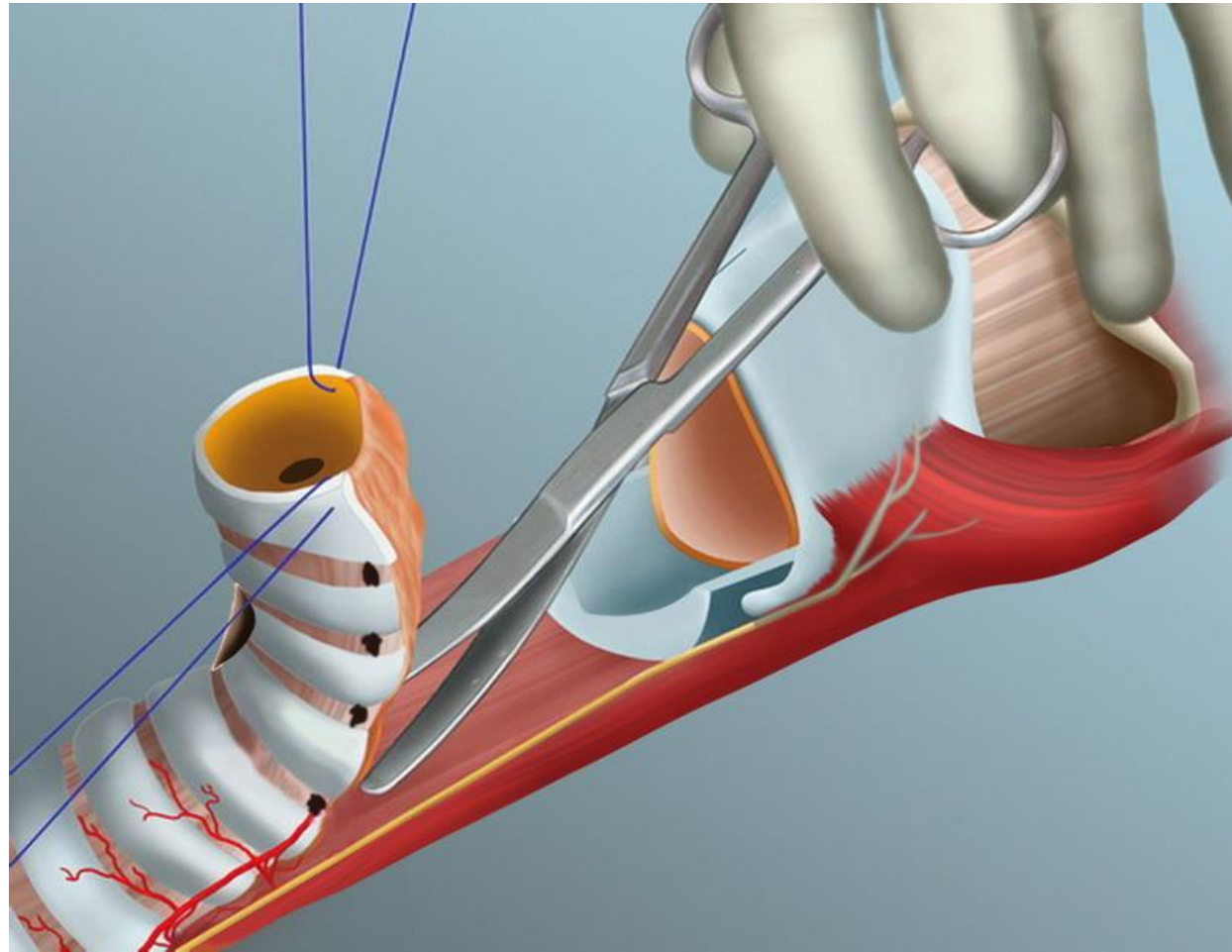
- > Superior resection line
  - inferior border of thyroid cartilage
- > Inferior resection line
  - first normal tracheal ring
- > Lateral resection line
  - anterior to cricothyroid joints



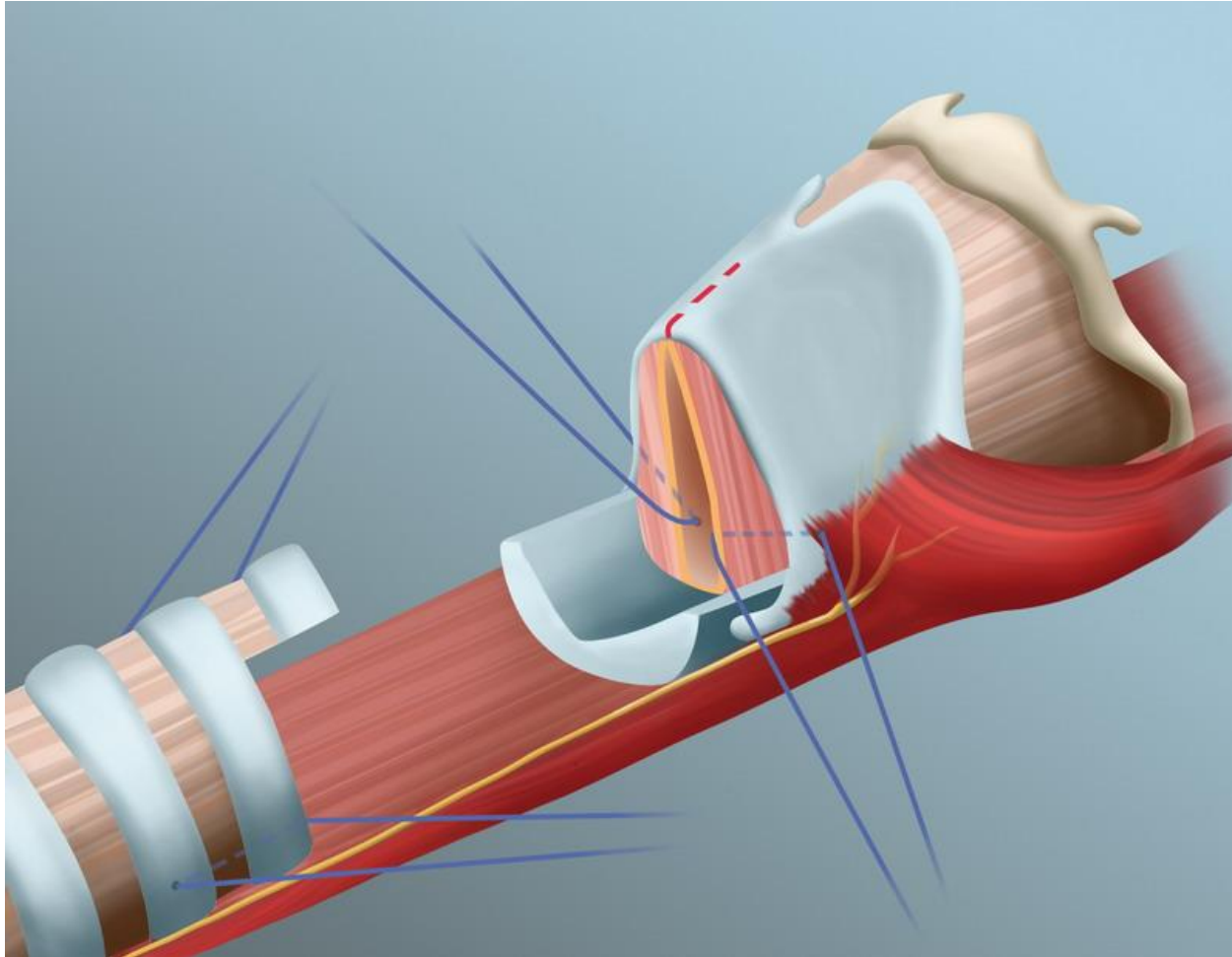


## TRACHEAL STUMP

- > Cranial mobilization of tracheal stump
- > Limited tracheo-esophageal separation



