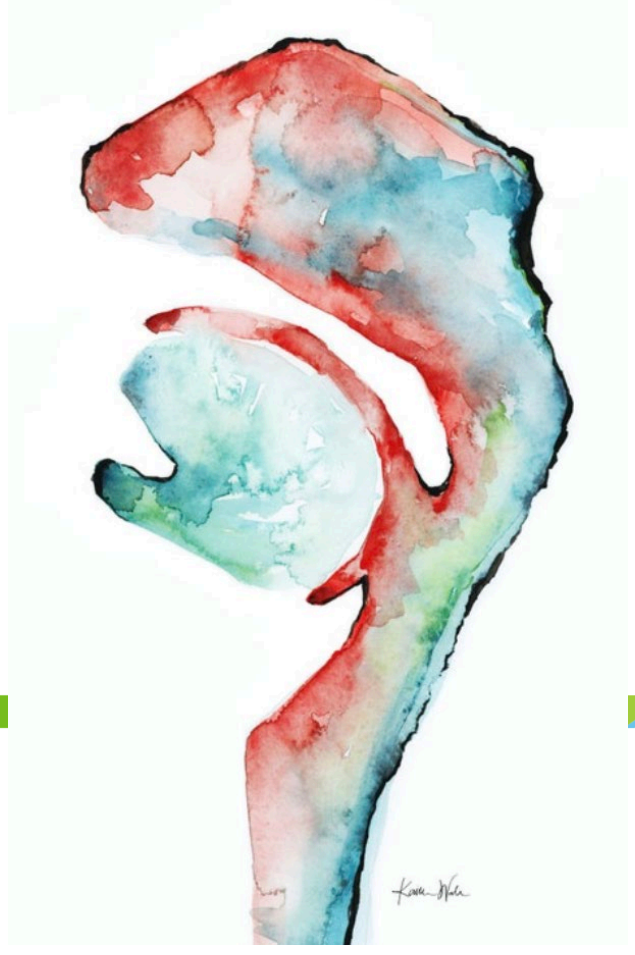
Pediatric Airway Anomalies and Reconstruction

Ochsner Aerodigestive Program

Maria Carratola, MD

7/19/24

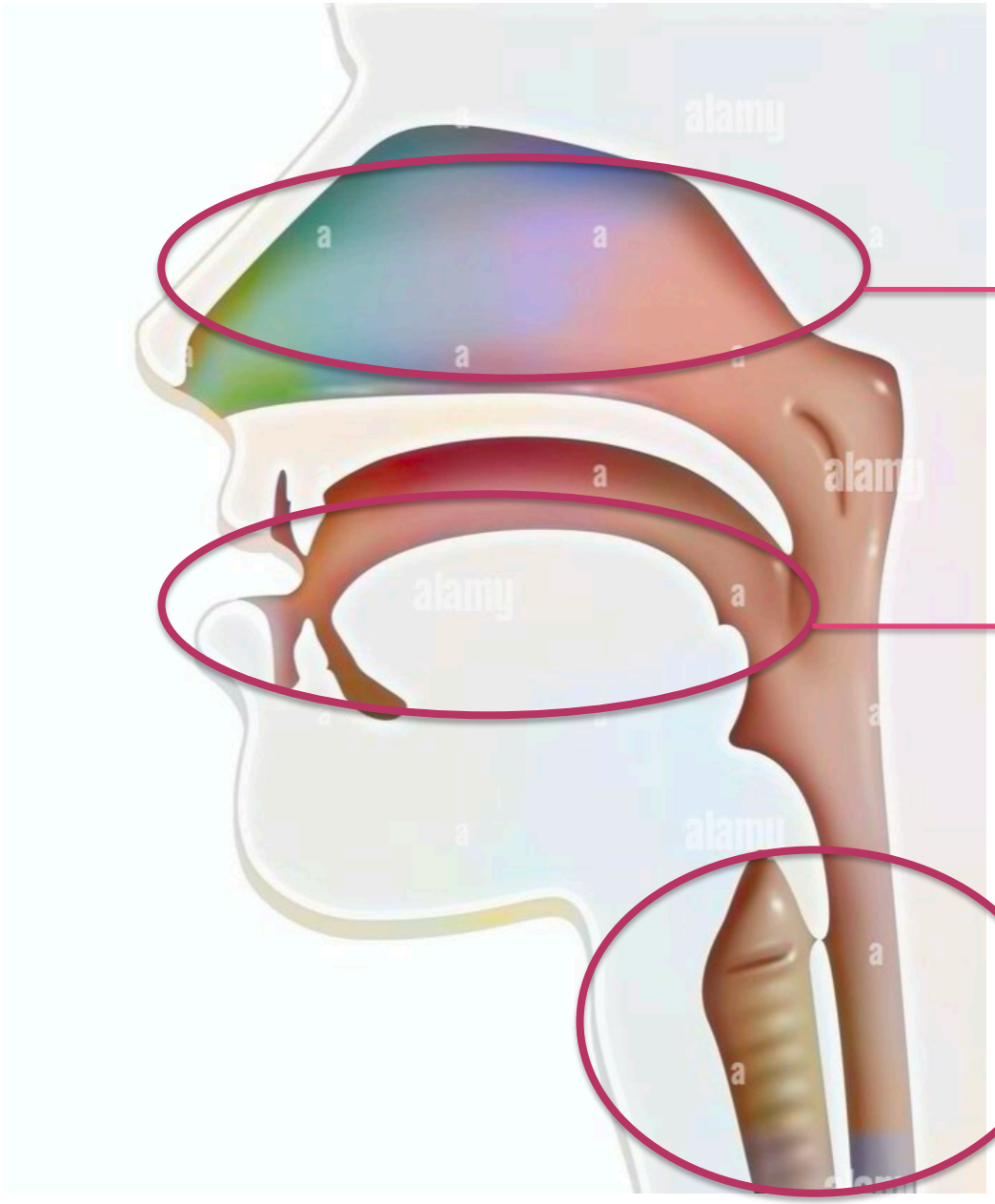
Ochsner Pediatrics Update



- Nothing to disclose

Objectives

- Identify some pediatric airway anomalies, focusing on causes of pediatric airway stenosis and dysphagia
- Describe the process of evaluation
- Describe the options for treatment/reconstruction
- Consider goals of surgery
- Discuss utility of multidisciplinary aerodigestive program



Pyriform aperture stenosis, choanal atresia, midface hypoplasia, etc.

Micrognathia, glossoptosis, macroglossia, cleft palate, oral congenital masses (VLM, foregut duplication cysts, etc.)

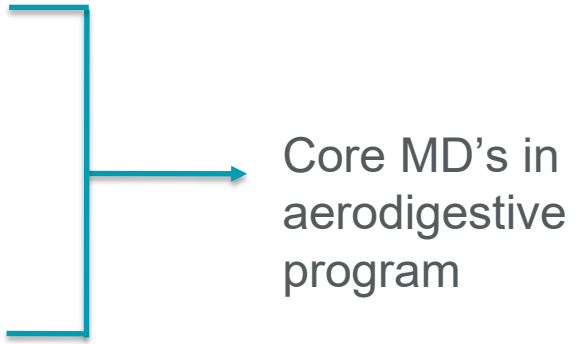
Laryngeal cleft, Vocal cord paralysis, subglottic stenosis, tracheal stenosis/collapse

Etiology of laryngotracheal stenosis

- Iatrogenic
  - Traumatic intubations
  - Prolonged intubations
  - Prolonged tracheostomy use
  - Nerve injury (chest surgery)
- Congenital
  - Congenital subglottic stenosis
  - Vocal fold paralysis
  - Lymphovascular malformations
  - Laryngeal atresia (CHAOS)
- Infection
  - Tracheitis, croup - invasive MRSA or pseudomonas infections. Recurrent croup likely points to an underlying problem rather than being the cause of the problem.
- Inflammatory
  - GPA (teenagers, young adults)
- Tumors
  - Hemangioma, papilloma, inflammatory pseudotumor, granular cell tumor
  - Carcinoid, mucoepidermoid carcinoma, adenoid cystic, rhabdomyosarcoma

Identifying the Problem

- How to work up a patient who is referred for an aerodigestive problem?
  - History/PE
  - Flexible bronchoscopy with BAL
  - Microlaryngoscopy and bronchoscopy
  - EGD with Impedance probe/Biopsies
  - Imaging?
  - Voice evaluation? Flexible laryngoscopy while awake?
  - MBSS or FEES?



Workup

- EGD, impedance probe, and biopsies - in low power studies, ~20% have change in management (8% in case of Nissen fundoplication)[1].
- Bronchoscopy and BAL - similar findings to above - 1 of 10 patients have change in management[2]

Workup

- Imaging - in select cases
  - CT chest
- Flexible laryngoscopy
  - Useful to establish vocal fold function prior to airway surgery
- Rigid or flexible strobe laryngoscopy - ideal for LTP's with goal of improving voice

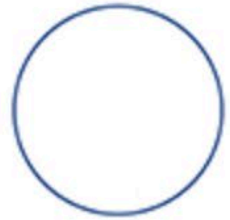
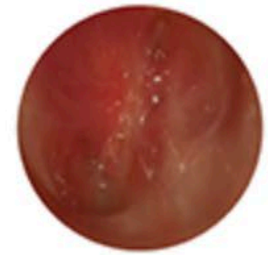
Treating aerodigestive problems

- Depends on your goal!

Expand airway
-Decannulation
-Preventing tracheostomy
-Safer airway

Improve Aspiration
-allow to PO
-improve lung health

Improve voice
-QoL

Classification	From	To	Endoscopic appearance
Grade I	 No Obstruction	 50% Obstruction	
Grade II	 51%	 70%	
Grade III	 71%	 99%	
Grade IV	No detectable lumen		

Fixing the Problem - expanding the airway

- Endoscopic
  - Endo-lumenal issue
  - Thinner scars/webs

  - Balloon dilation
    - 3-5x at 1-2 week intervals
  - +/- Laser or cold knife scar excision
  - +/- Kenalog injection

* BVFP - endoscopic lateralization (more often in adult population), cordotomy/cordectomy
* Endoscopic AP split (if young enough, 0-24 months reported but usually before 6 months)
* Endoscopic graft

Fixing the Problem - expanding

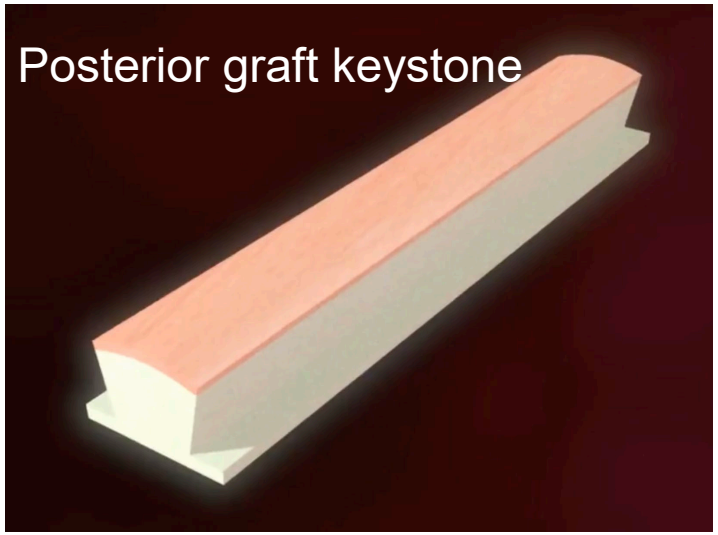
- Open
  - Framework issue
  - Failed endoscopic

