Surgical Options in Tracheal Stenosis

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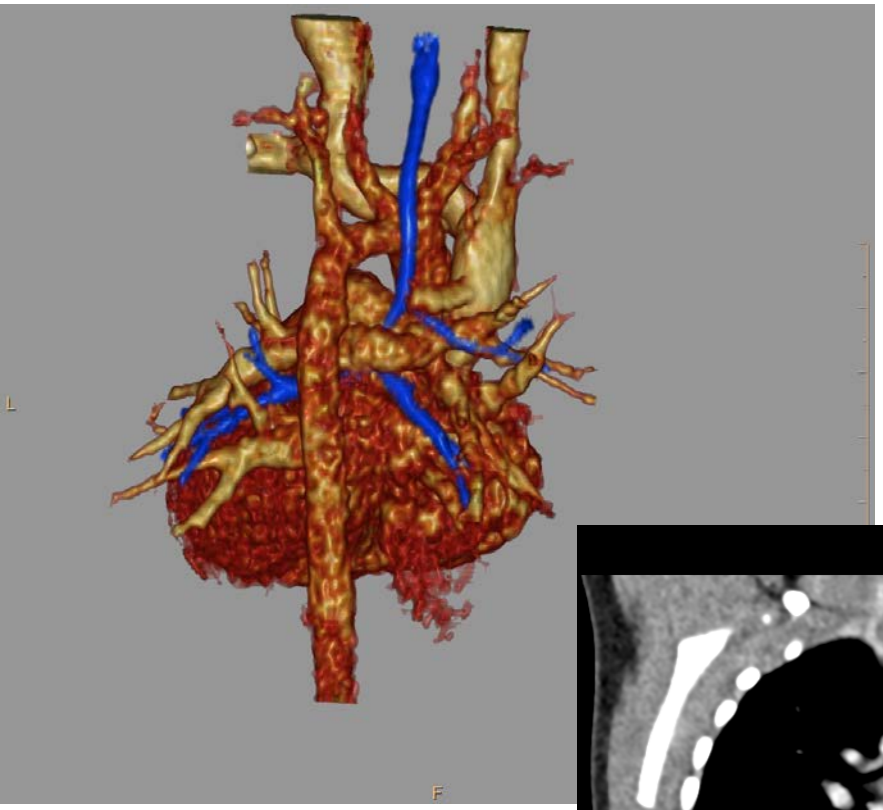
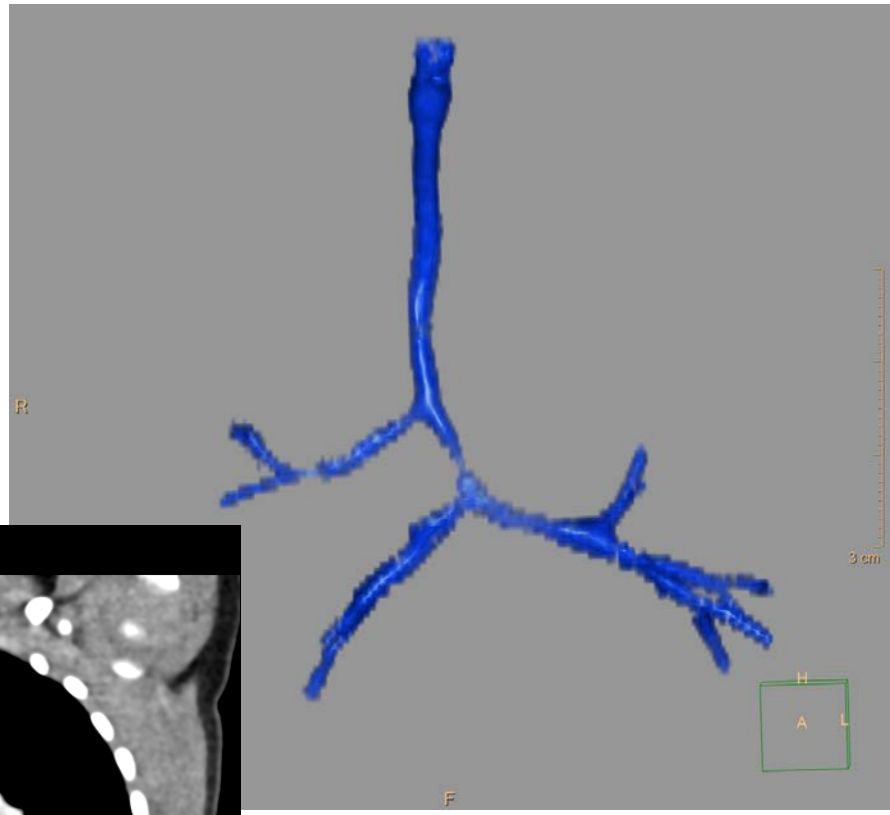
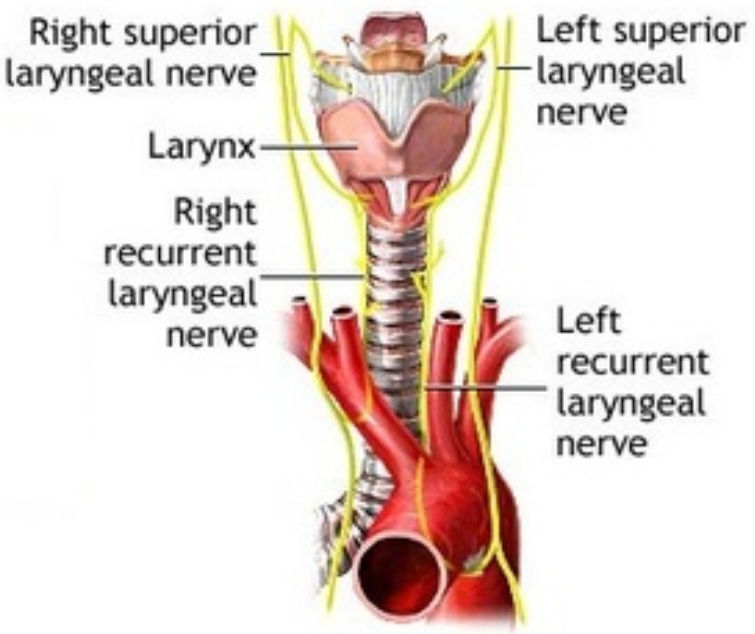
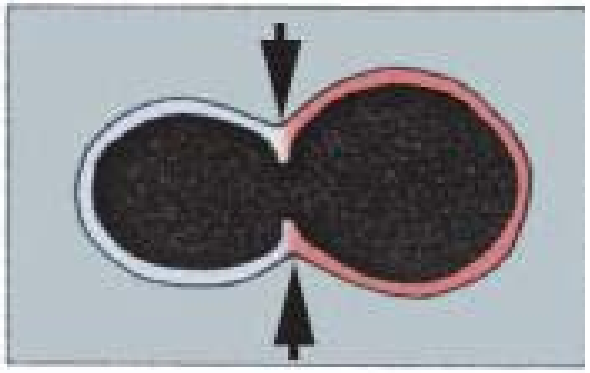
Introduction