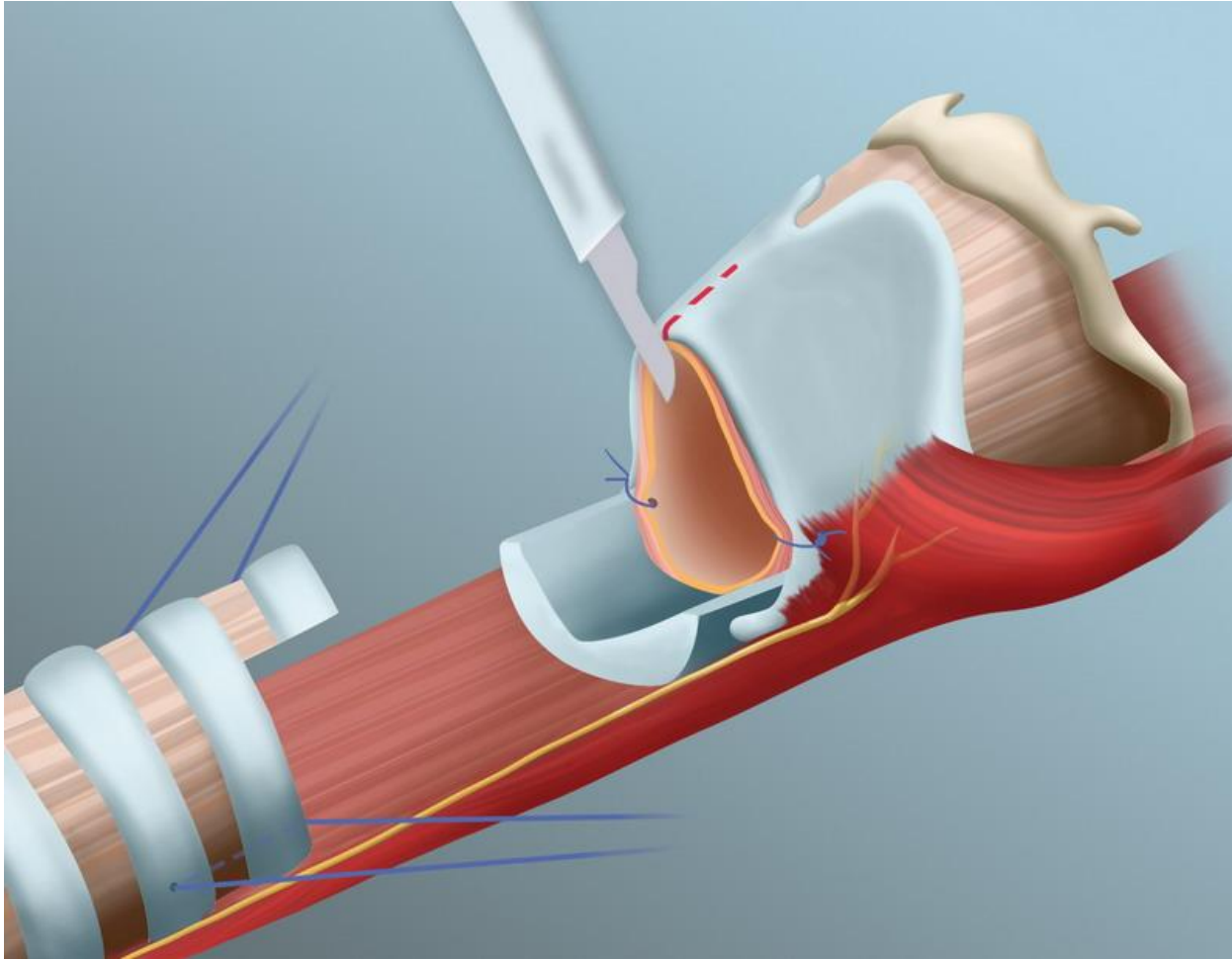
# **SUBGLOTTIC ENLARGEMENT**



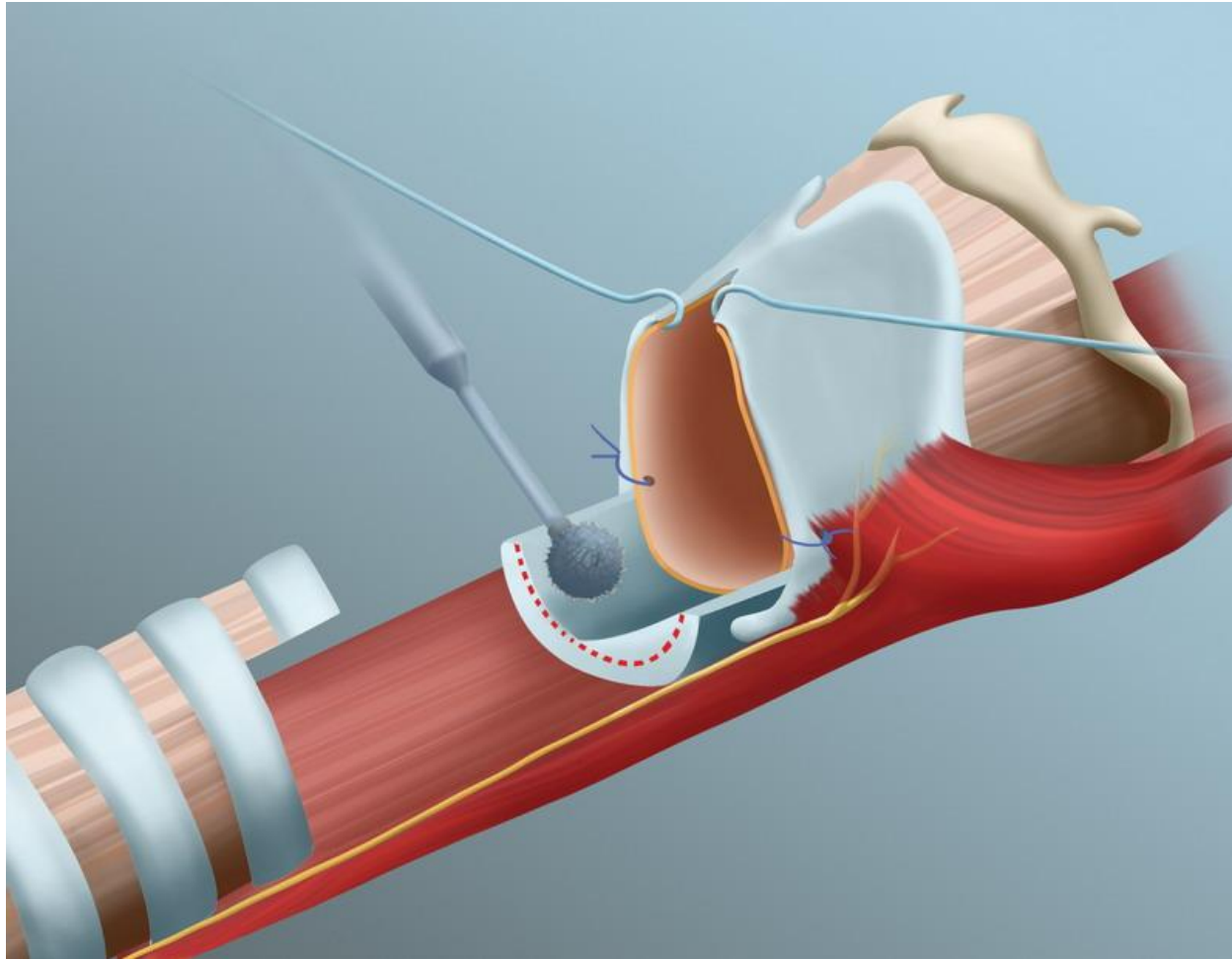
Lateral suture of subglottic mucosa to thyroid cartilage

*Pediatric PCTR - Surgical steps*

# **SUBGLOTTIC ENLARGEMENT**



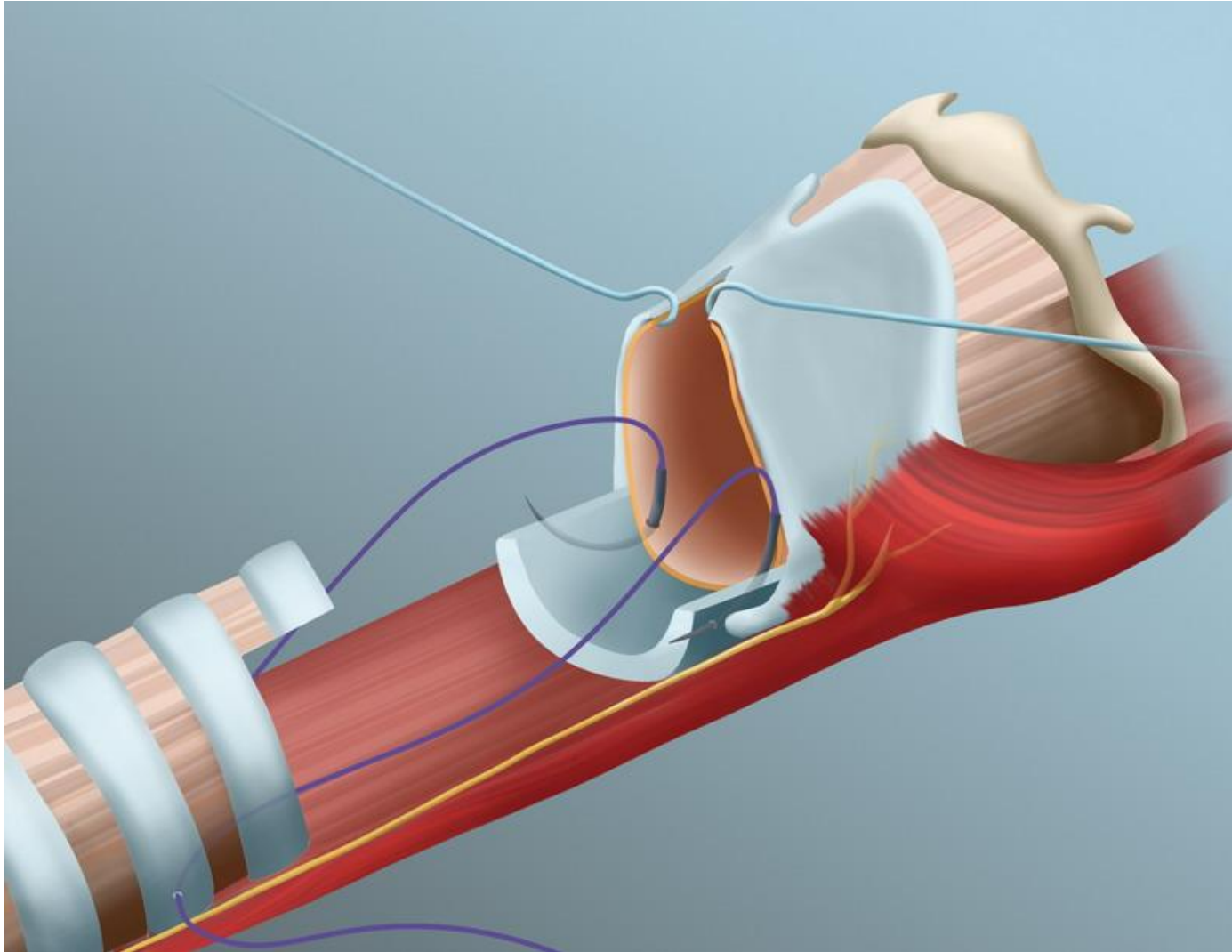
# **SUBGLOTTIC ENLARGEMENT**



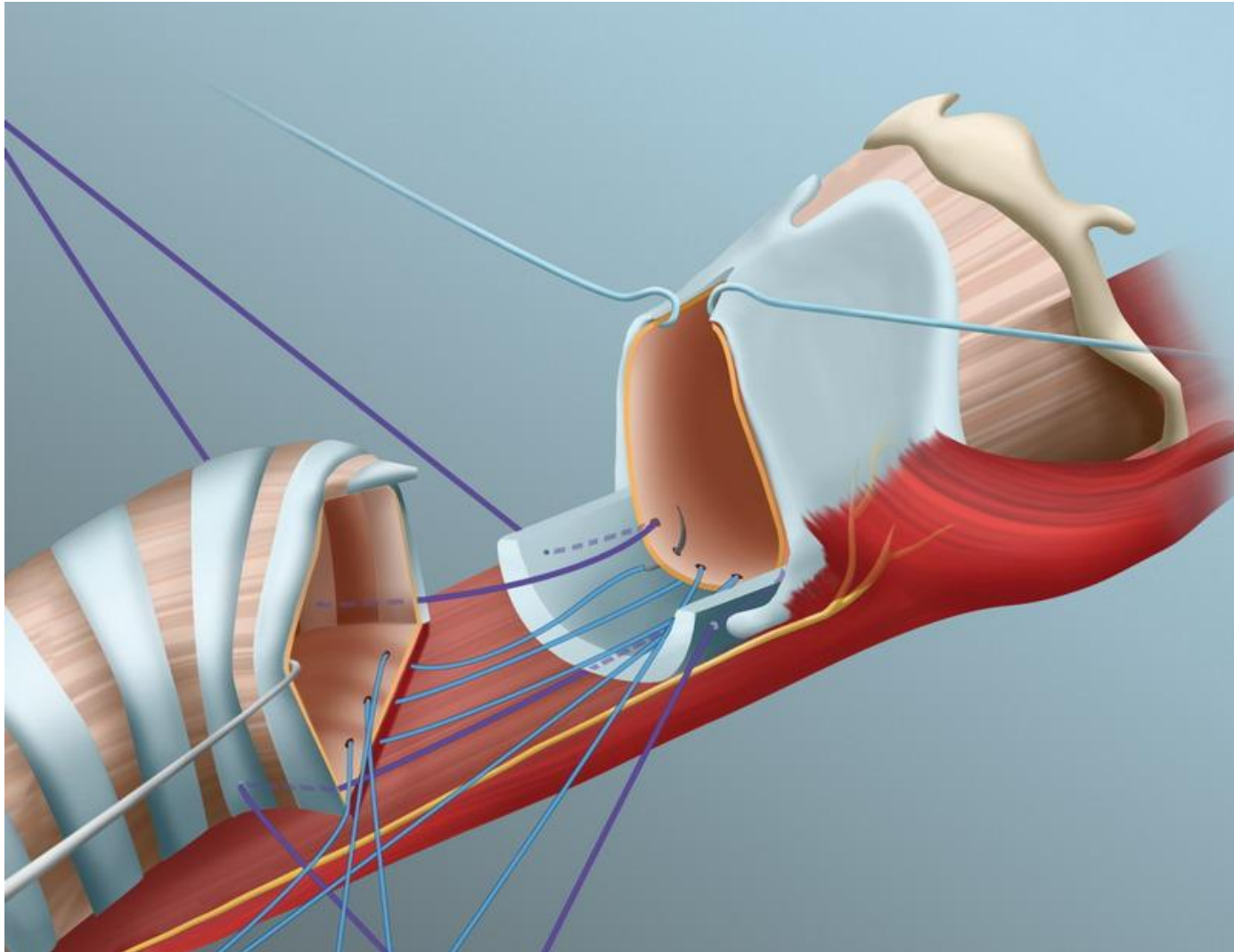
Widening and flattening cricoid plate with a diamond burr