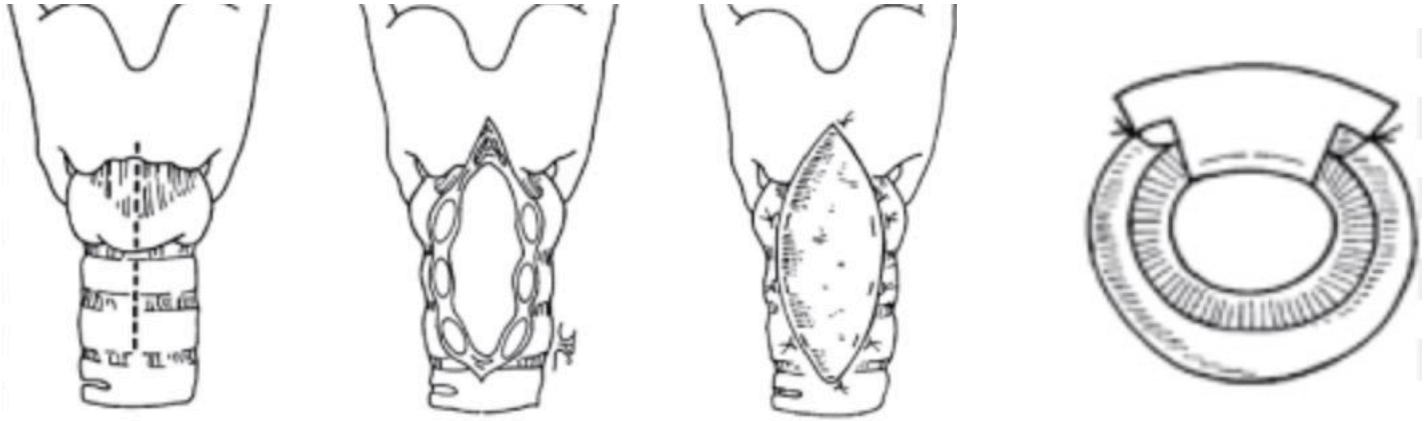
Open Reconstruction

- Laryngotracheoplasty “LTP”
  - Anterior
  - Posterior
- Resection - CTR, TR
- Slide tracheoplasty

Laryngotracheoplasty

- LTP
  - Double stage
  - Single stage
  - Anterior grafts and posterior grafts



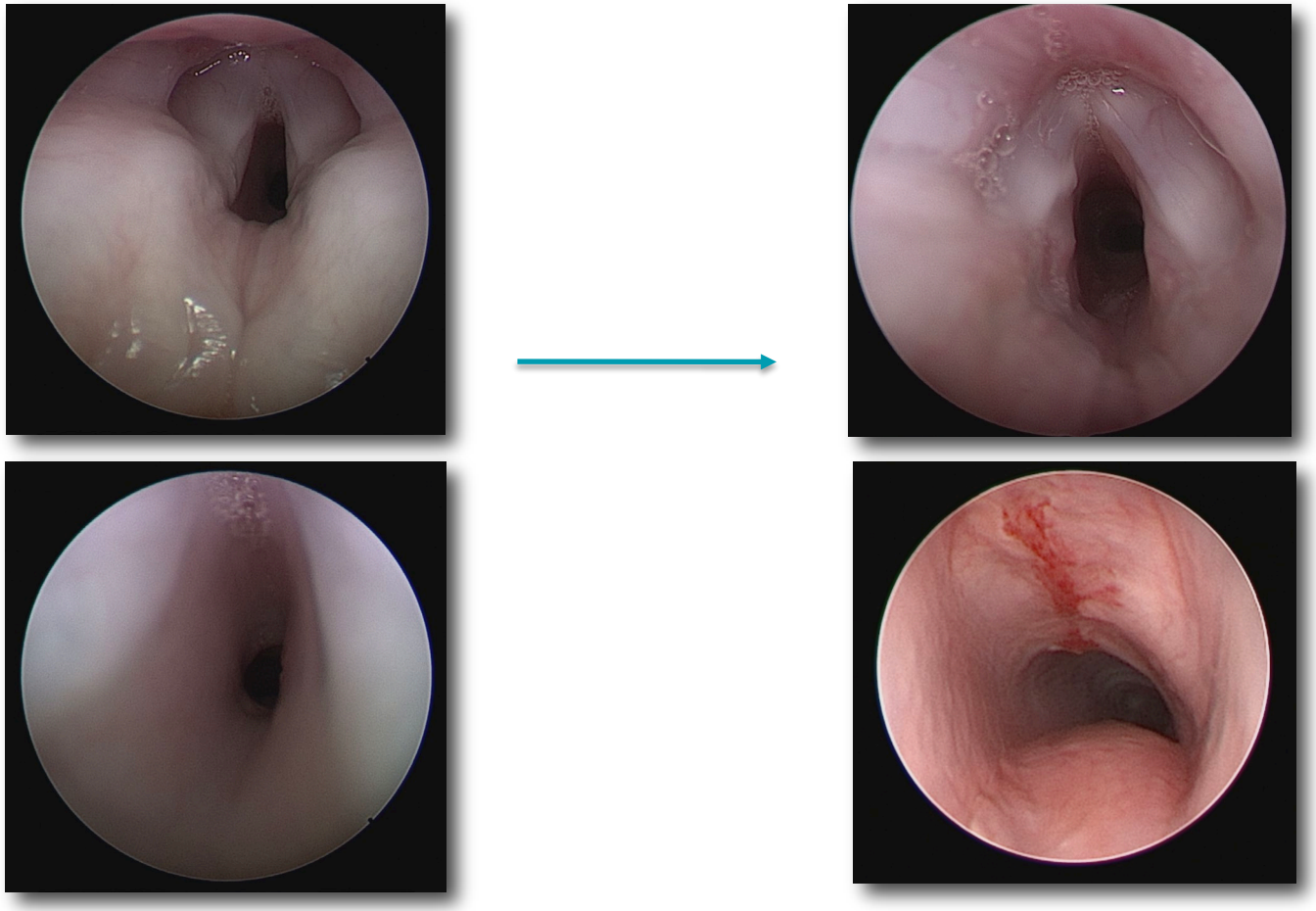


Anterior graft

Laryngotracheoplasty

- LTP - double vs. single stage
  - Double stage - relative indications
    - Higher grade of stenosis (3+)
    - Multilevel stenosis
    - Revision surgery
  - Single stage - relative indications
    - Stoma problem
    - Lower grade stenosis
    - Patients previously not trached

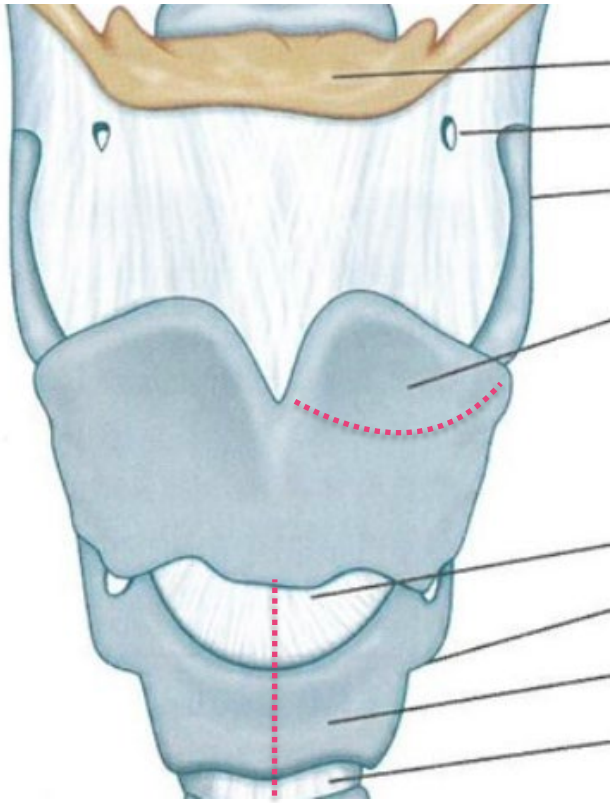
Congenital subglottic stenosis



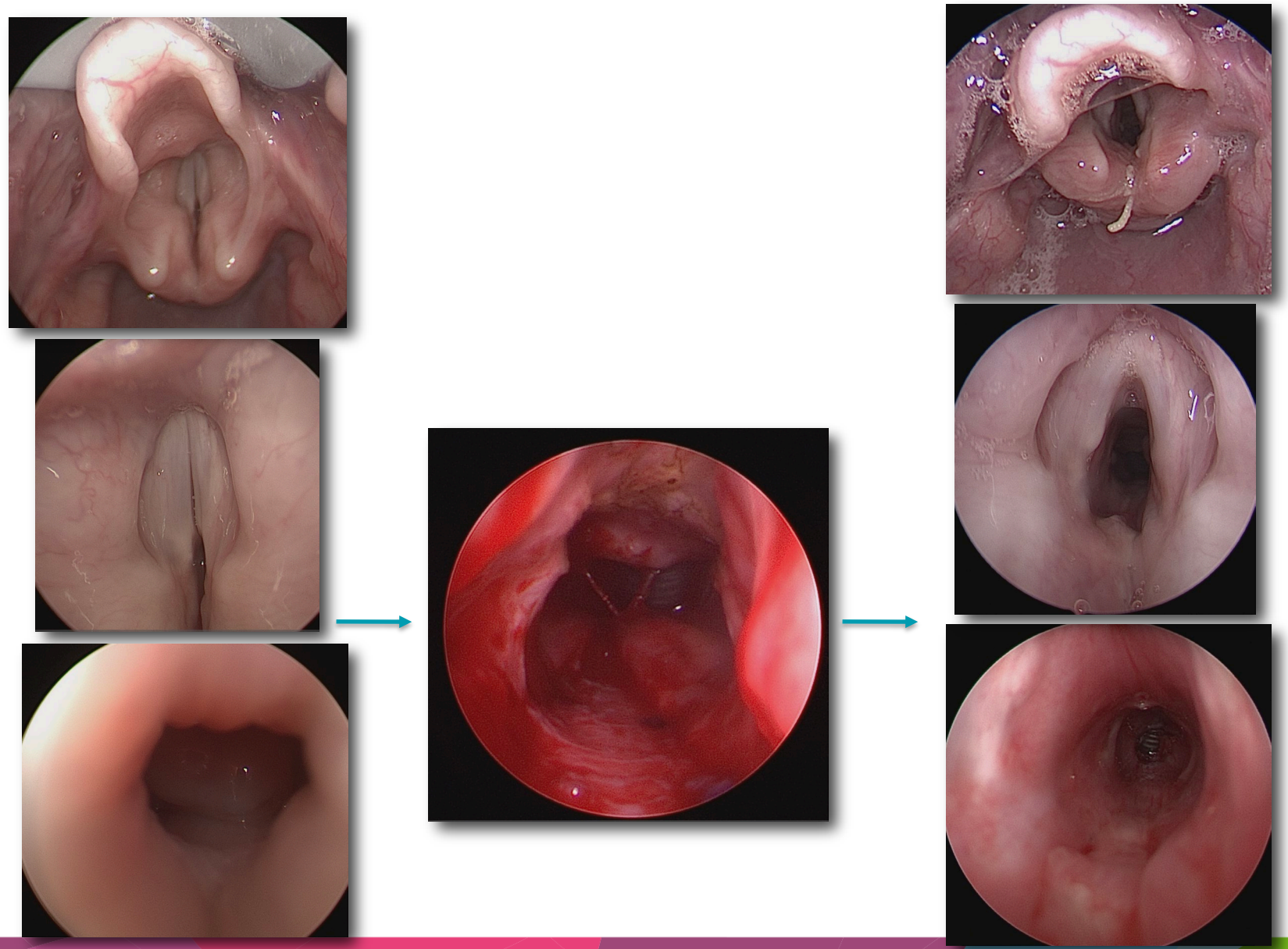
2 month old girl presented with feeding difficulty and biphasic stridor, attempted dilations at home institution with no success

ssLTP with ATA graft & posterior cricoid split. Intubated ~10 days, c/b rhinovirus, VF granulation from ETT but still able to be discharged 3 weeks postop