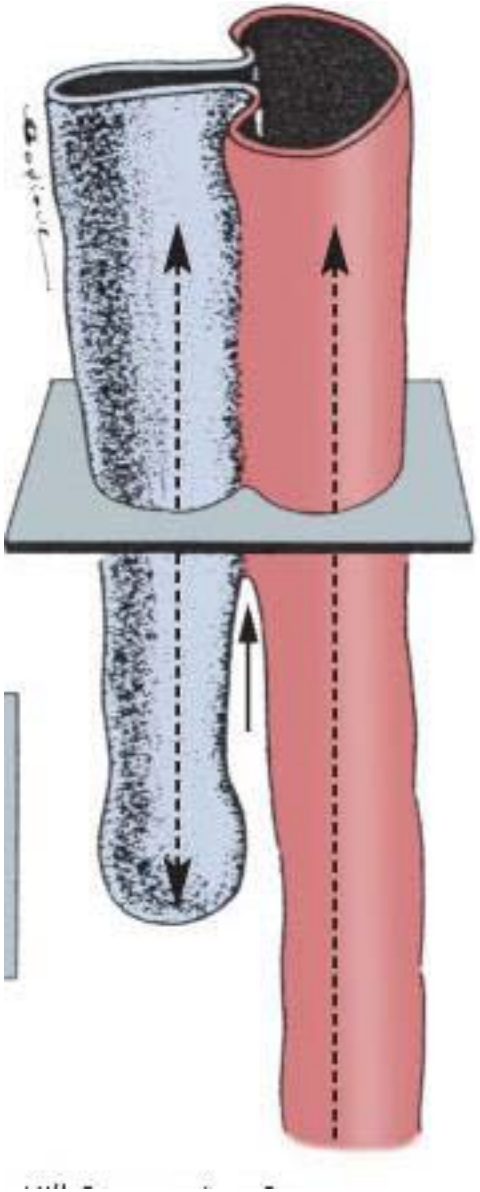


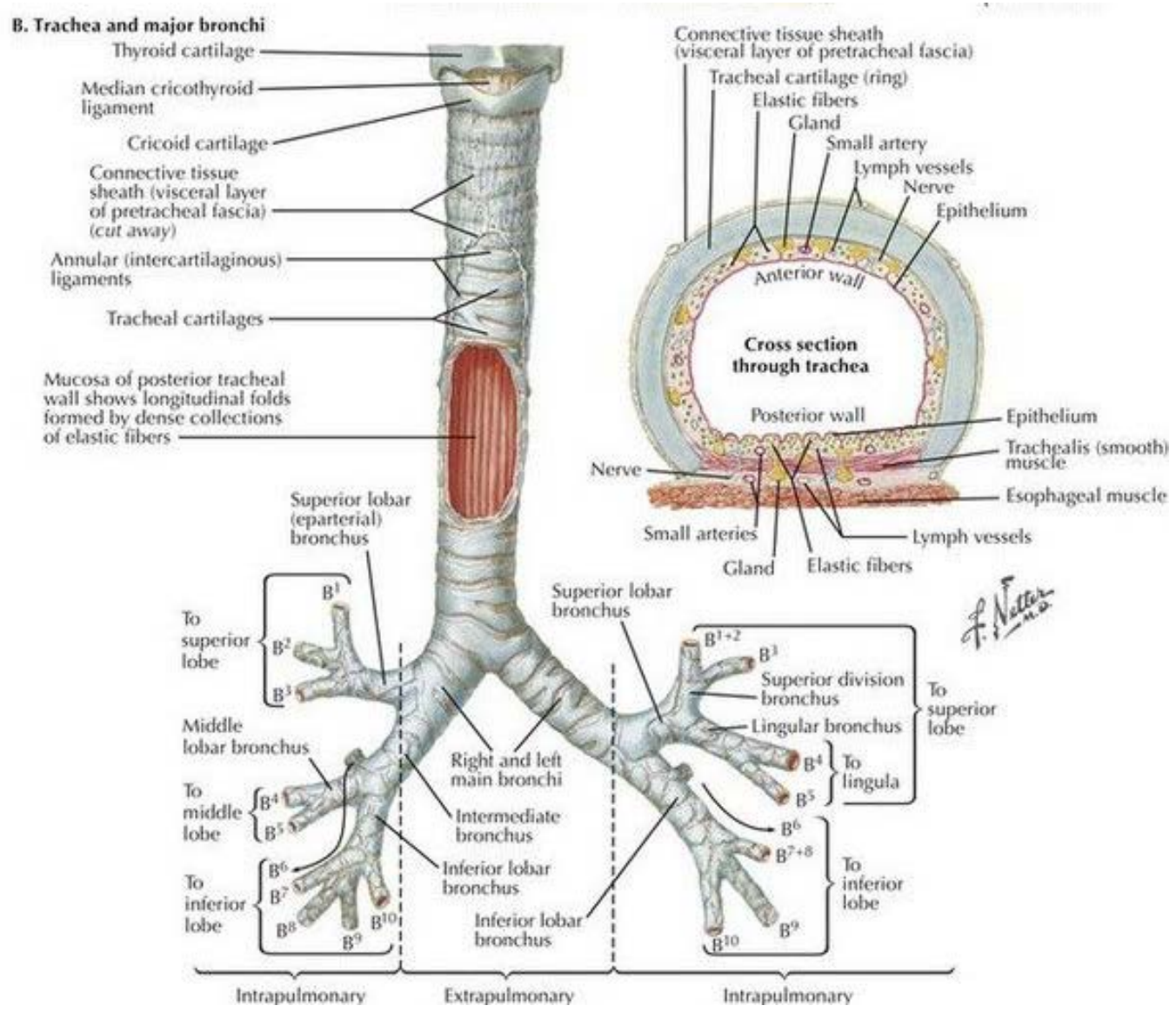


Anatomy of the Trachea



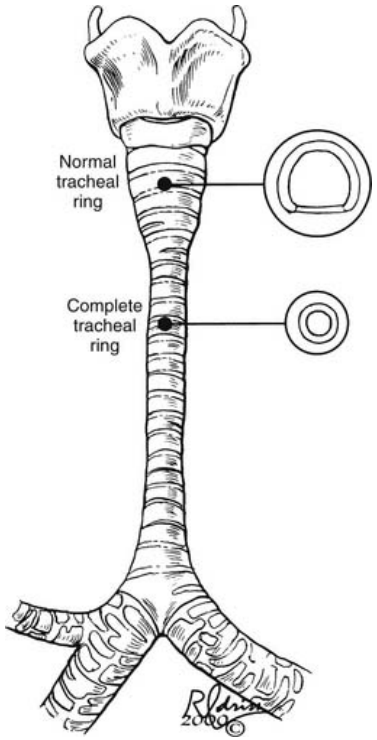


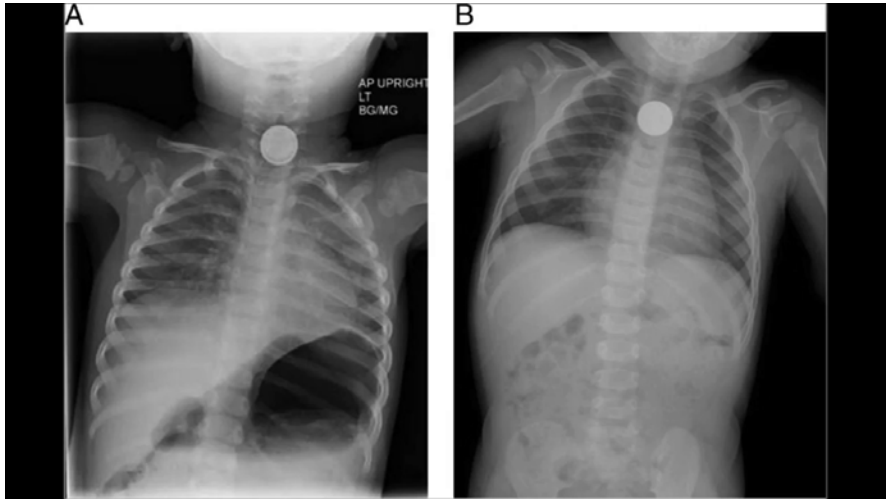



B. Trachea and major bronchi
Thyroid cartilage
Median cricothyroid ligament
Cricoid cartilage
Connective tissue sheath (visceral layer of pretracheal fascia) (cut away)
Annular (intercartilaginous) ligaments
Tracheal cartilages
Mucosa of posterior tracheal wall shows longitudinal folds formed by dense collections of elastic fibers
Connective tissue sheath (visceral layer of pretracheal fascia)
Tracheal cartilage (ring)
Elastic fibers
Gland
Small artery
Lymph vessels
Nerve
Epithelium
Anterior wall
Cross section through trachea
Posterior wall
Epithelium
Trachealis (smooth) muscle
Nerve
Esophageal muscle
Small arteries
Lymph vessels
Gland
Elastic fibers