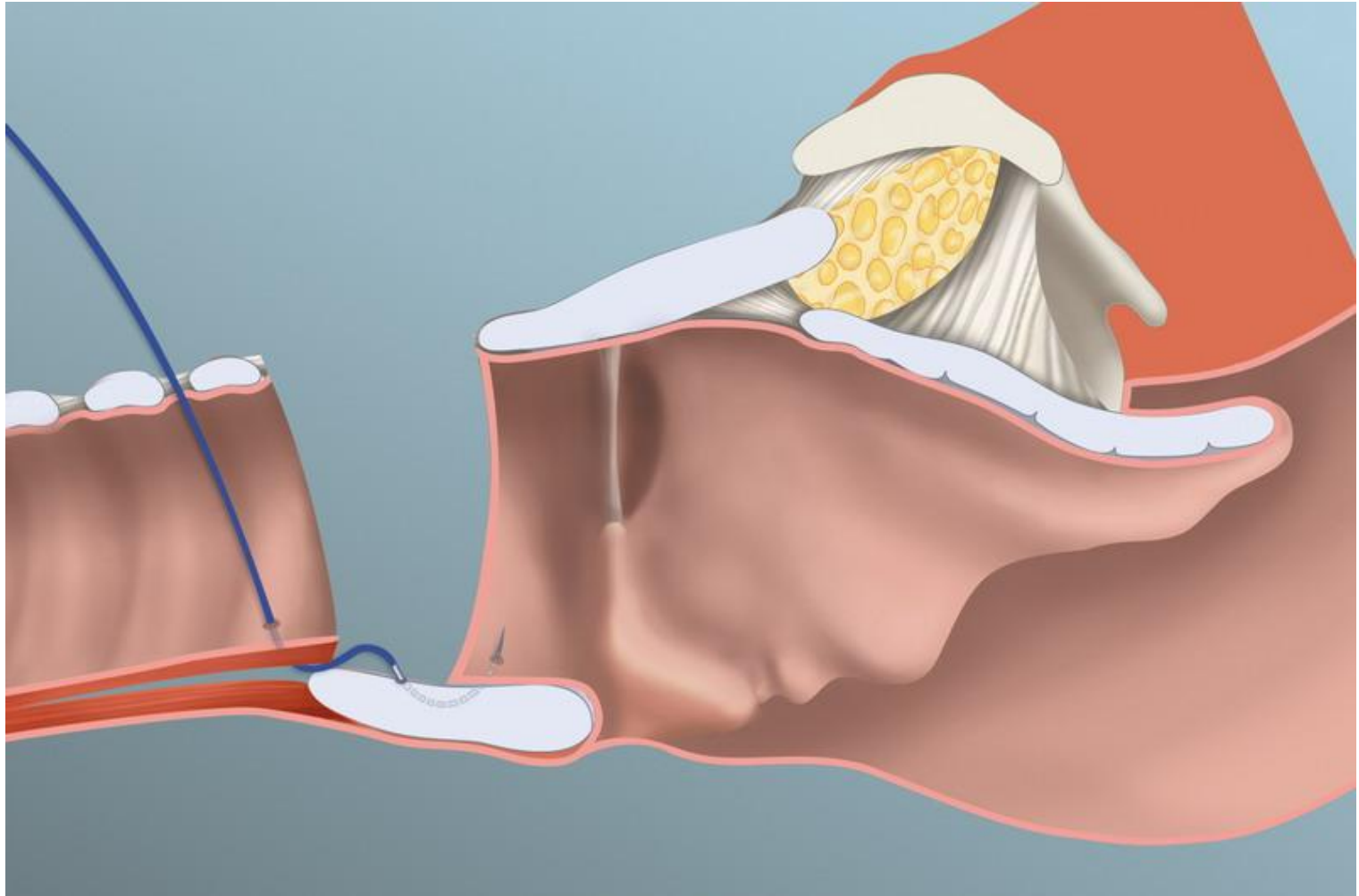
# POSTEROLATERAL STITCHES



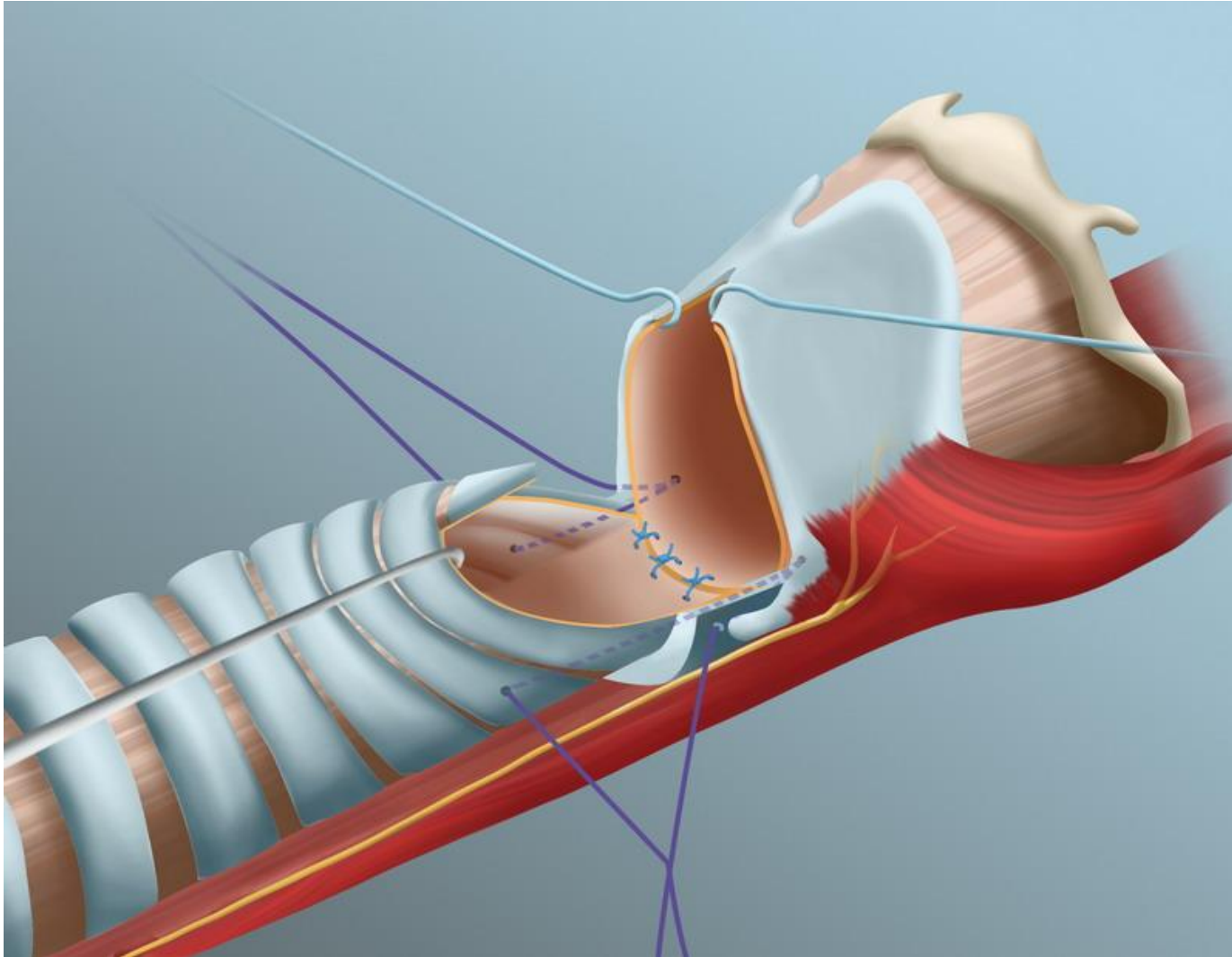
# POSTERIOR ANASTOMOSIS



# POSTERIOR ANASTOMOSIS



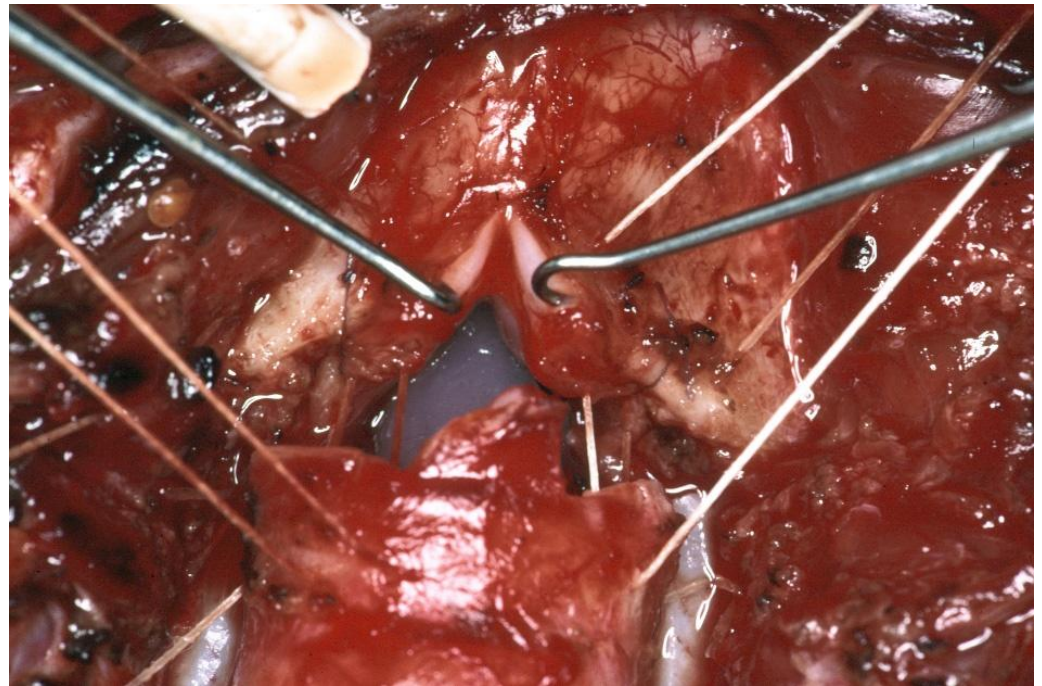
# POSTERIOR ANASTOMOSIS



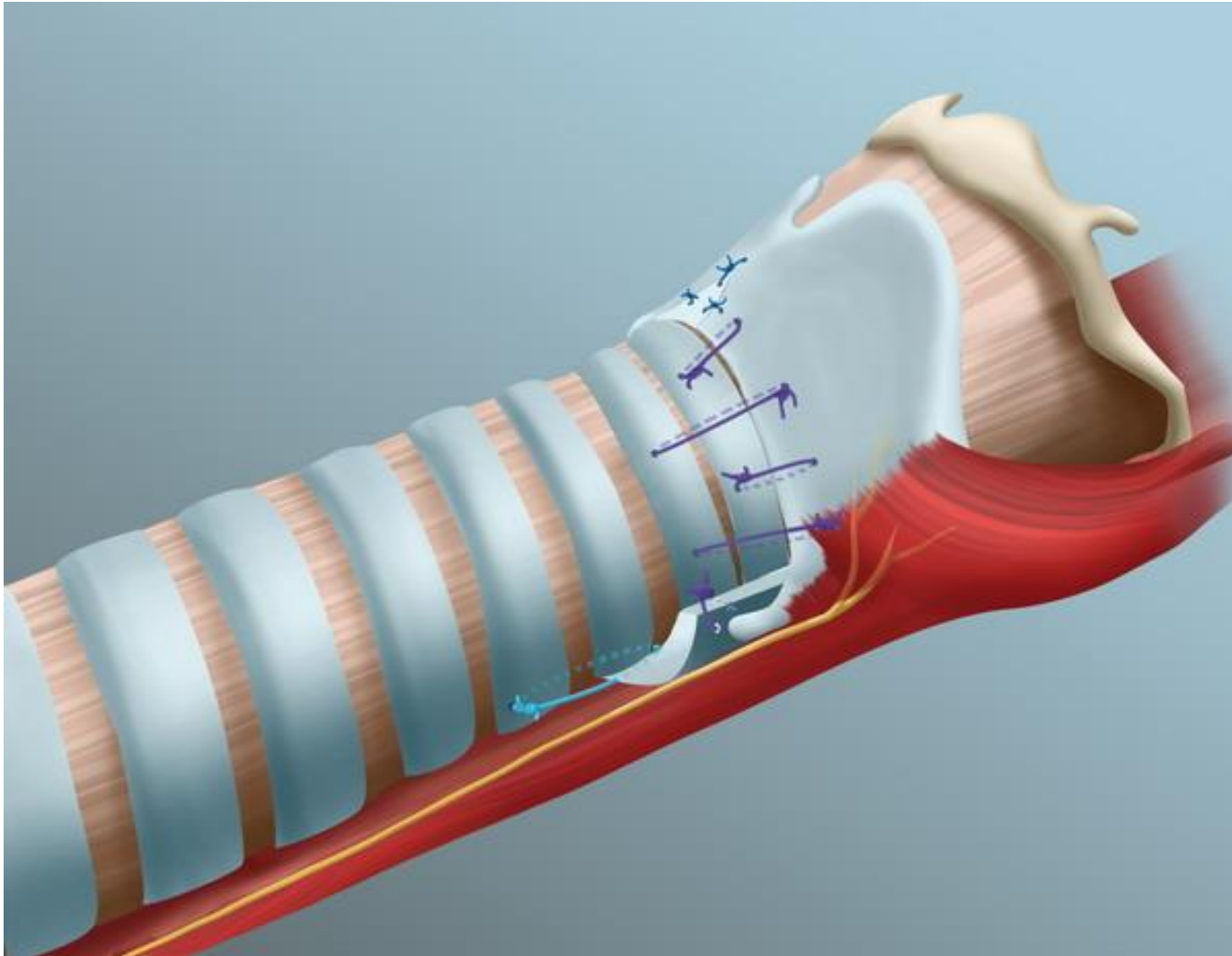


## WIDENING OF SUBGLOTTIC LUMEN

- > wedge of pedicled cartilage to fit thyroid defect
- > increase in subglottic lumen