Thyroid ala graft

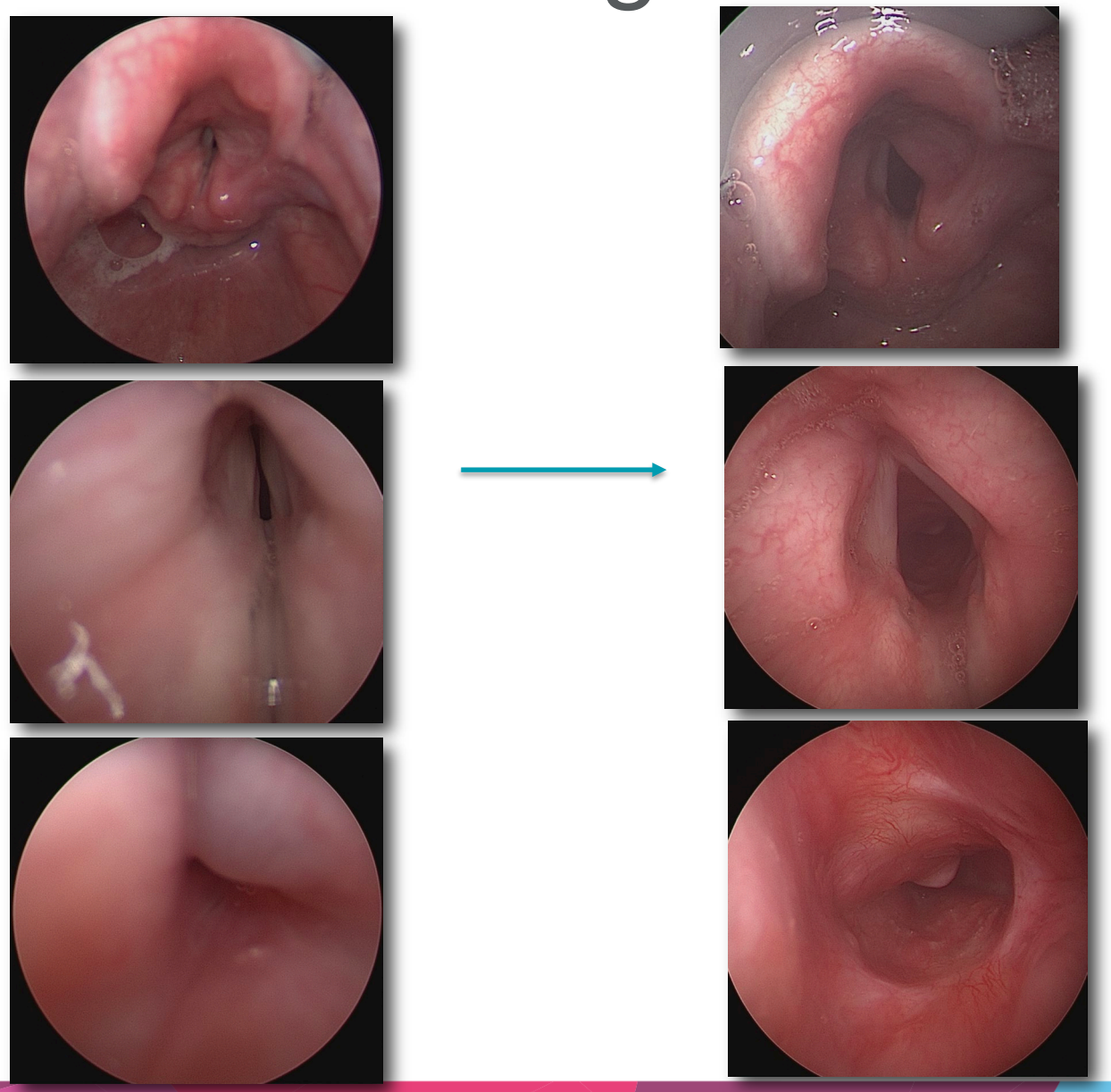


Glottic and subglottic stenosis



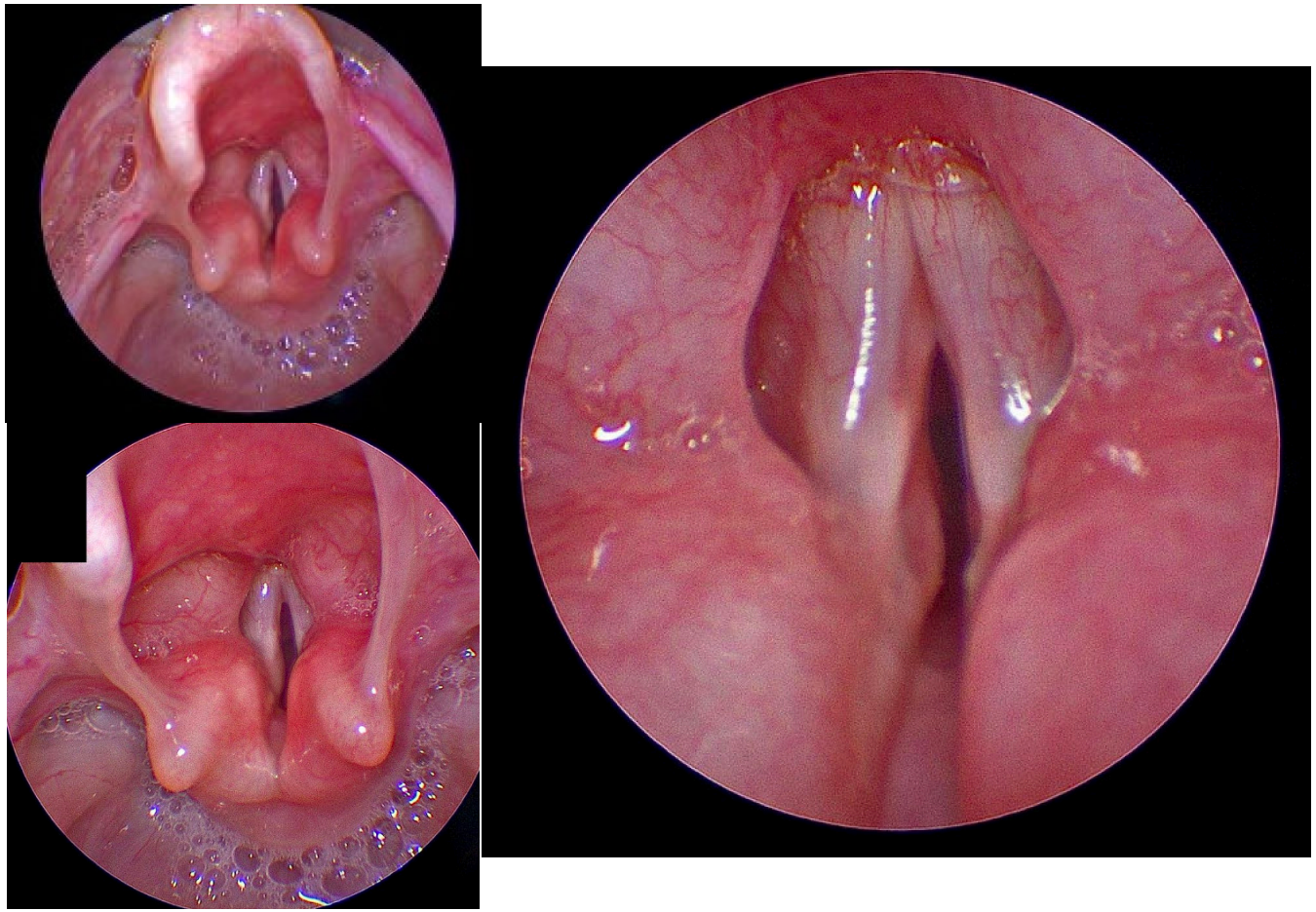
Endoscopic dsLTP with posterior graft

Glottic and subglottic stenosis

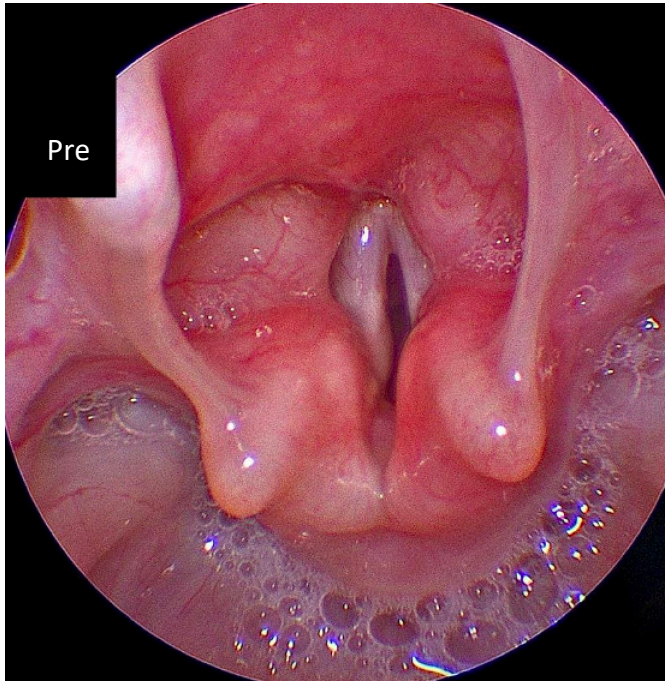


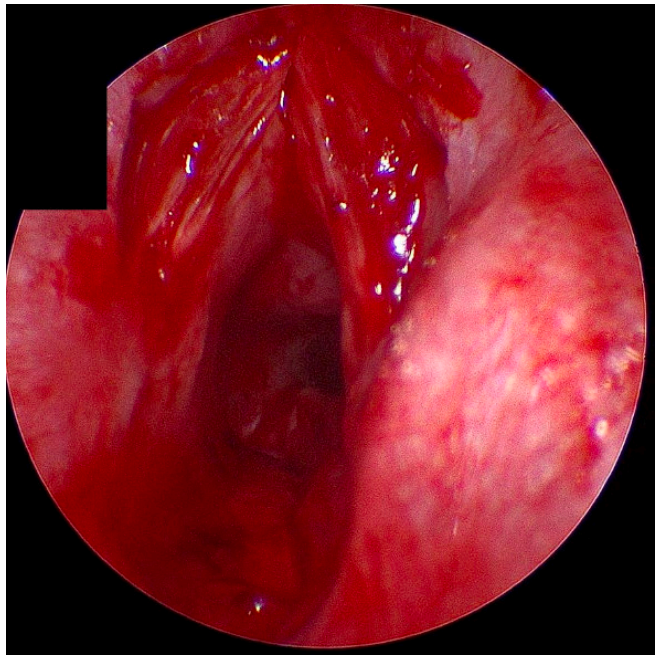
Endoscopic dsLTP with posterior graft

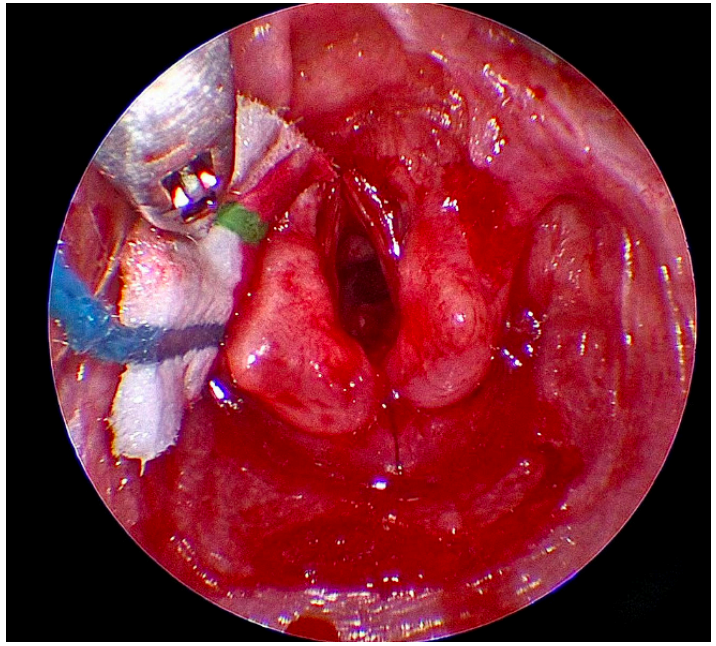
Single stage endoscopic LTR PCCG

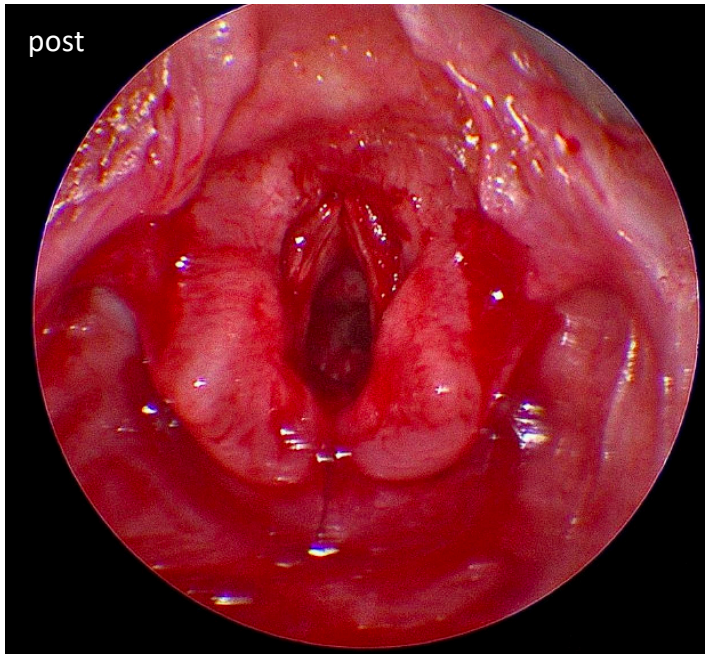


Bilateral VCP due to Chiari.
Tracheostomy vs LTR









Single stage endoscopic LTP PCCG

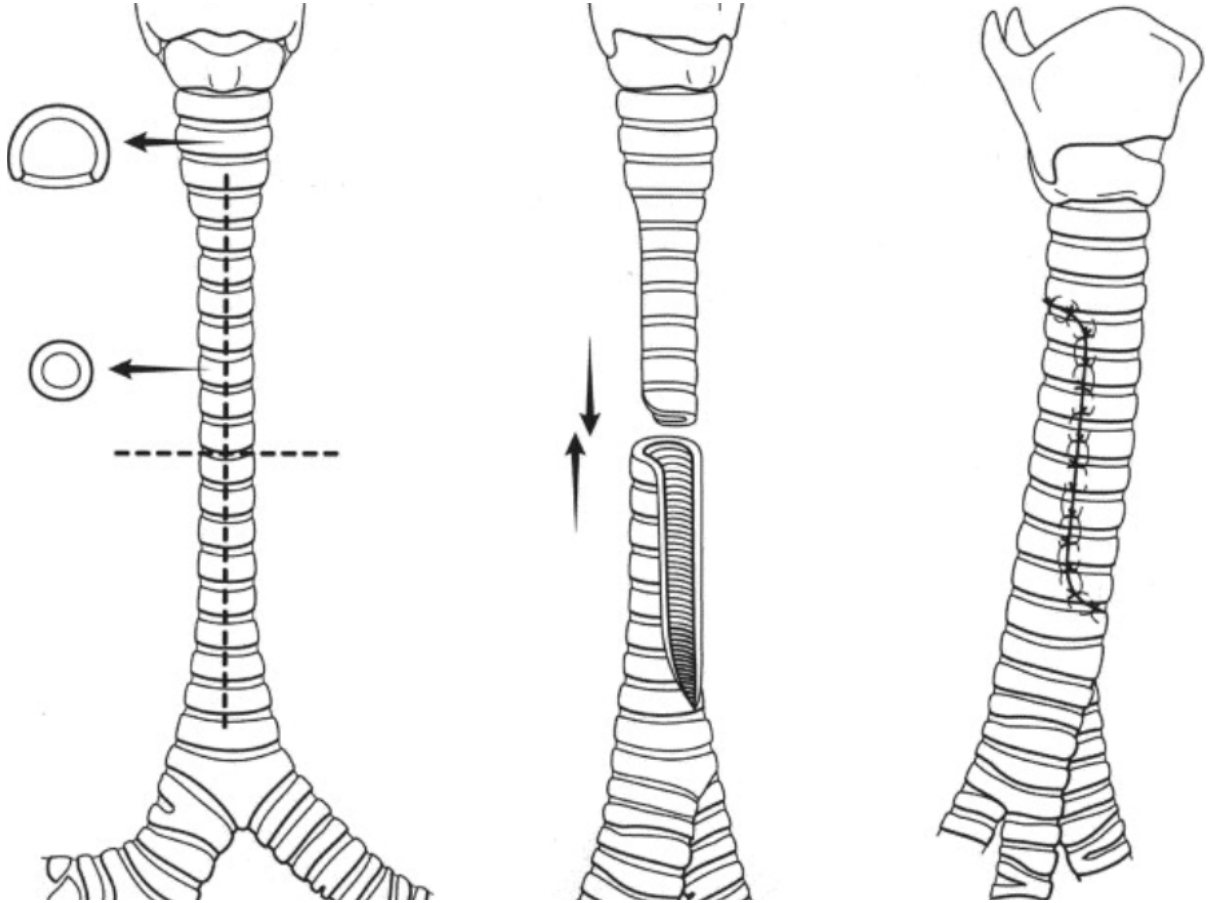
Cricotracheal Resection

- Found to be surgeon dependent more so than LTP with grafting (making LTP better for training environments)
- Relative indications:
  - high grade stenosis
  - poor quality cartilage, especially laterally (grafts need something to hold onto)
- Relative contraindications:
  - Stenosis close to vocal folds
  - Young age

Slide Tracheoplasty

- Often is a combination of resection/slide