Superior lobar (eparterial) bronchus
Superior lobar bronchus
To superior lobe
Middle lobar bronchus
To middle lobe
To inferior lobe
Right and left main bronchi
Intermediate bronchus
Inferior lobar bronchus
Inferior lobar bronchus
Superior division bronchus
Lingular bronchus
To lingula
To superior lobe
To inferior lobe
Intrapulmonary
Extrapulmonary
Intrapulmonary

Ethiology tracheal stenosis

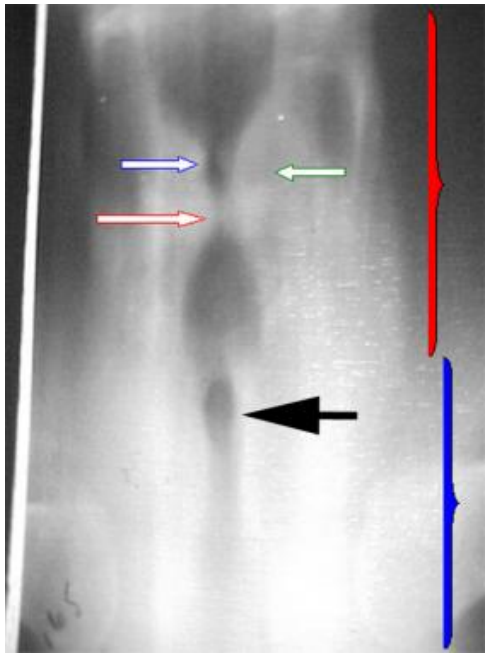
- Congenital
  - Complete rings
  - TE-fistulas
  - Compression
- Acquired
  - Trauma
  - Tumor
  - Intubation
  - Battery ingestion
- Associated lesions
  - Cardiac defects
  - Vascular
  - Genetics

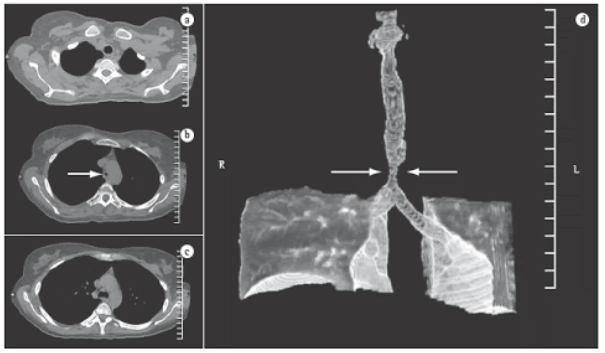


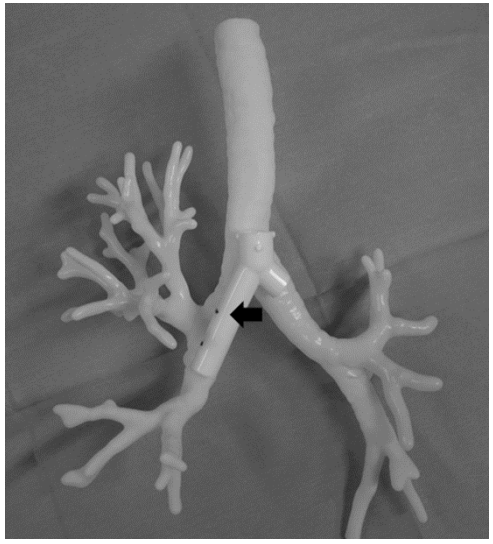


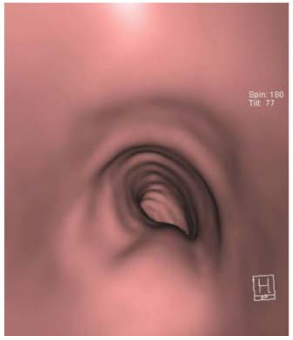
Diagnosis

- X-ray
- CT scan
- Endoscopy
- Functional testing
- 3D printing
- Virtual reality