# FINAL ANASTOMOSIS



## CLASSICAL INDICATION

- Purely SGS
- Grade III or IV
- Normal VC function



**SINGLE-STAGE SURGERY**



## **EXTENDED PCTR WITH PCCG**

- Principle

- > PCTR + PCCG

- > reconstruction of a steady,  
fully mucosalized airway

- > Mandatory 2 stage procedure

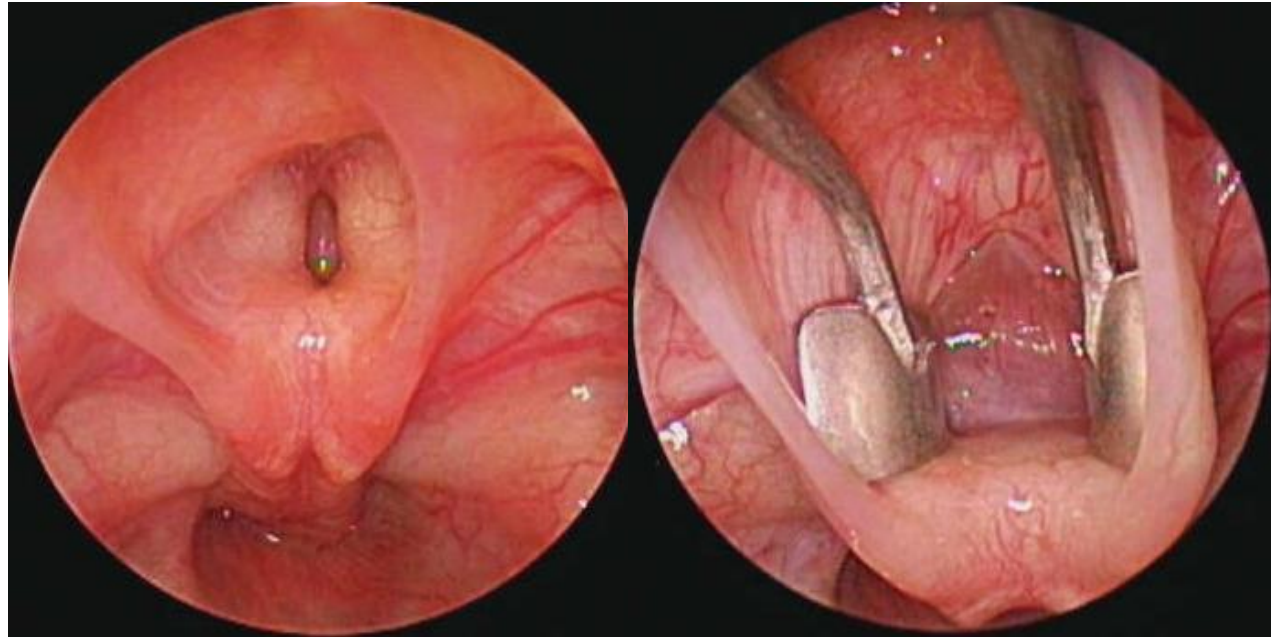
# INDICATIONS FOR E-PCTRs

## CONGENITAL

LARYNGEAL ATRESIA: ASSOCIATED SGS, CRICOARYT. ANKYLOSIS  
- Benjamin et al.