- Narrow portion is transected, edges beveled, and then the proximal and distal segments re-attached
- Can be done single or double stage
  - May need to relocate stoma
- Can be done without bypass (cervical slide) or, if thoracic trachea involved, on bypass via sternotomy.

Slide tracheoplasty



- Transect
- Bevel
- Anastomose
- Grillo's description - we do it backwards
- Bevel posterior/inferior trachealis + anterior/superior tracheal rings

Grillo HC. Slide tracheoplasty for long-segment congenital tracheal stenosis. Ann Thorac Surg. 1994 Sep;58(3):613-9 discussion 619-21.

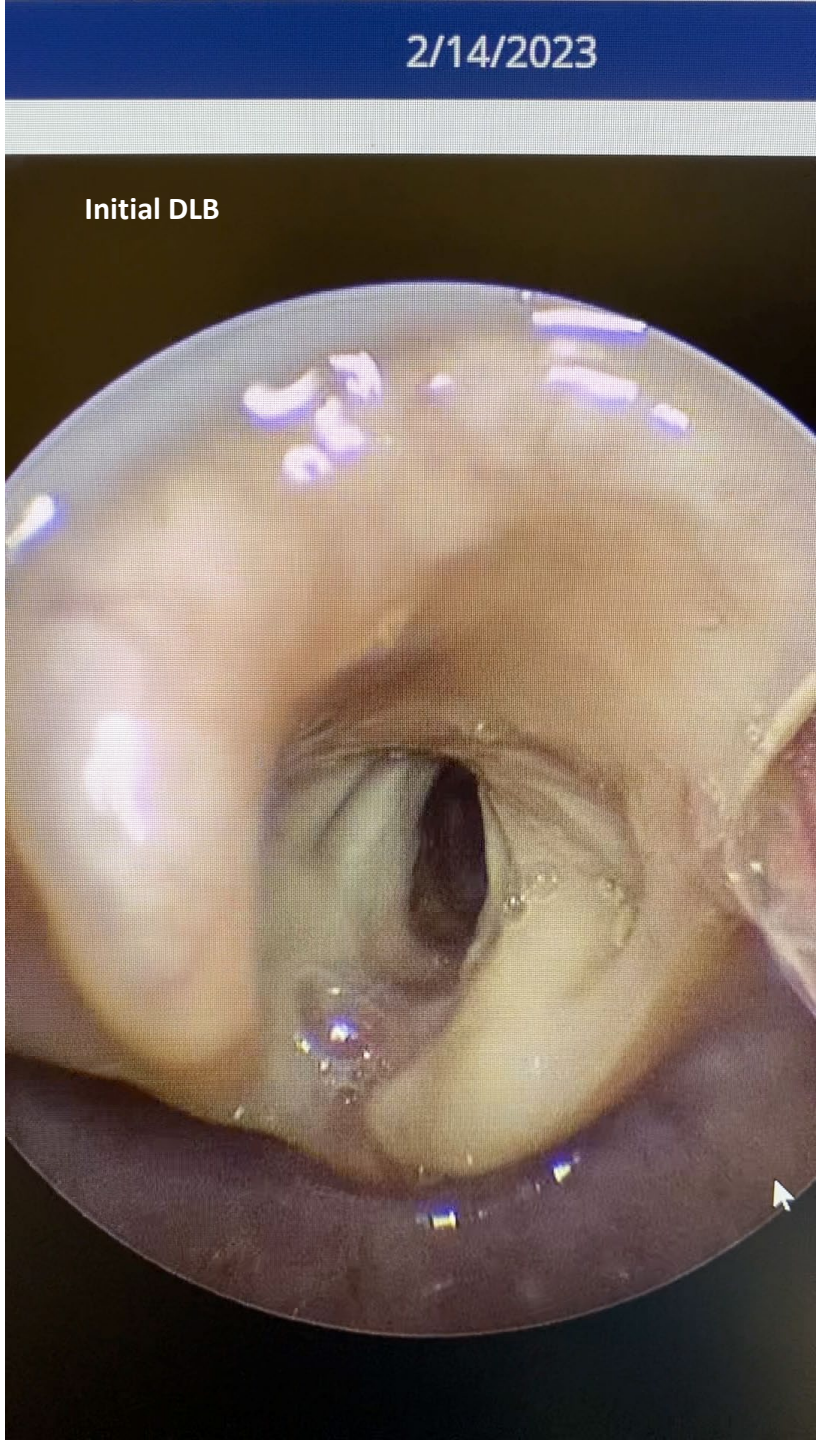
Slide Tracheoplasty

- If a tracheostomy is in place at beginning of procedure, can be left with a stent above at the anastomosis
- If no tracheostomy, leave intubated postop - extubation may be done as early as same day.

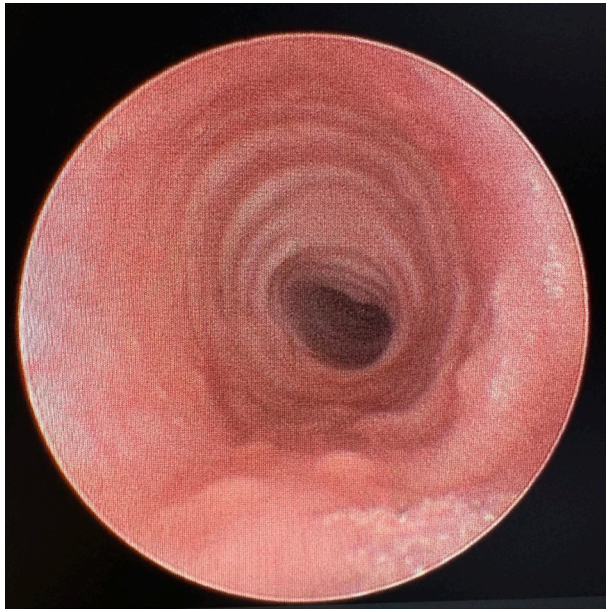
Thoracic Slide Tracheoplasty

Single stage

Done with CT surgery on cardiopulmonary bypass



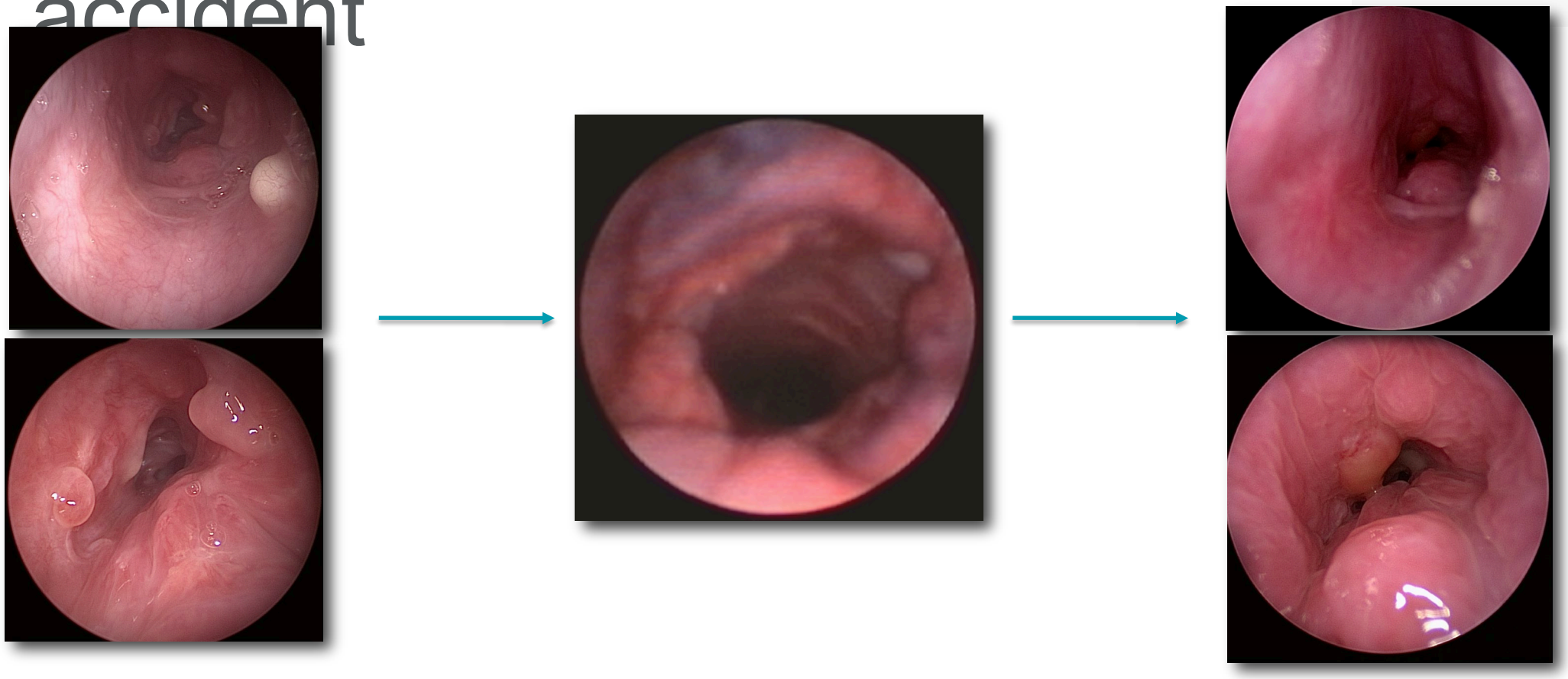
3 yo Complete tracheal rings



Which operation?