Surgical Options Tracheal Stenosis

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{dy}+w\frac{\partial u}{\partial z}\right)=$$

$$\rho g_x-\frac{\partial p}{\partial x}+\frac{\partial}{\partial x}\left[2\mu\frac{\partial u}{\partial x}+\lambda\nabla\cdot\mathbf{V}\right]+\frac{\partial}{\partial y}\left[\mu\left(\frac{\partial u}{\partial y}+\frac{\partial v}{\partial x}\right)\right]+\frac{\partial}{\partial z}\left[\mu\left(\frac{\partial w}{\partial x}+\frac{\partial u}{\partial z}\right)\right]$$

$$\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{dy}+w\frac{\partial v}{\partial z}\right)=$$

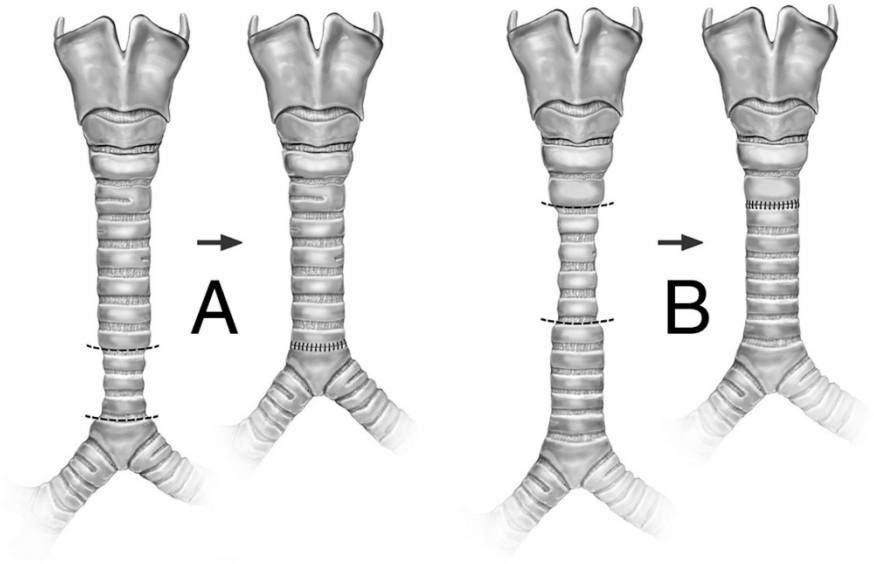
$$\rho g_y-\frac{\partial p}{\partial y}+\frac{\partial}{\partial y}\left[2\mu\frac{\partial v}{\partial y}+\lambda\nabla\cdot\mathbf{V}\right]+\frac{\partial}{\partial z}\left[\mu\left(\frac{\partial v}{\partial z}+\frac{\partial w}{\partial y}\right)\right]+\frac{\partial}{\partial x}\left[\mu\left(\frac{\partial u}{\partial y}+\frac{\partial v}{\partial x}\right)\right]$$

$$\rho\left(\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial x}+v\frac{\partial w}{dy}+w\frac{\partial w}{\partial z}\right)=$$

$$\rho g_z-\frac{\partial p}{\partial z}+\frac{\partial}{\partial z}\left[2\mu\frac{\partial w}{\partial z}+\lambda\nabla\cdot\mathbf{V}\right]+\frac{\partial}{\partial x}\left[\mu\left(\frac{\partial w}{\partial x}+\frac{\partial u}{\partial z}\right)\right]+\frac{\partial}{\partial y}\left[\mu\left(\frac{\partial v}{\partial z}+\frac{\partial w}{\partial y}\right)\right]$$

- Resection, ETE anastomosis
- Patch plasty
- Sliding tracheoplasty
- Graft interposition
- Stenting