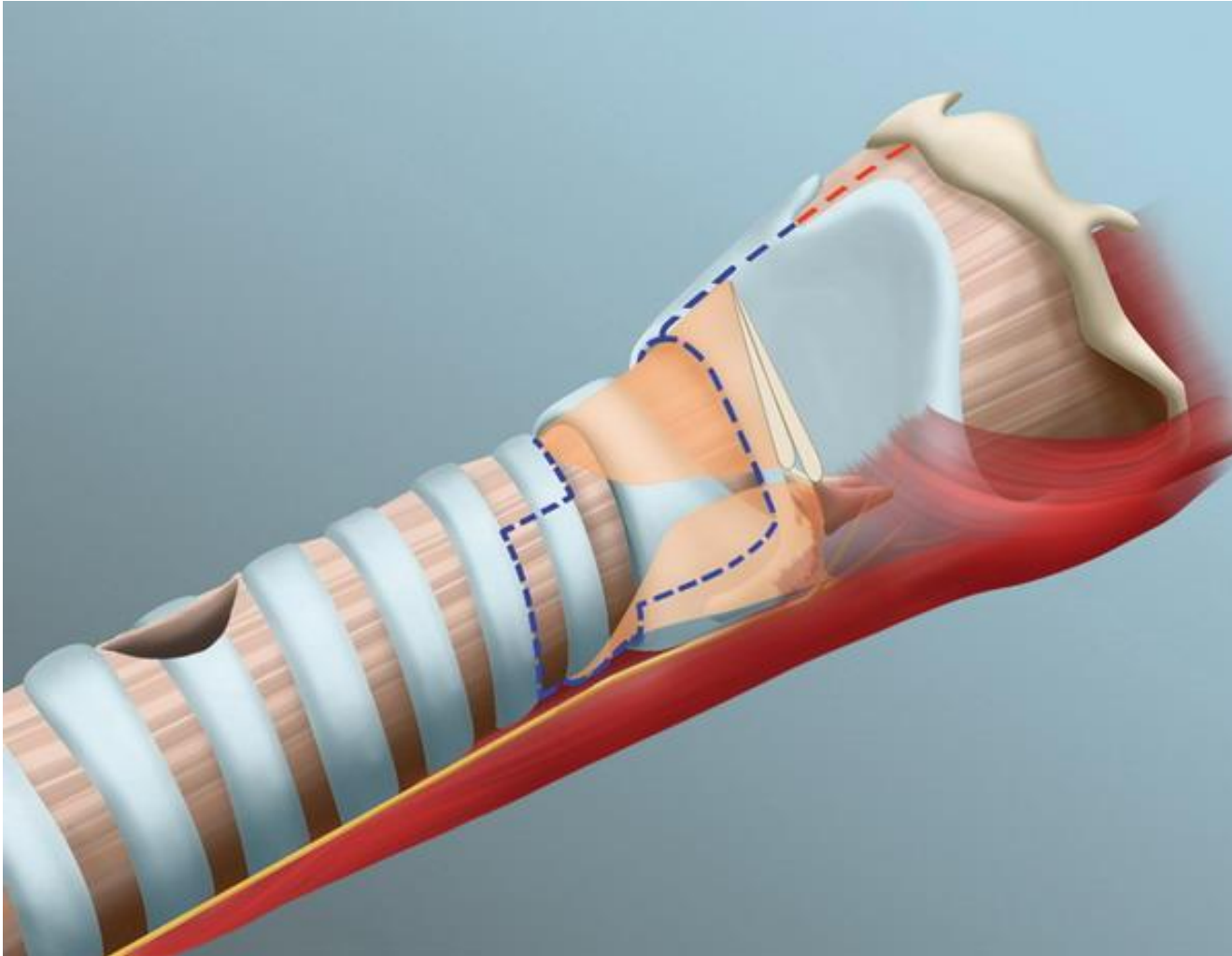
Supraglottic web



Glottic web

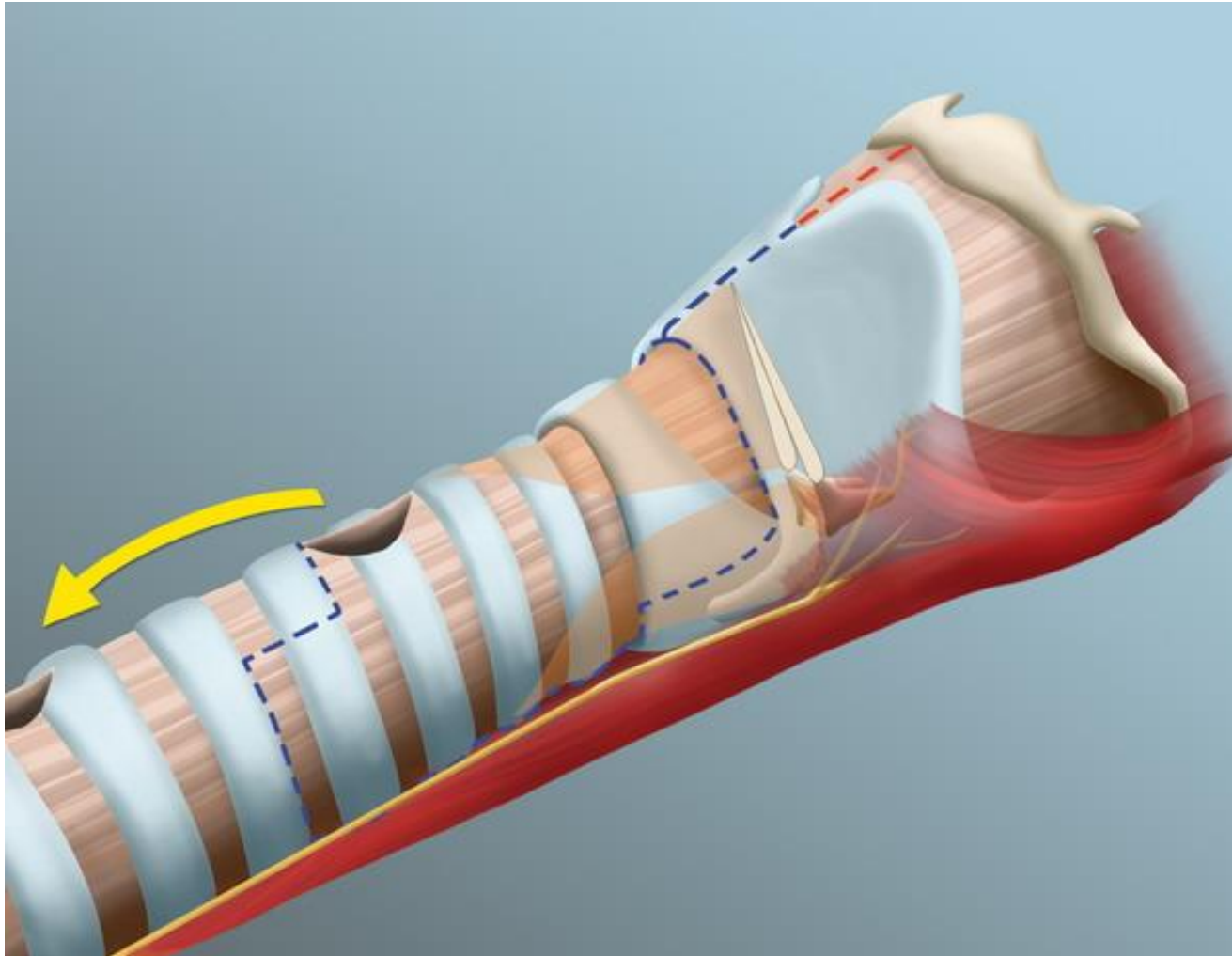
*Transglottic LTS with bilateral CAA*

**EXTENDED PCTR**



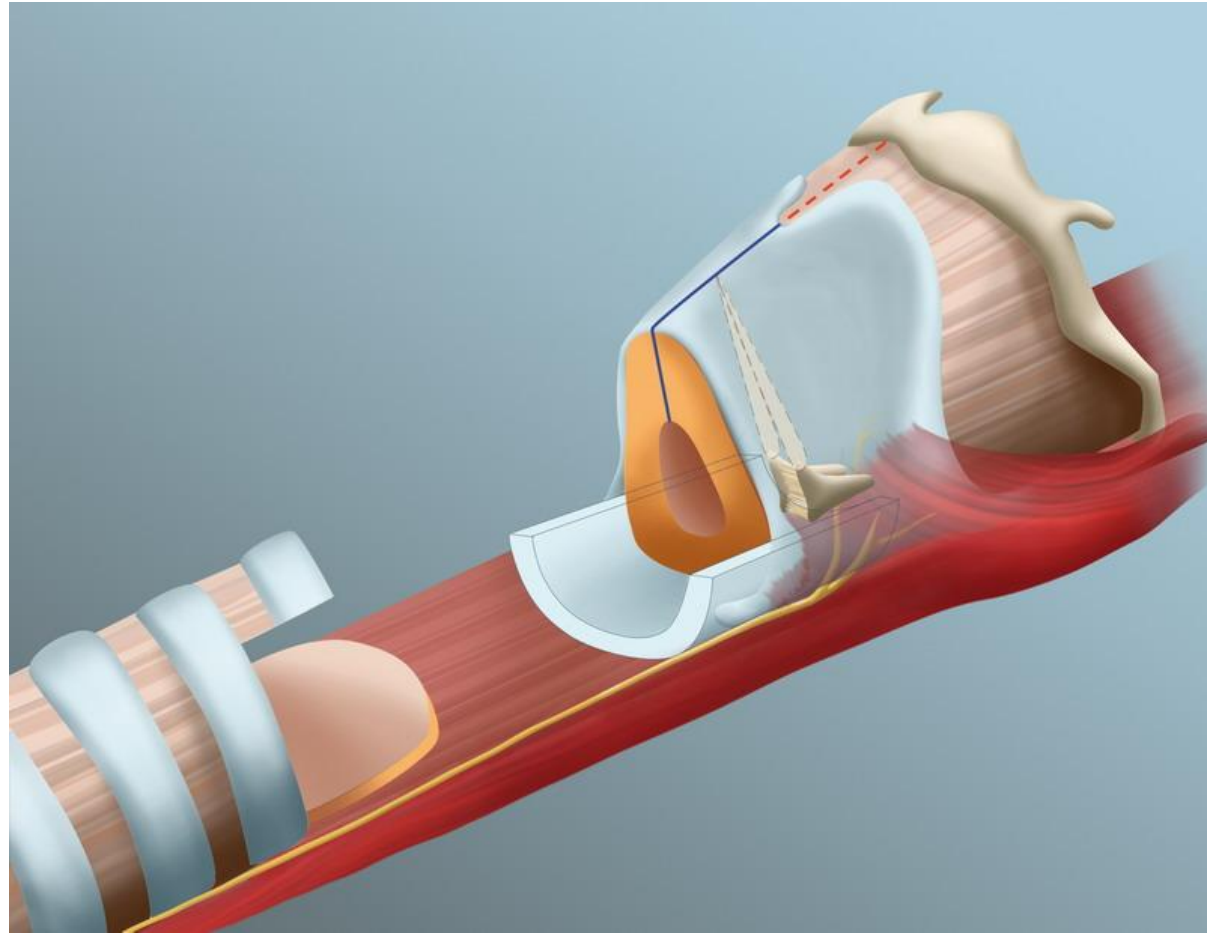
## Transglottic LTS with bilateral CAA

# EXTENDED PCTR



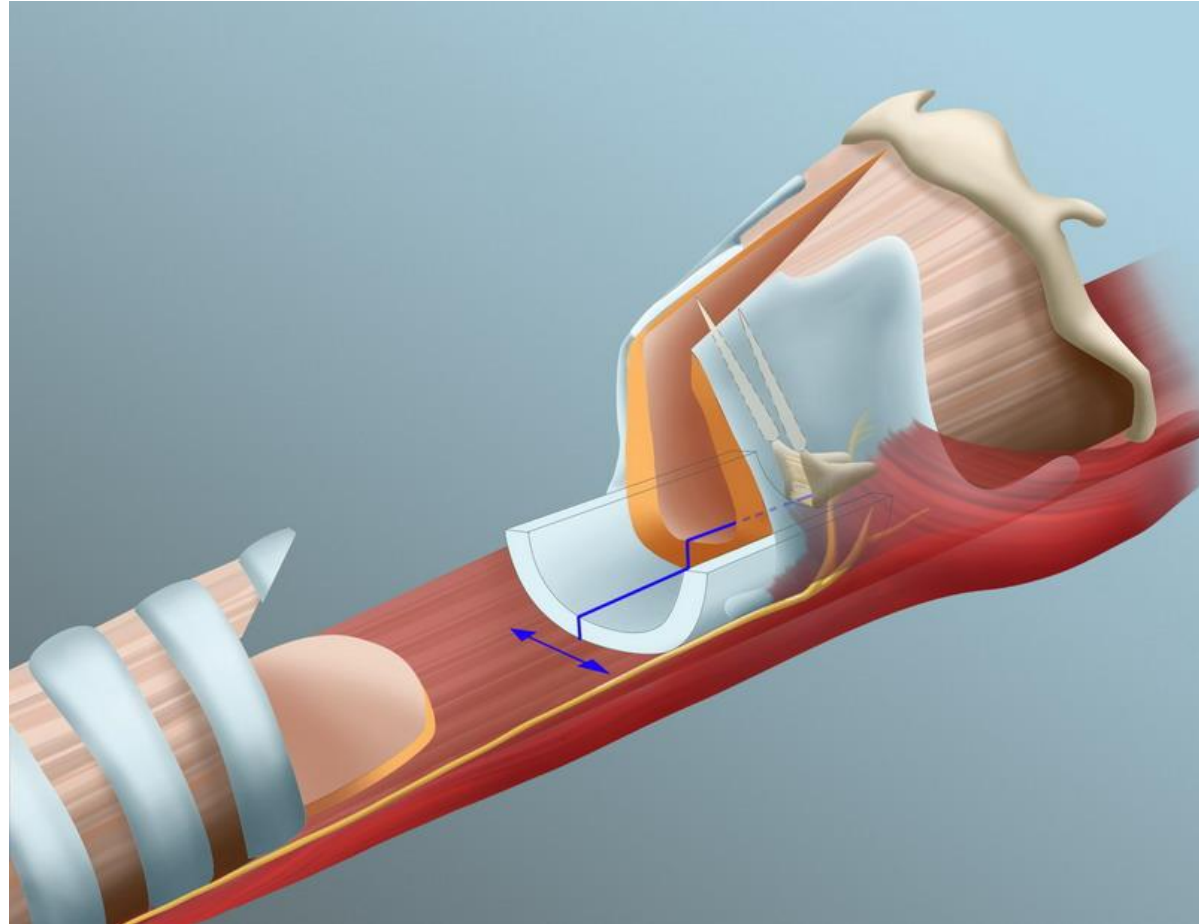
# EXTENDED PCTR ①

- > PCTR
- > Pedicled flap of posterior tracheal mucosa
- > Full laryngofissure
- > Submucosal excision of fibrous tissue