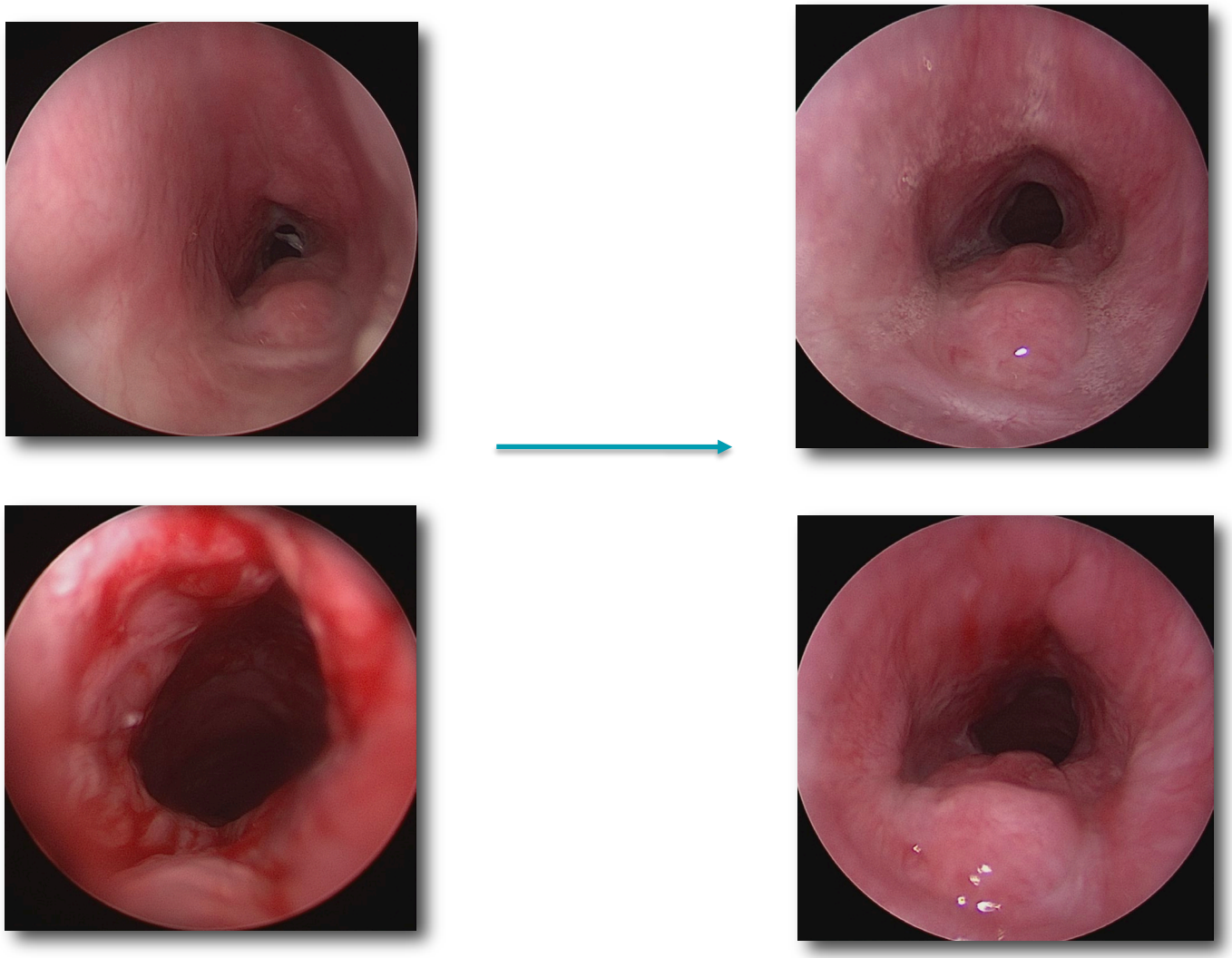
- Stenosis high grade 3 or 4 —> Resection > LTP*
- Stenosis length > 1/3 trachea —> Slide > resection/LTP
- Stenosis involves distal 1/2 of trachea —> thoracic approach to slide tracheoplasty on bypass
- Stenosis within 5 mm of vocal folds* —> LTP > resection
- Stenosis is due to poor cartilage structure —> Resection/slide > LTP
- Stenosis involves posterior glottis —> need a posterior graft (either LTP or extended CTR with PCCG)
- Misc.
  - Patient age < 4* —> LTP/Slide > resection
  - Supraglottic collapse (petiole prolapse) —> complete laryngofissure with petiole resuspension, must be double staged

Tracheal stenosis - ATV accident



Cervical slide tracheoplasty - extubated next day.
Symptomatic dyspnea worsening 1 week postop

Tracheal stenosis



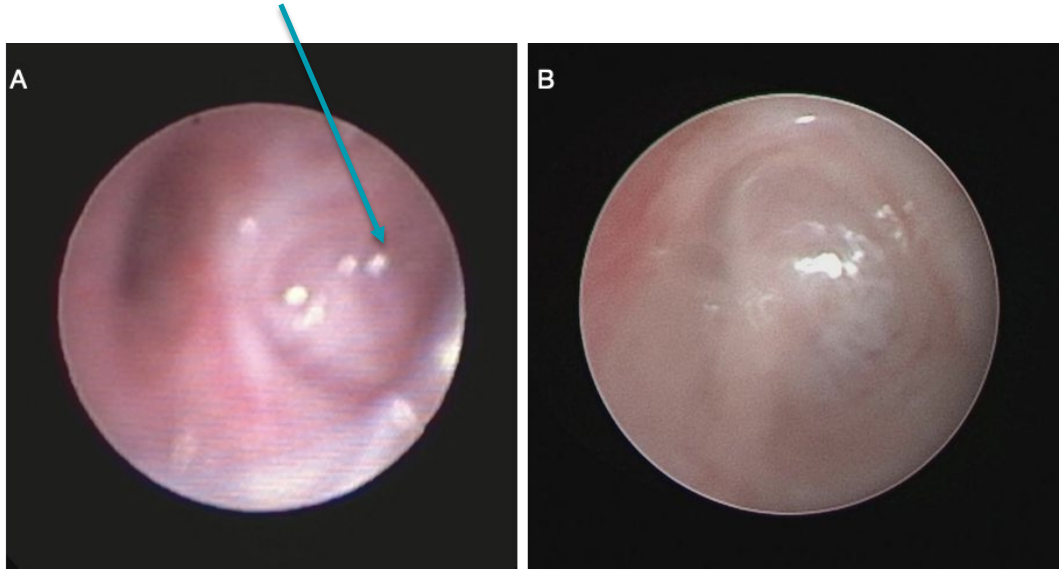
Serial dilations q 7-10 days x 5

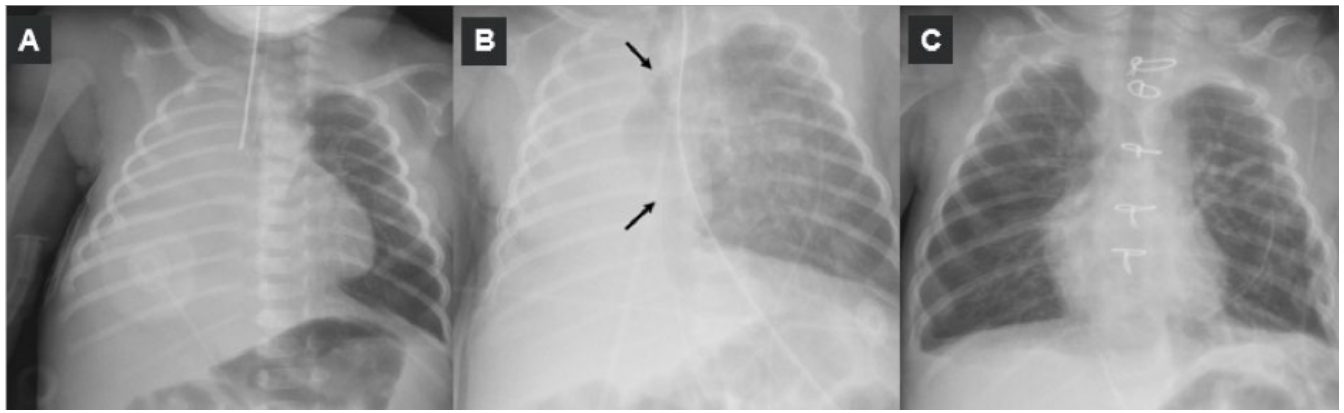
Became asymptomatic by 2 weeks postop

Discharged home and dilations continued on outpatient basis

Tracheobronchial stenosis - complete rings

- Can be extended into mainstem bronchi
- Done on CPB
- MSB atresia repaired @ 32 days of life