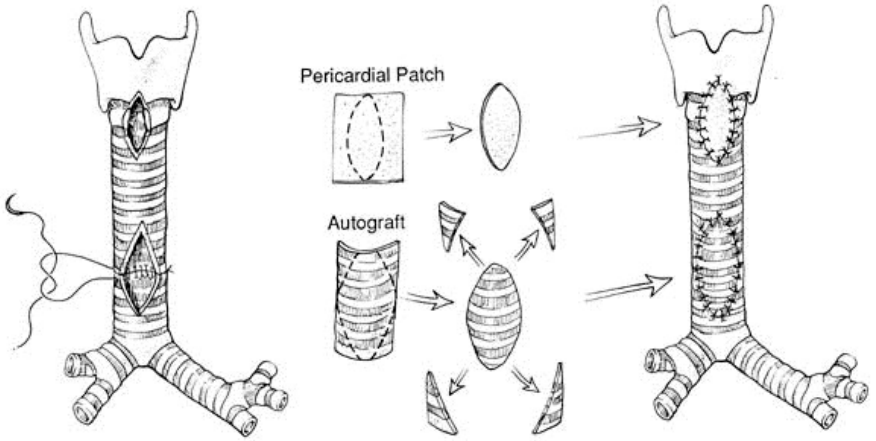
Resection and Anastomosis



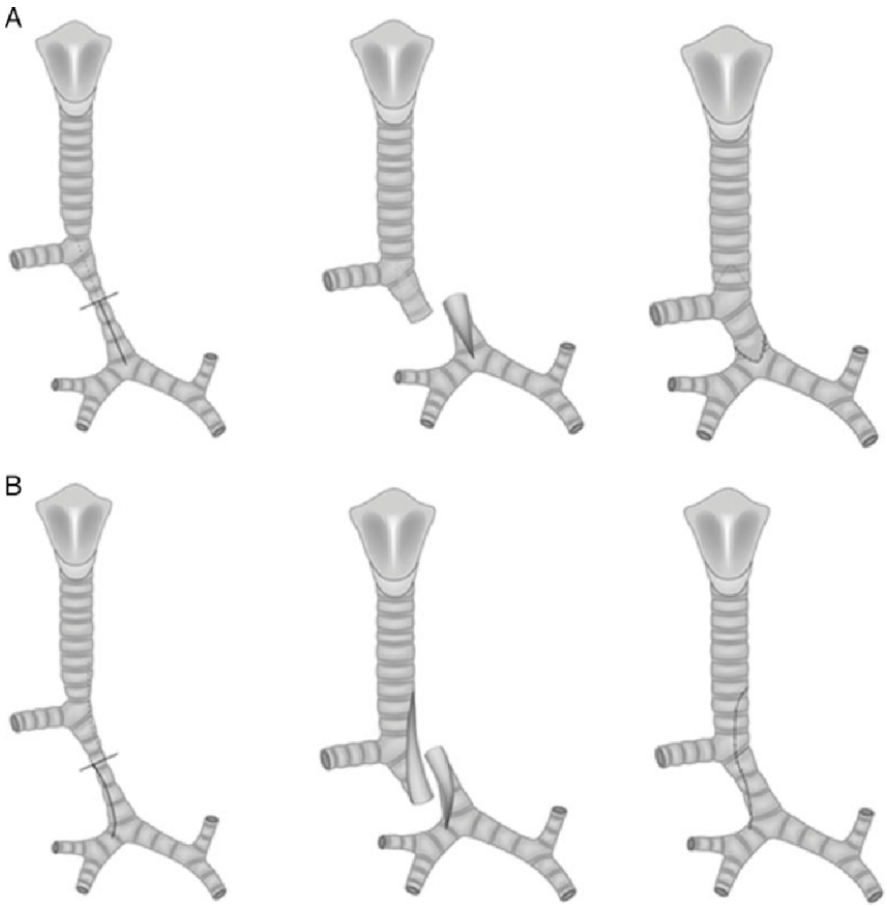
- Relatively easy
- Short segments only
- Outgrowth satisfactory
- Tension on anastomosis
- Chin-sternal fixation
- External fixation

Patch plasty

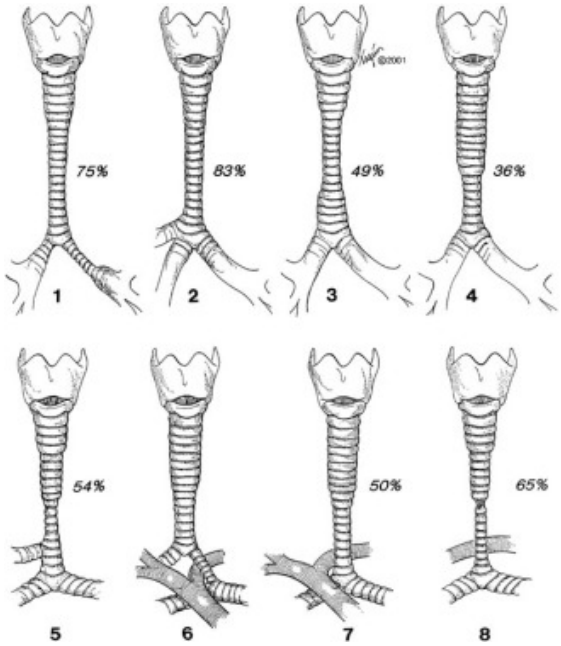
- Which material?
- Support
- Infection
- Necrosis
- Malacia