## EXTENDED PCTR ②

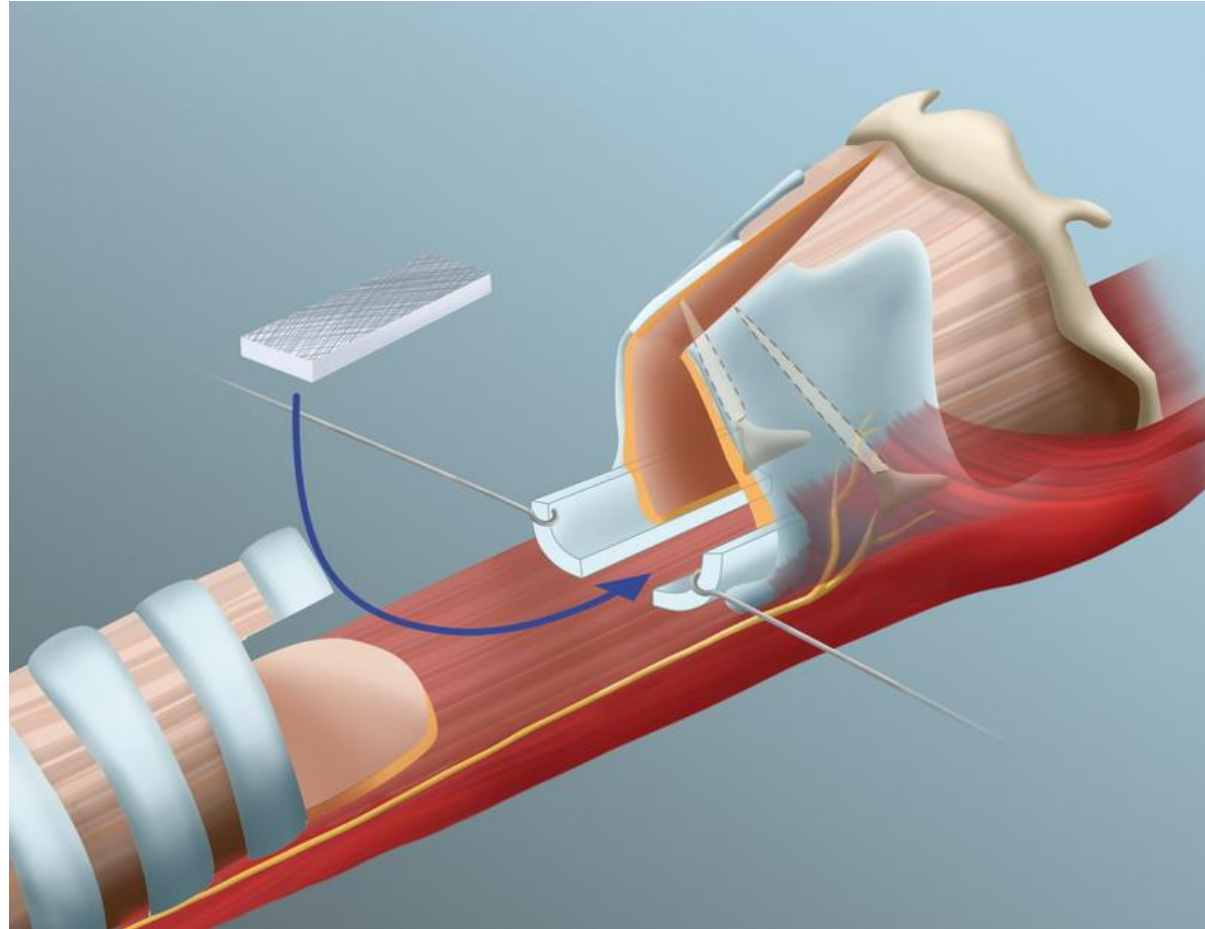
- > Posterior cricoid split
- > Section of transverse interarytenoid muscle





## EXTENDED PCTR ③

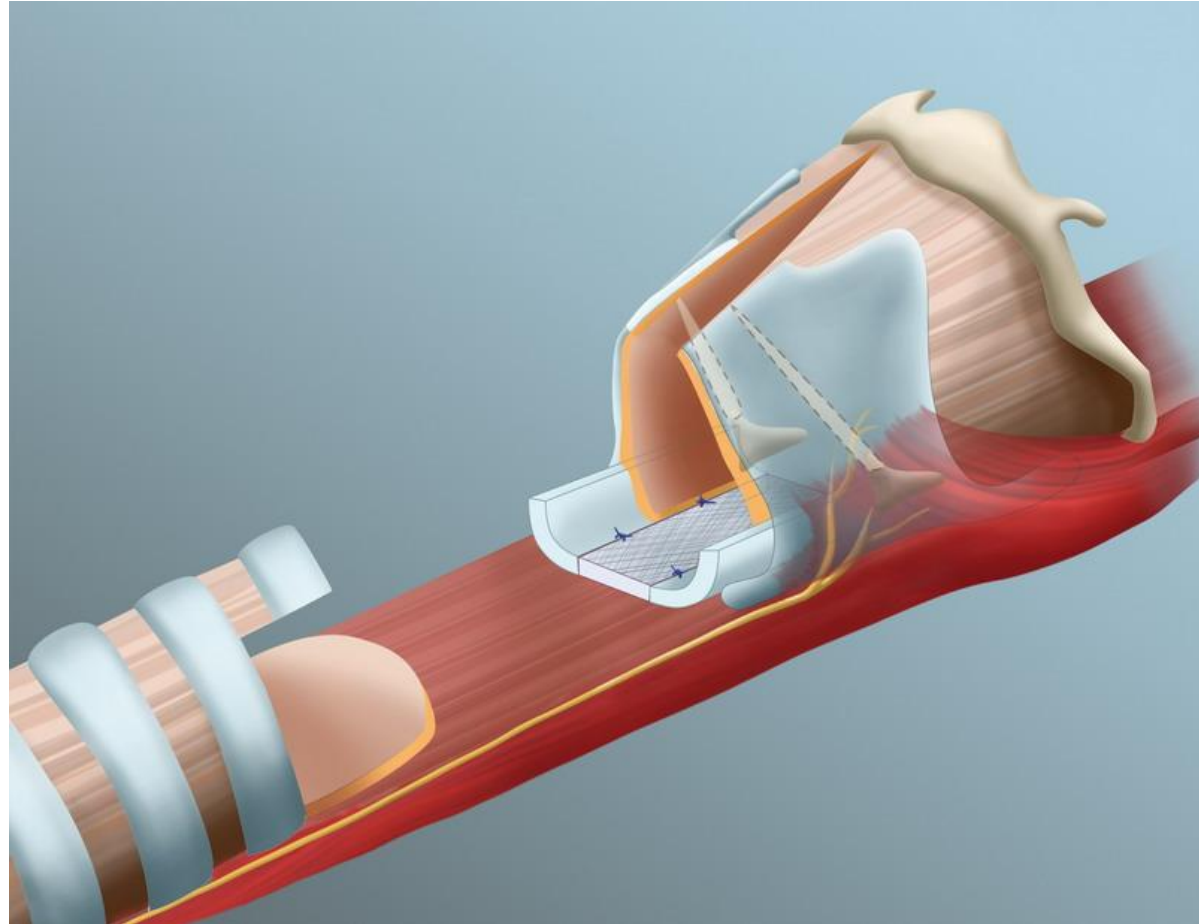
- > Harvest of costal cartilage graft
- > Separation of cricoid laminae





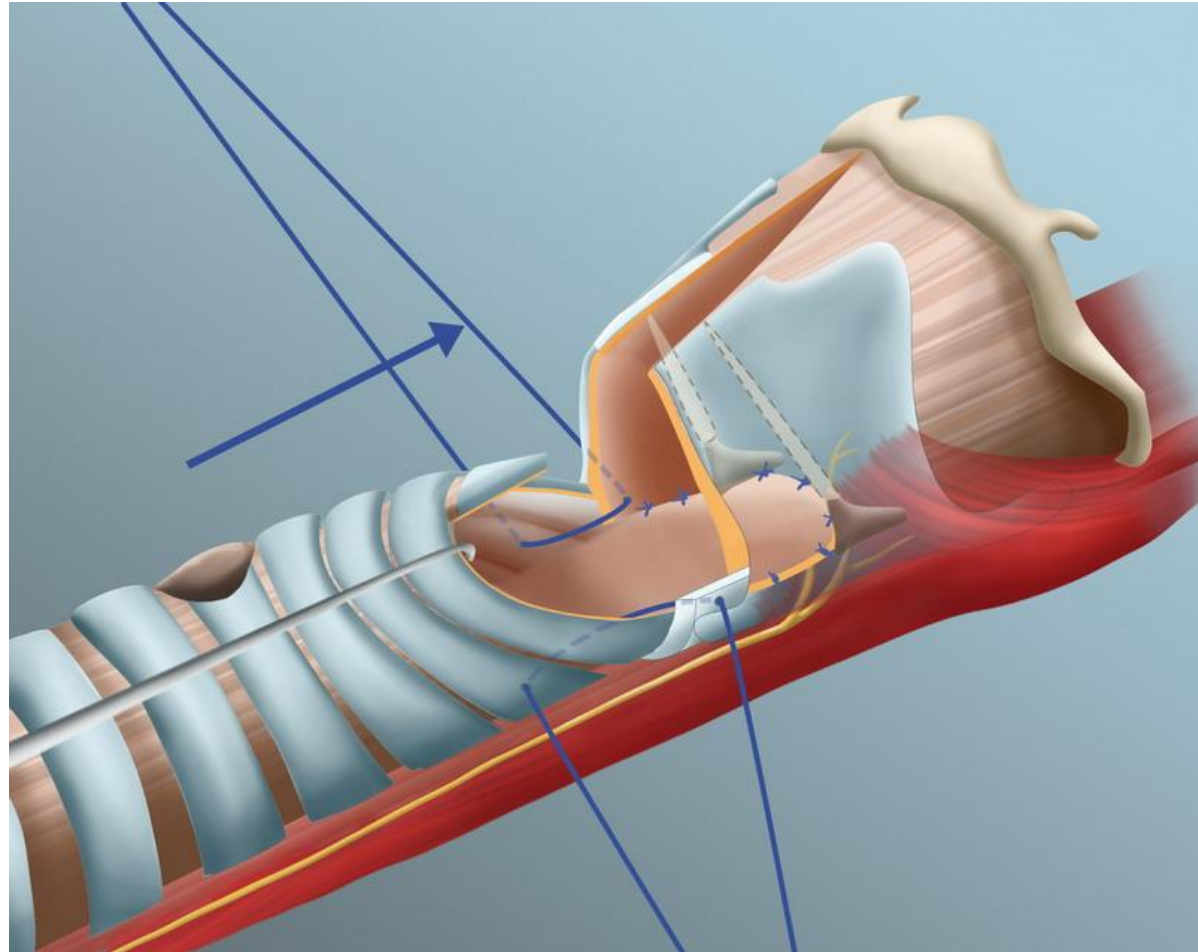
## EXTENDED PCTR ④

- > Suture of costal cartilage graft between the two cricoid laminae



## EXTENDED PCTR ⑤

- > Cranial mobilization of tracheal stump
- > Suture of mucosal flap at posterior laryngeal commissure