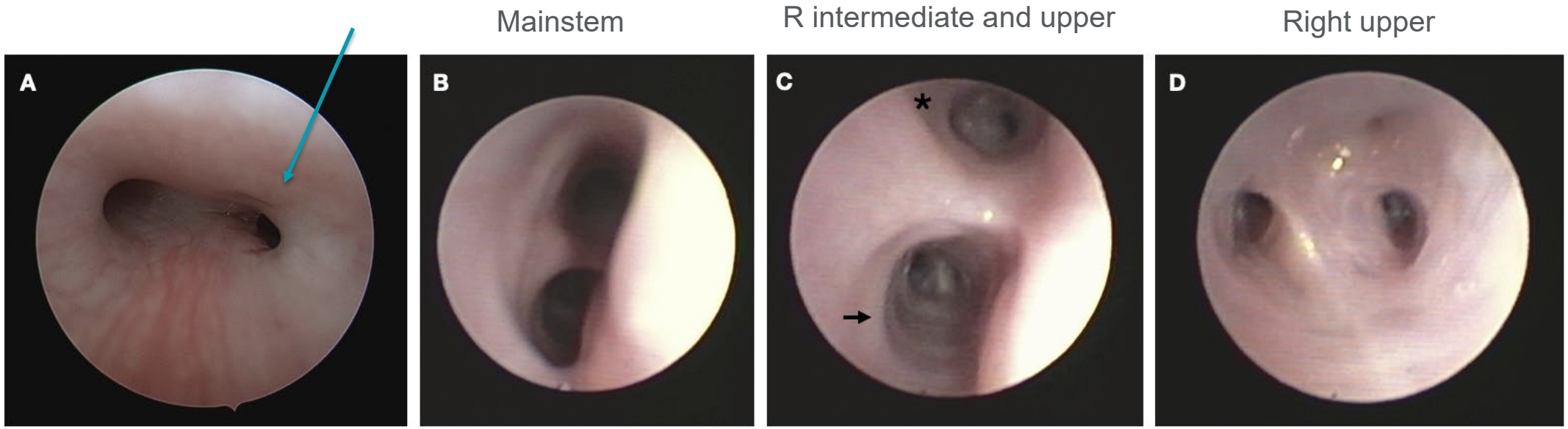




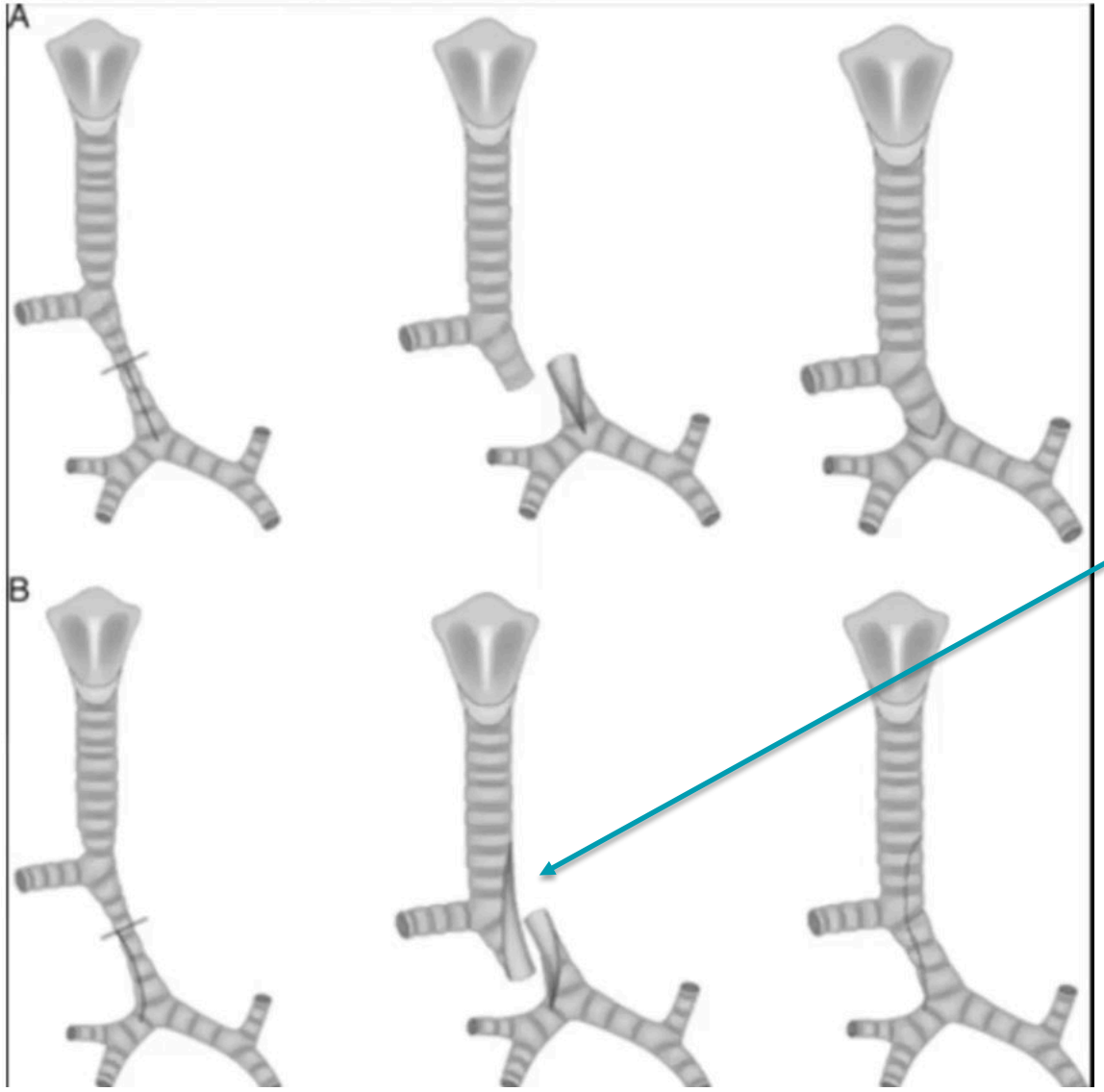
A,B - CXR, Serial echo with worsening RVP due to LPA stenosis from progressive rightward mediastinal shift.

Slide tracheobronchoplasty

- Transect, bevel edges, anastomose



Slide tracheobronchoplasty



- Transect, bevel edges, anastomose

"Ignoring" a bronchus

Chung SR, Yang JH, Jay TG, et al. Clinical outcomes of slide tracheoplasty in congenital tracheal stenosis. *Eur J Cardiothorac Surg.* 2015 Mar;47(3):537-42.

Voice problems

- Post airway reconstruction - over correction of a narrowing
- Nerve injury

Narrowing the airway

- What about those with a terrible voice after a successful expansion laryngoplasty?
  - Posterior cricoid reduction
  - CO2 laser, done endoscopically
  - Allows vocal folds to get closer together but still maintains a patent airway
  - Usually a 2-3 mm segment removed, measurements aided by Dynamic Voice CT.

Reinnervation

- Non-selective RLN reinnervation
  - Restores tone, improves voice, but does not restore mobility
- Selective RLN reinnervation
  - Can potentially improve mobility

Dysphagia, surgeons perspective

Etiology

- Dysphagia, NOS - poor coordination, aspirators, slow feeders without an identifiable cause
- Laryngomalacia
- Laryngeal cleft
- Tracheoesophageal fistula
- Vocal fold paralysis
- Airway obstruction
  - SGS, Lingual TGDC, VLM
  - Syndromic - Craniofacial (Crouzon, Apert, Pfeiffer, PRS)
  - non-syndromic cleft lip/palate
- Non-anatomical — neurologic etiology
  - Trisomy 21, Chiari malformation, Neurodegenerative disorders (Leigh Syndrome)

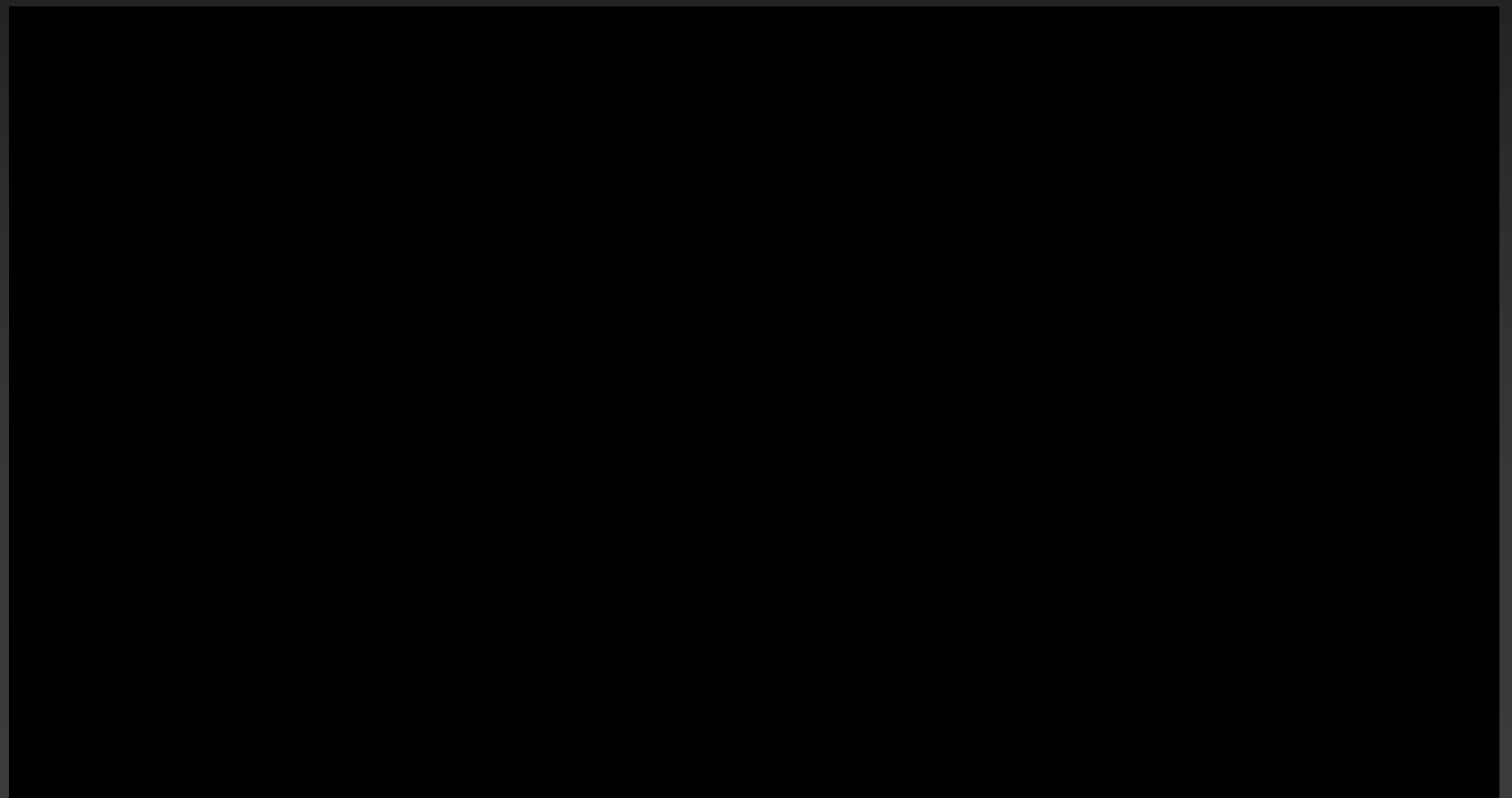
Case BP
20 mo

- History of 30 week prematurity, aspiration since birth. Maintained on thickened liquids since she left the NICU.
- Referred to ENT at 20 months of age.
- Flexible endoscopy in office
- DLB