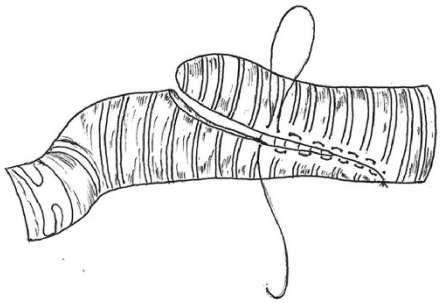
Sliding Tracheoplasty

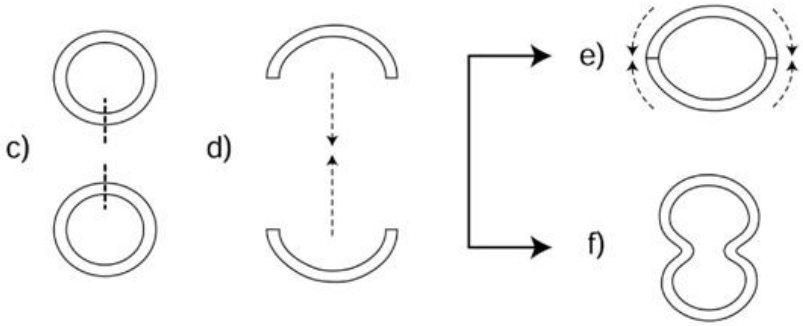


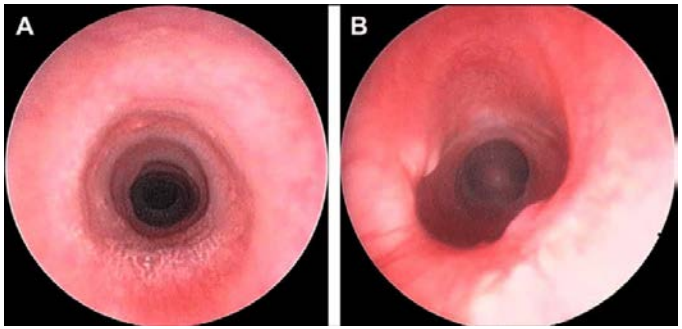
- Most used Technique
- Long segments
- Combination with patch
- Challeging cases