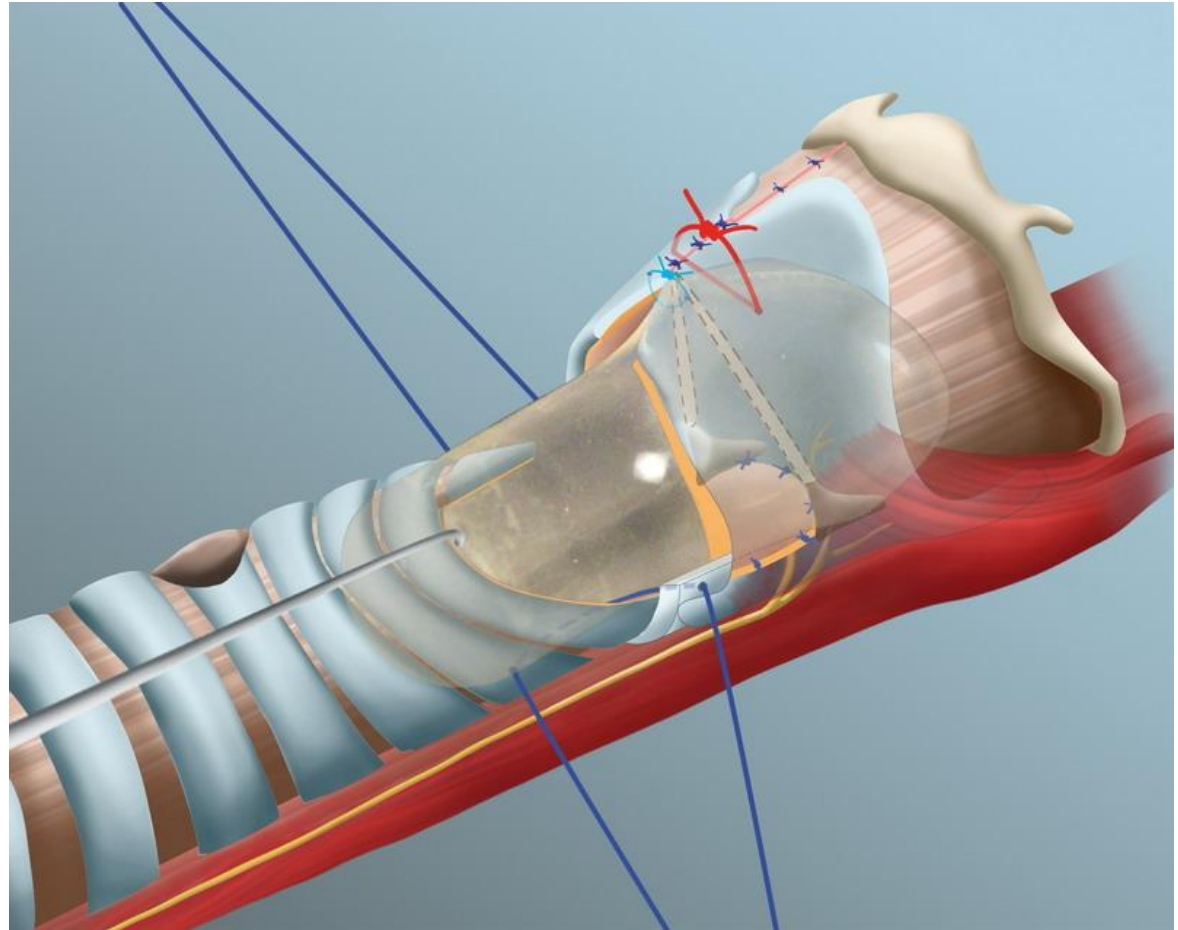
# CURRENT DESIGN



4 different lengths for each size

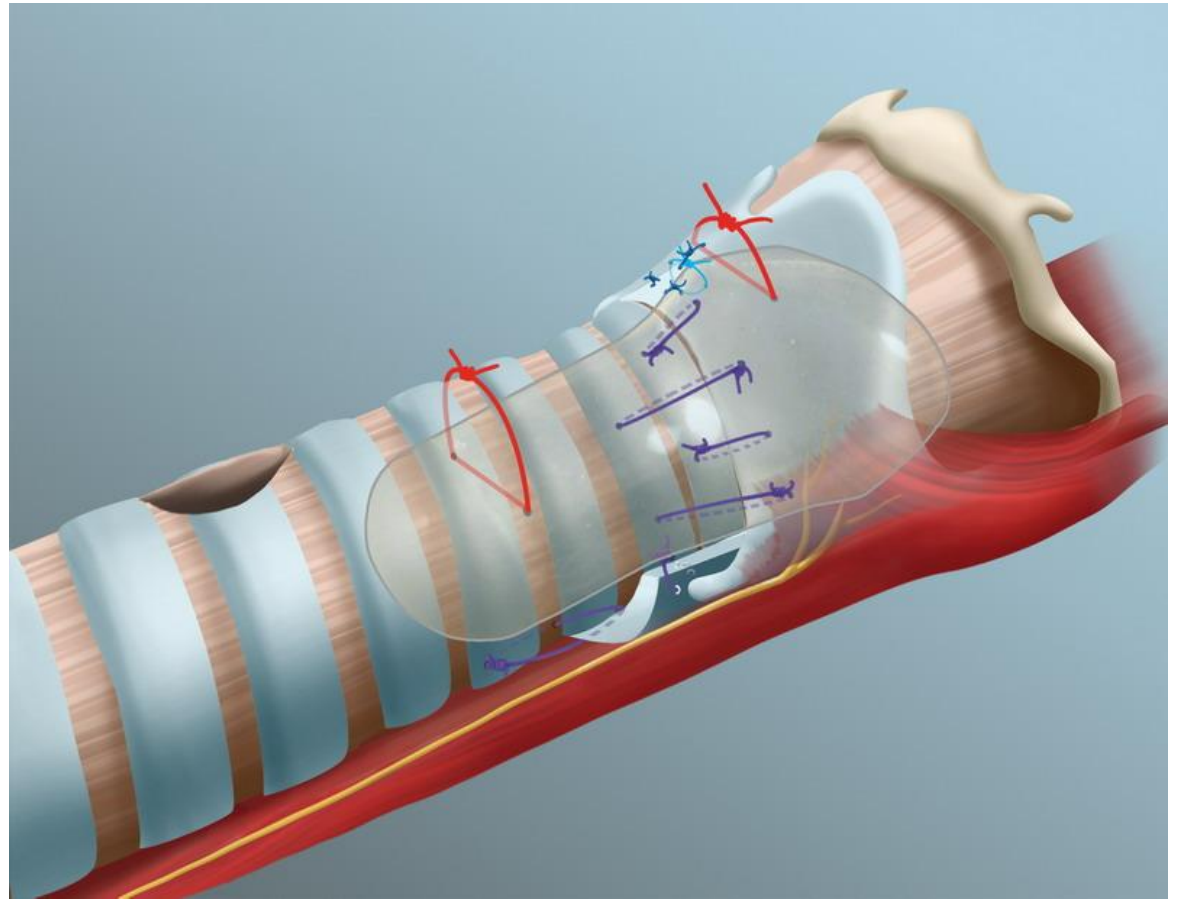
## EXTENDED PCTR ⑥

- > Insertion of LT-mold in glotto-subglottic space



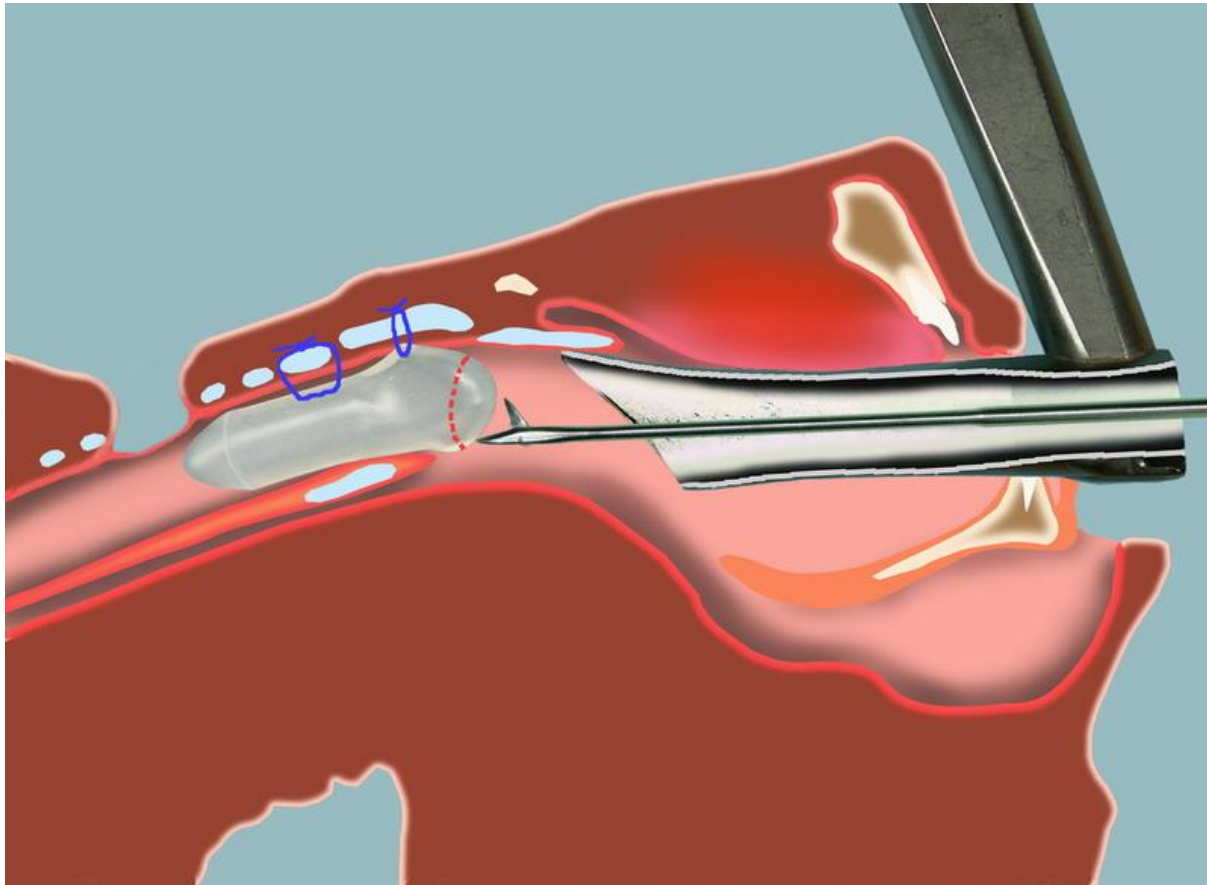
## EXTENDED PCTR ⑦

- > Fixation of LT-mold
- > Closure of laryngofissure cranially to anterior commissure