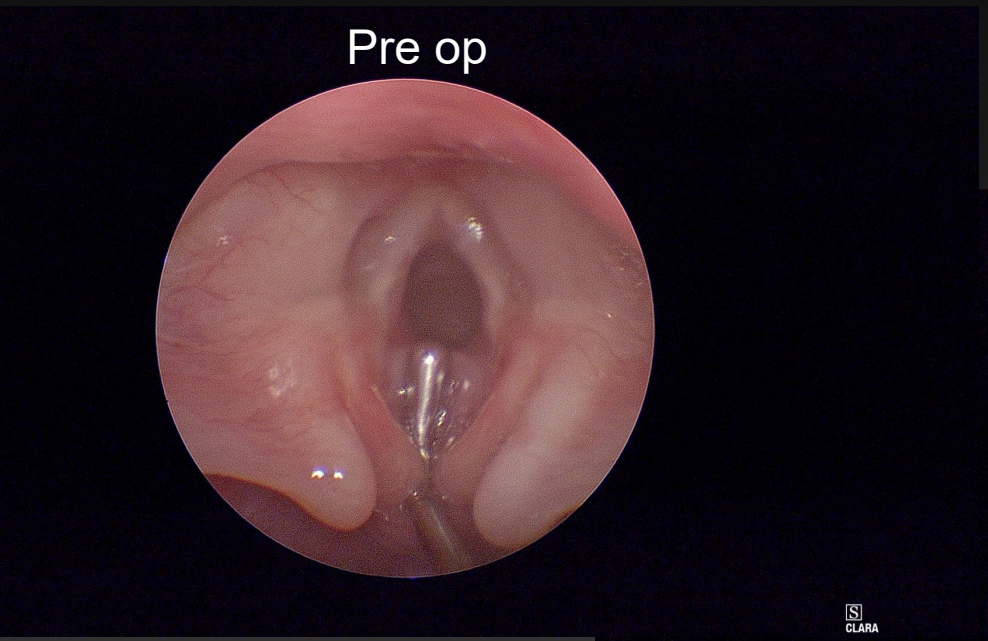
Ochsner Hospital for Children

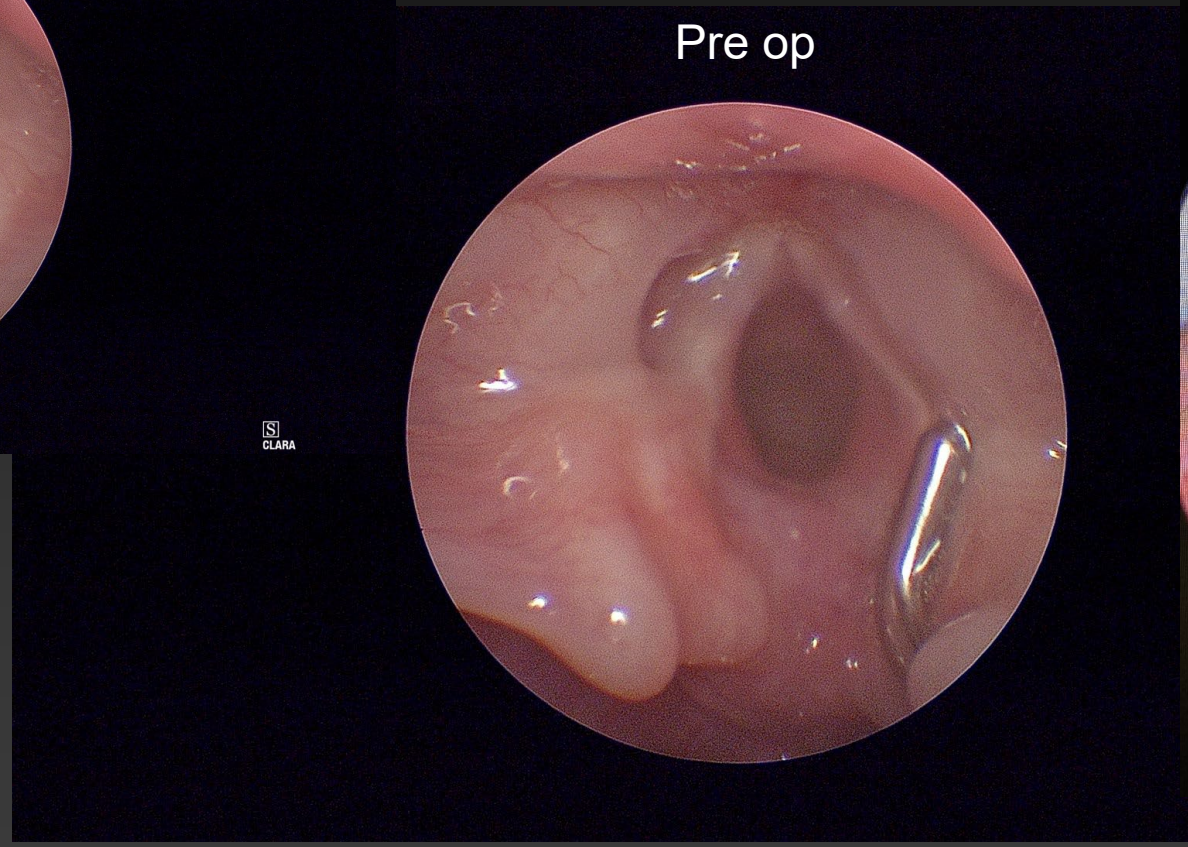
Case BP

- Flexible laryngoscopy



Case BP





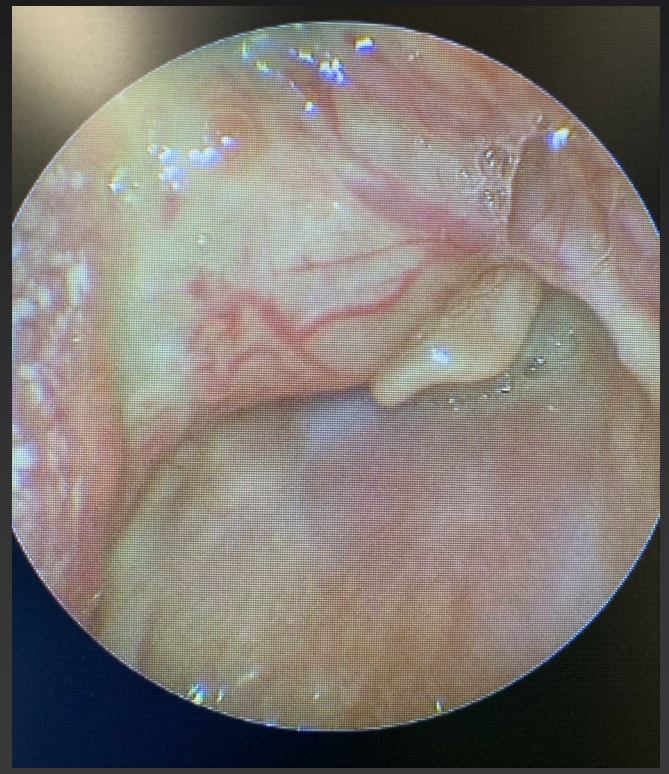
- Plan: endoscopic laryngeal cleft repair. Post-op MBSS, no aspiration

Ochsner Hospital for Children

Case TA

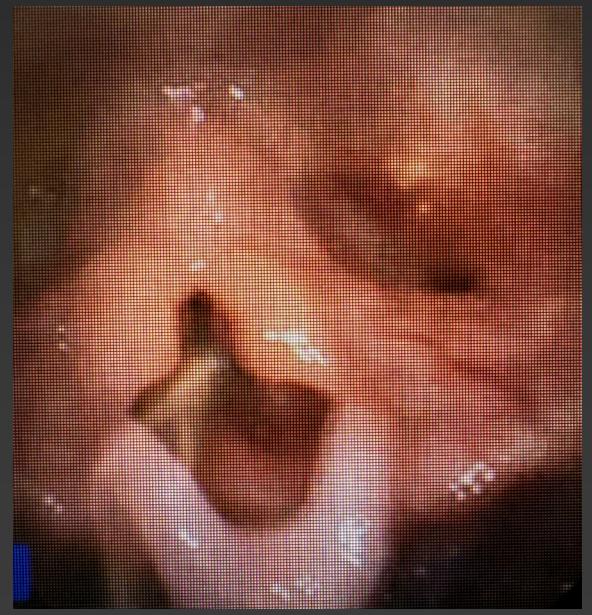
- 8 week old with noisy breathing
- Went to ER a few days prior, discharged with nasal saline

Case TA



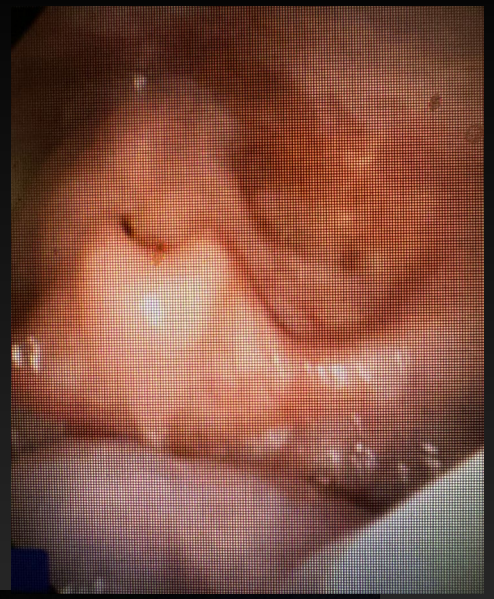
Base of tongue mass

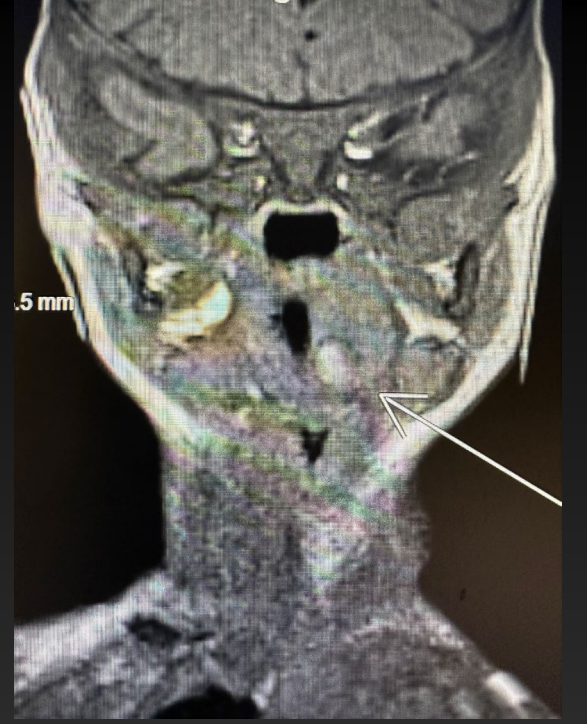
- 6 week old with FTT
- Stridor, inability to lie flat, severe reflux
- Congenital hypothyroidism

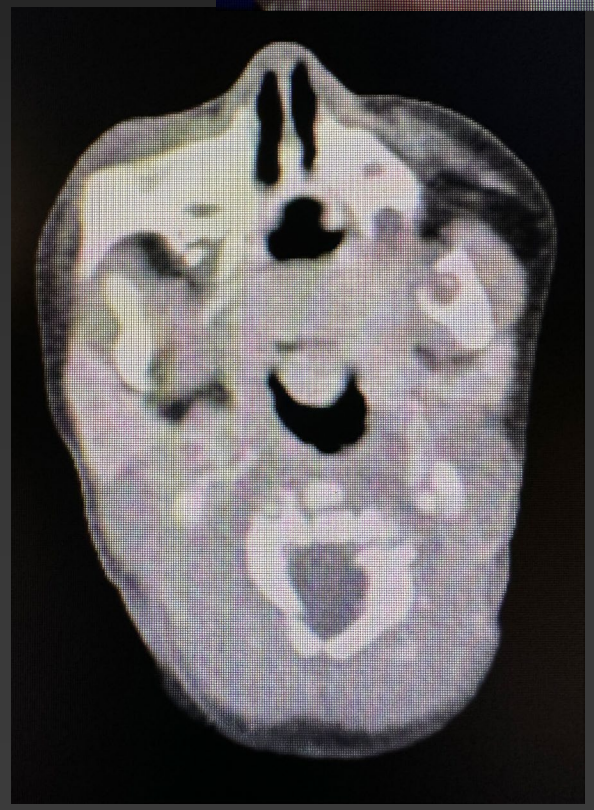


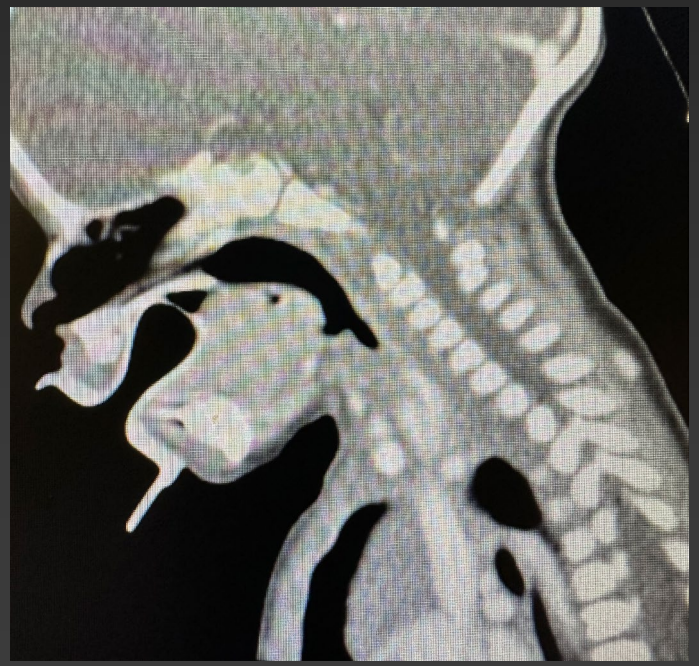
Base of tongue mass

- Workup -
  - thyroid US (no obvious thyroid tissue)
  - Tc-99 thyroid scan (no functional thyroid tissue)
  - MRI - mass present but distorted, could not tell if thyroid gland
  - CT - likely thyroid gland