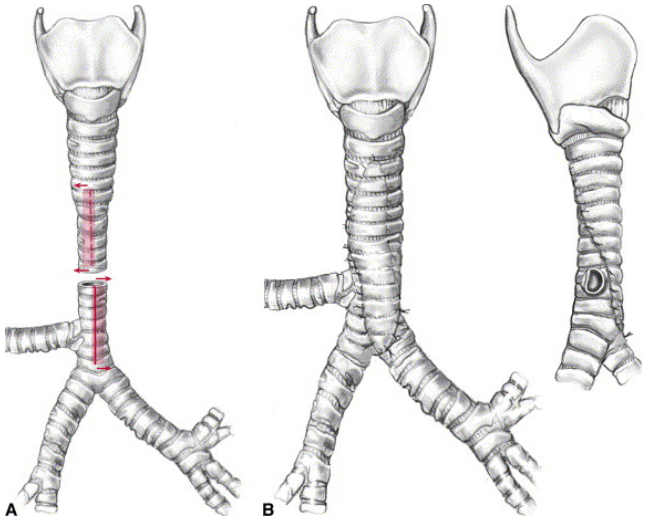


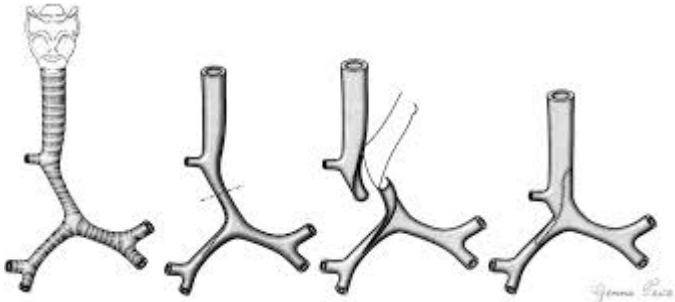
Sliding tracheoplasty





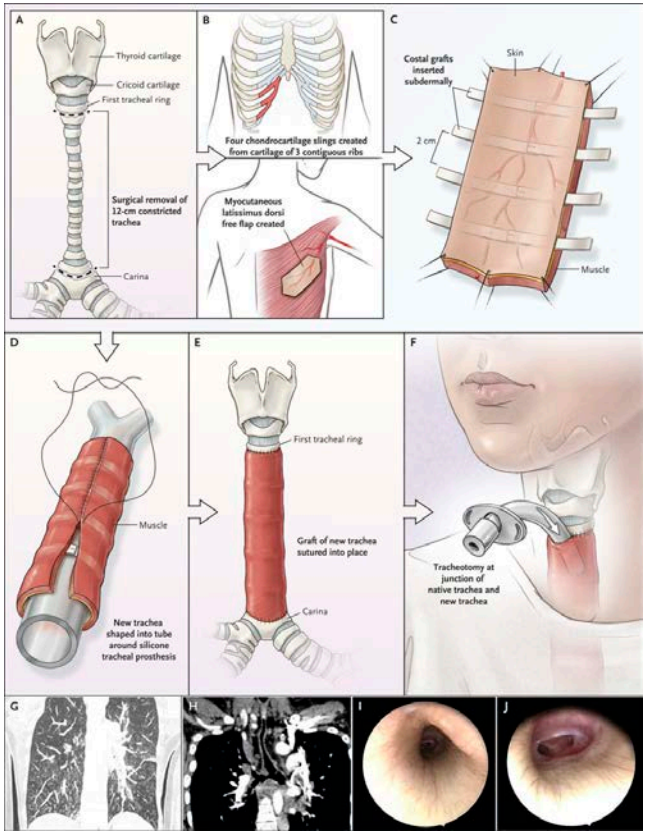




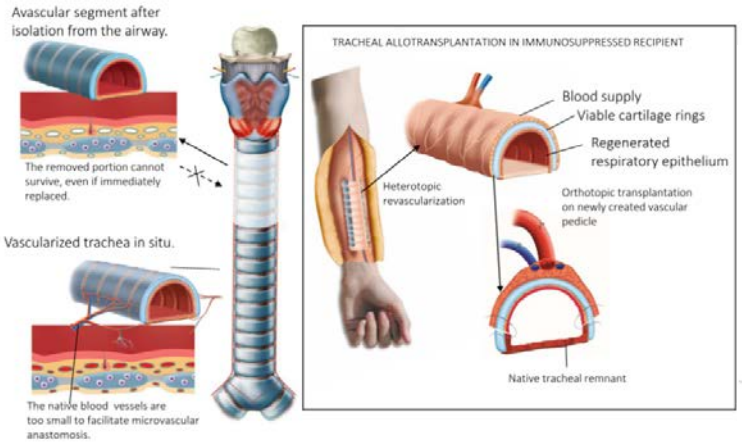


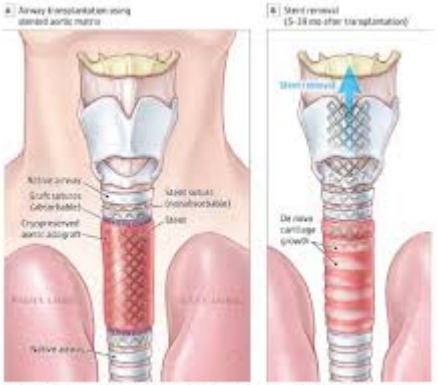
Graft Interposition

- Allograft vessel
- Cartilage graft
- Tracheal transplantation
  - Vascularization
  - Outgrowth
  - Sputum transport



The trachea: one of the most complex organs to transplant