*Easy LT-mold*

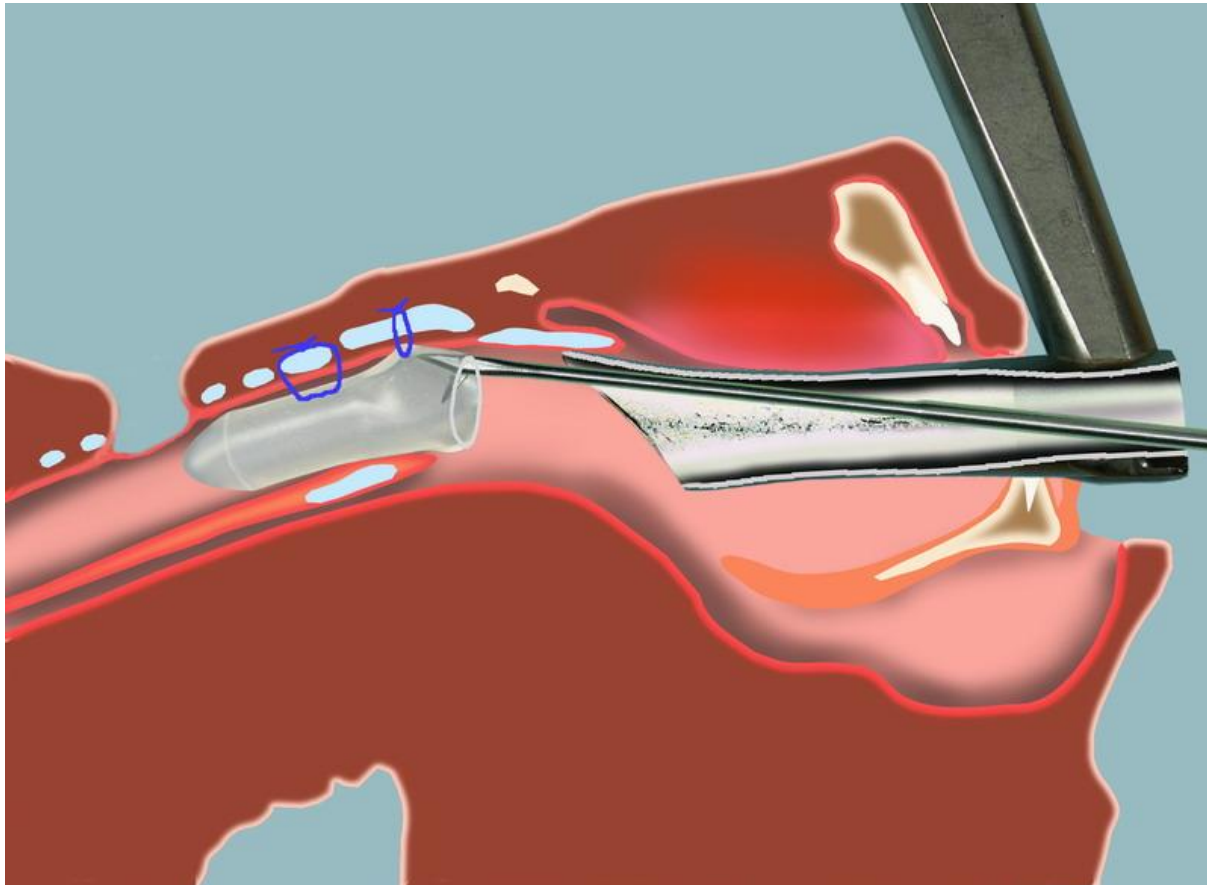
# REMOVAL AFTER PEROPERATIVE FIXATION



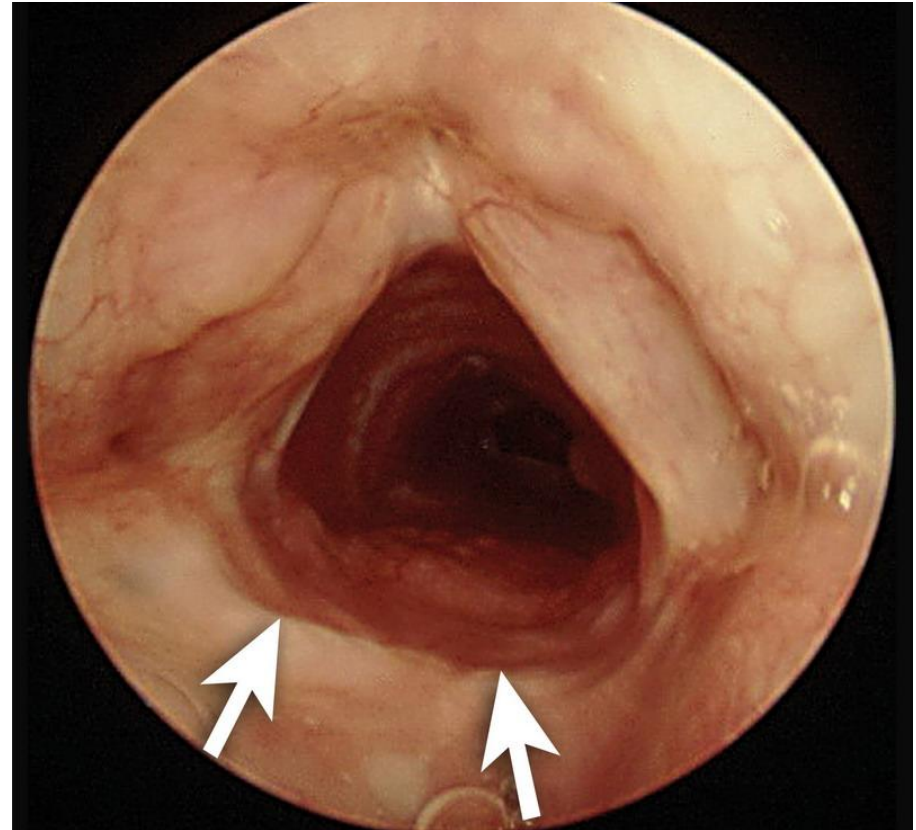
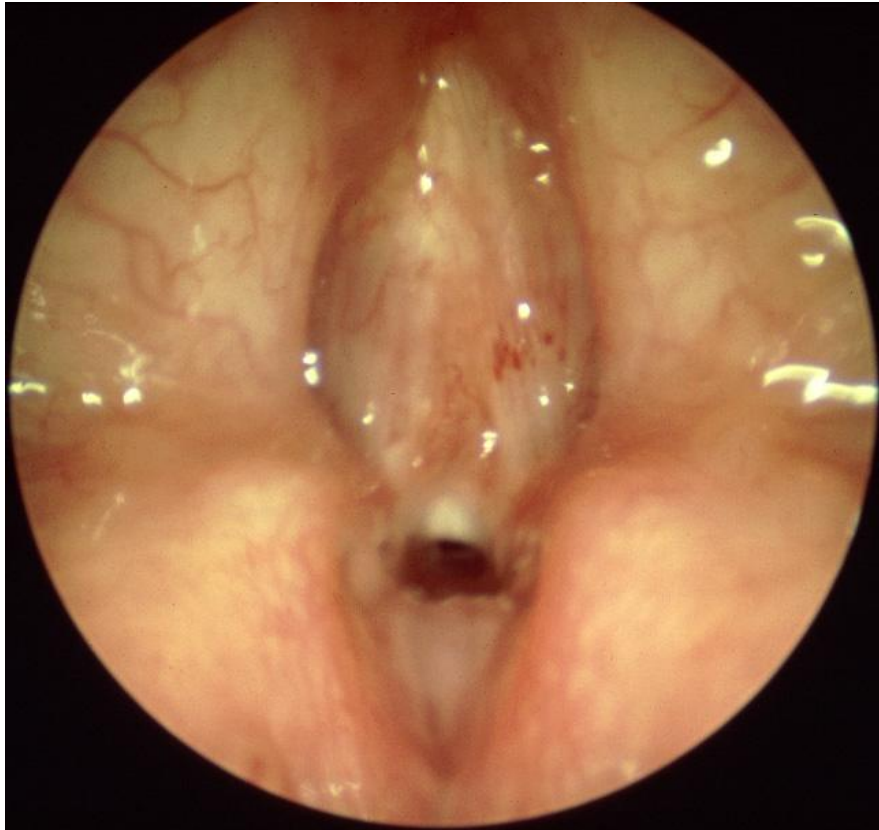


*Easy LT-mold*

# REMOVAL AFTER PEROPERATIVE FIXATION



## SGS + FUSION OF VC



# RESULTS

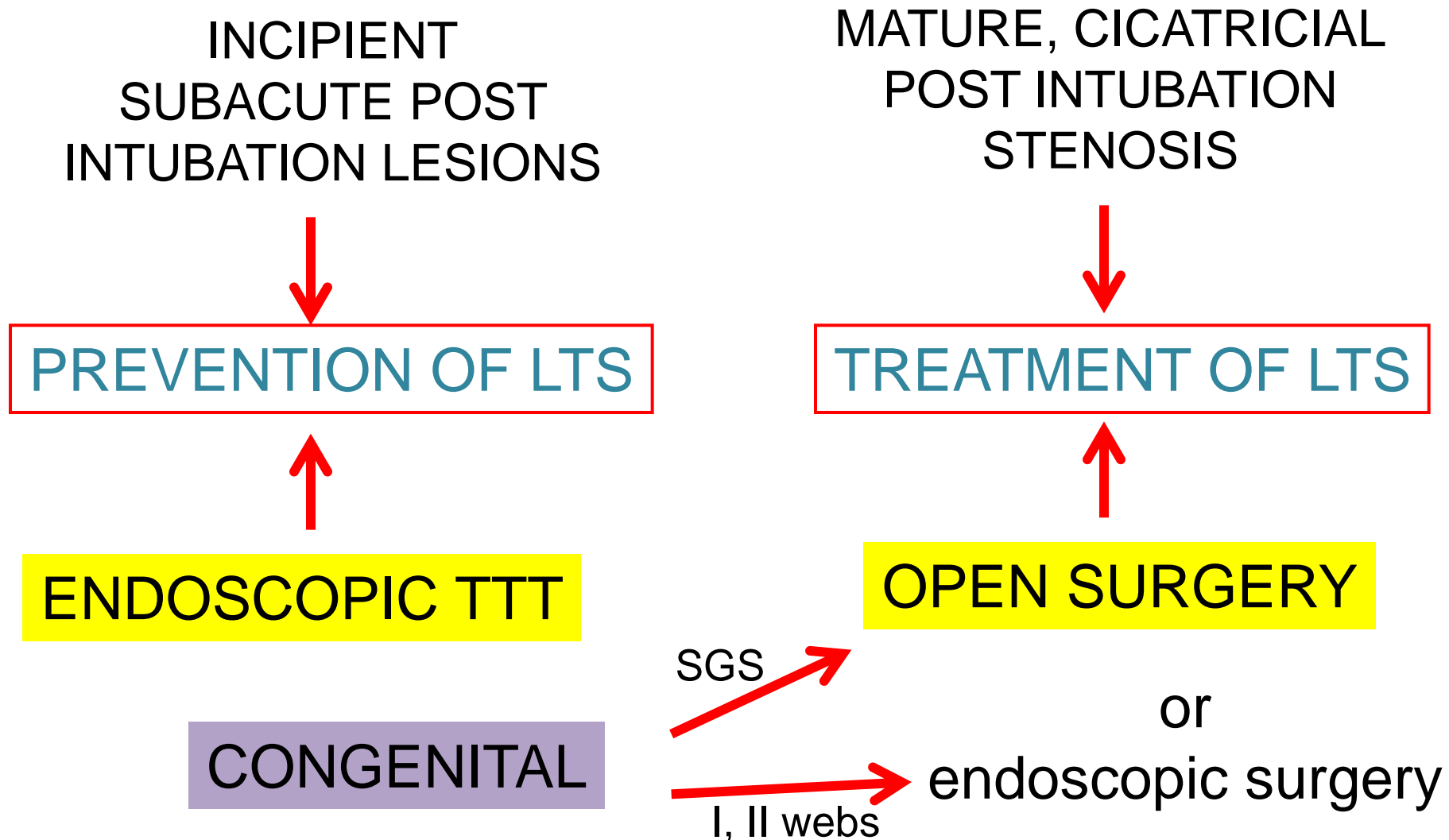
## 1. Decannulation

- Time from surgery until decannulation
- Complimentary, additional procedures

## 2. Voice

## 3. Swallowing

# CONCLUSION (1)



## CONCLUSION (2)

- Associated Synchronous airway lesions SAL's + SGS
- Precise endoscopic investigation
- Correct diagnosis & patient selection
- Selection of appropriate surgical strategy
  - > Single vs double stage

# THE BEST CHANCE FOR THE PATIENT LIES IN THE FIRST OPERATION







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COURSE

2<sup>nd</sup> edition

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