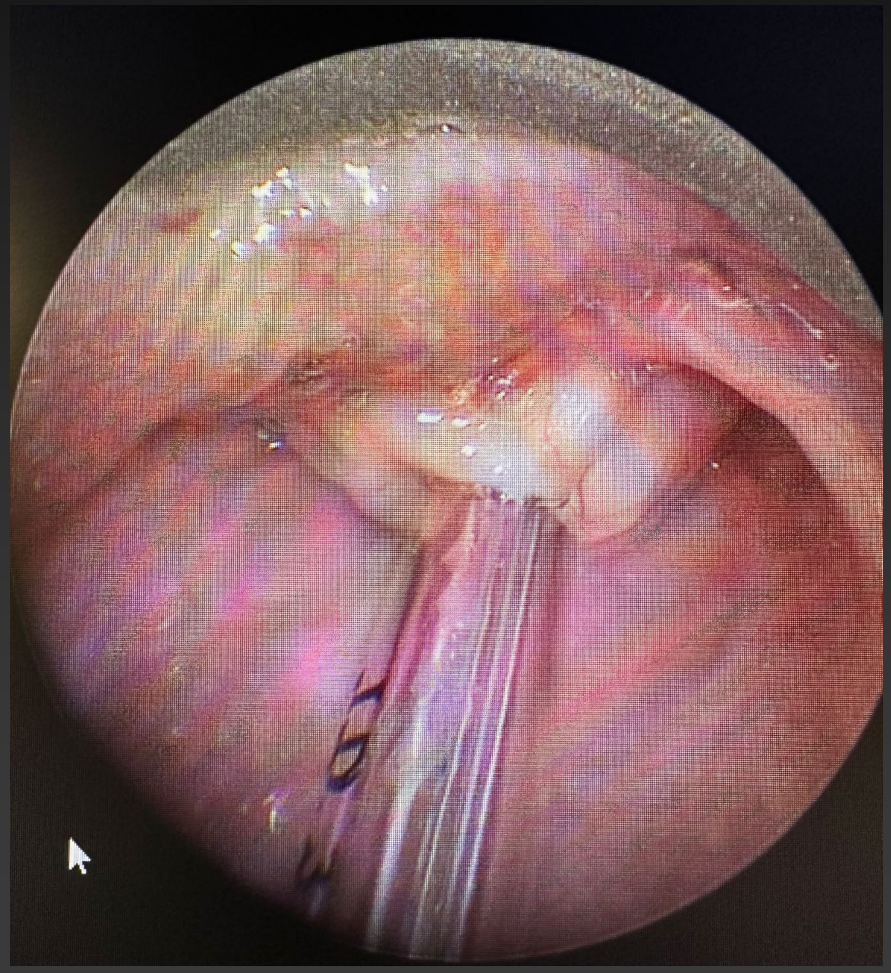


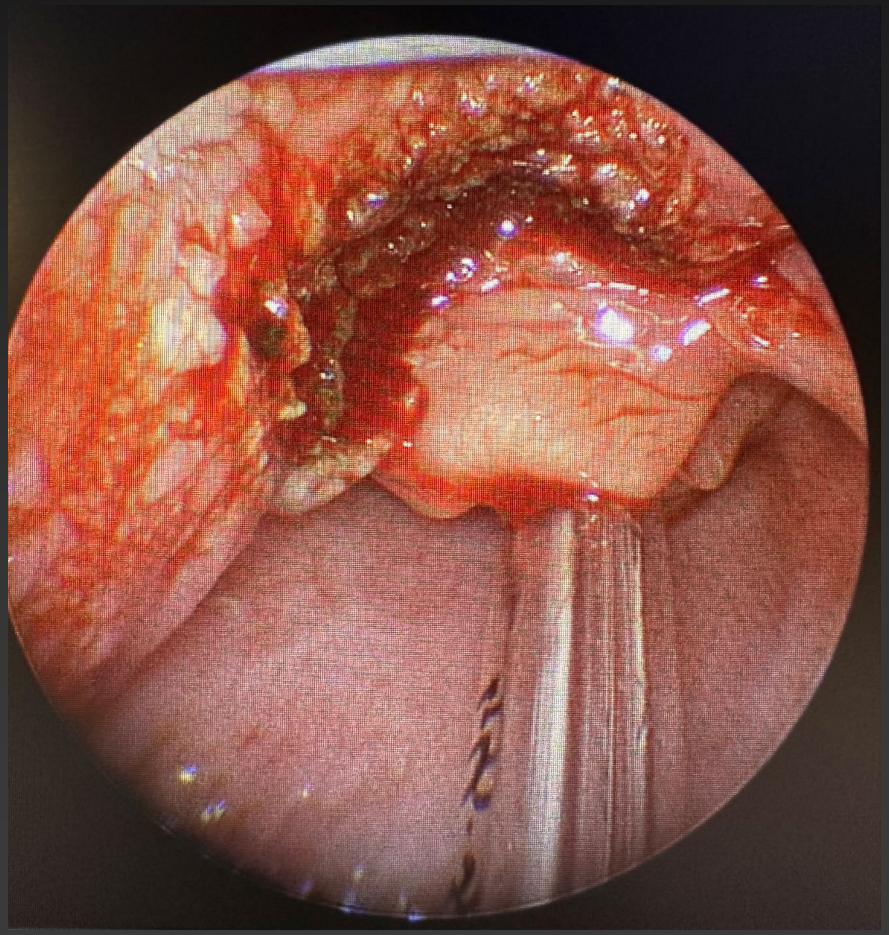




Lingual Thyroid Gland

- Path consistent with lingual thyroid
- Weight/FTT improved over next month
- Lifelong thyroid hormone



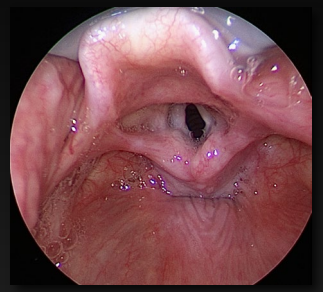


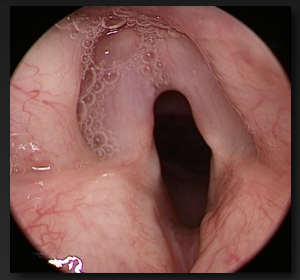
Case DS

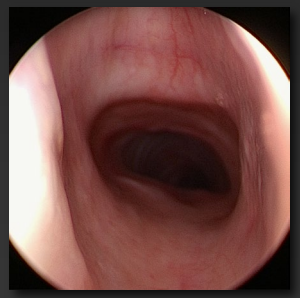
- 15 year old boy with CHARGE and longstanding dysphagia and aspiration. Always put fist to his throat and flexed neck when swallowed. Laryngeal cleft repair done 9/2020. Continued symptoms. Then found to have H-type TEF just below carina a few months after endoscopic cleft repair. Attempted bugbee cautery 2x and prolaryn injection around TEF.

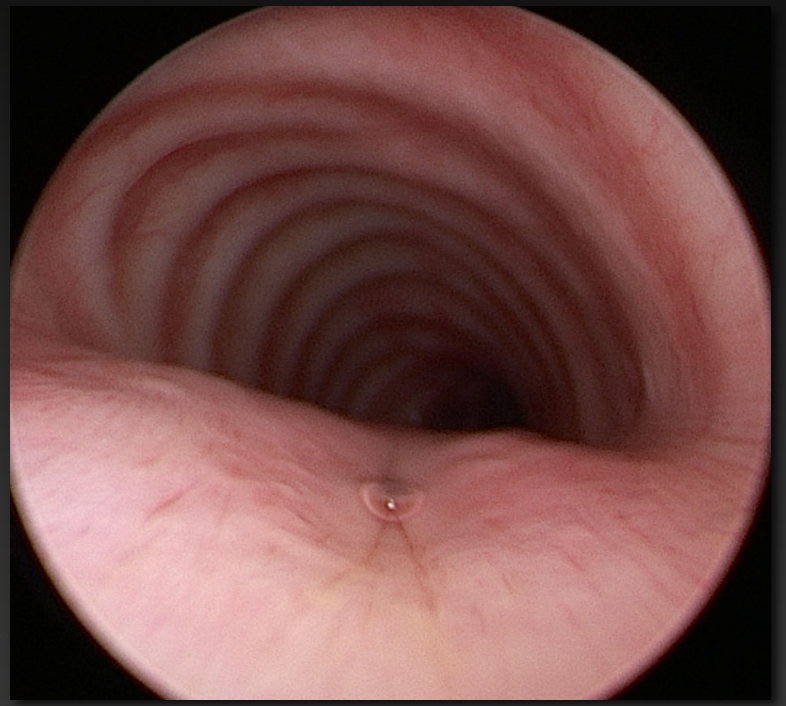
Ochsner Hospital for Children

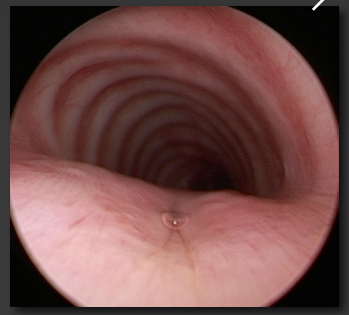
Case DS

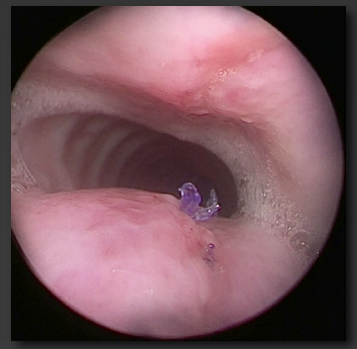


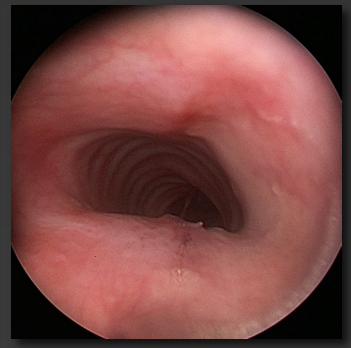


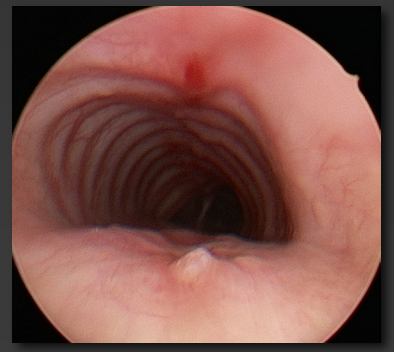












Pre Op

1 week post

2 wks post

3 mos post

Passed esophagram 1 week postop. Regular diet, including thin liquids.

Ochsner Hospital for Children

Aerodigestive Program

- Comprehensive multi-disciplinary care[3,4]
- Key people: ENT, Pulmonary, GI, Pediatric surgery, Speech language pathologists, Nutritionists, Social workers
- What conditions do we treat?

Aerodigestive Program

- ENT
- Subglottic stenosis
- Glottic stenosis
- Tracheal stenosis
- Vocal fold immobility
- Laryngomalacia
- Aspiration
- Laryngeal cleft
- Dysphonia

- Pulmonary
- Tracheobronchomalacia
- Bronchiectasis
- BPD
- Aspiration

- GI
- Dysphagia
- G-tube dependence
- Esophageal strictures
- Esophageal dysmotility
- FTT

Aerodigestive Program

- What are common goals of care?
- Tracheostomy decannulation
- Safer airways
- Coordinated care

Aerodigestive Program

- https://www.ochsner.org/services/pediatric-aerodigestive-care
- Coordinator phone: 504-842-4983

References

1. Hart CK, de Alarcon A, Tabangin ME, et al. Impedance probe testing prior to pediatric airway reconstruction. *Ann Otol Rhinol Laryngol.* 2014 Sep;123(9):641-6.
2. Carratola MC, Kennedy AK, Talat R, Tabangin M, Rutter MJ, de Alarcon A, Smith MM, Myer IV CM, Torres-Silva CA, Hart CK. Utility of Bronchoalveolar lavage prior to airway reconstruction. Presentation. Combined Otolaryngology Spring Meetings, ASPO, May 2021.
3. Boesch RP, Balakrishnan K, Arca S, et al. Structure and function of pediatric aerodigestive programs: a consensus statement. *Pediatrics*. 2018;141(2):e20171701.
4. Ruiz AG, Bhatt JM, DeBoer EM, et al. Demonstrating the benefits of a multidisciplinary aerodigestive program. *Laryngoscope*. 2020 Feb;130(2):521-5.
5. Rutter MJ, Hart CK, de Alarcon A, et al. Endoscopic anterior-posterior cricoid split for pediatric bilateral vocal fold paralysis. *Laryngoscope*. 2018 Jan;128(1):257-63.


I got 99
problems
but a TRACH
ain't one!