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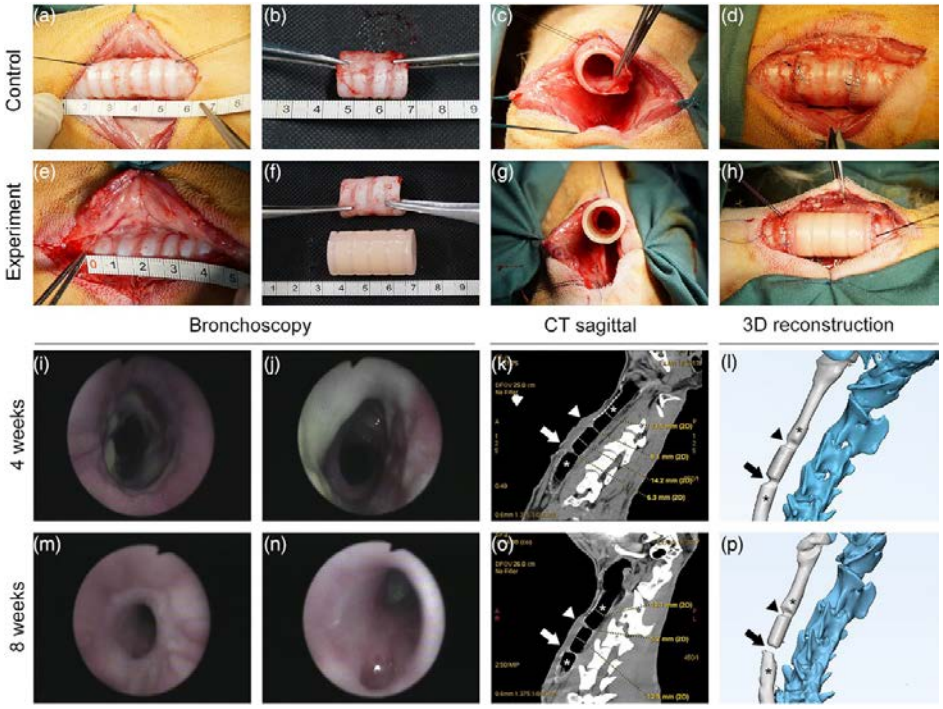
Tissue engineering

Tissue-engineered trachea from a 3D-printed scaffold enhances whole-segment tracheal repair in a goat model

Dekai Xia, Dawei Jin, Qian Wang, Manchen Gao, Jialing Zhang, Hengyi Zhang, Jie Bai, Bei Feng, Maolin Chen, Yanhui Huang, Yumin Zhong, Nevin Witman, Wei Wang, Zhiwei Xu, Haibo Zhang, Meng Yin, Wei Fu ... See fewer authors

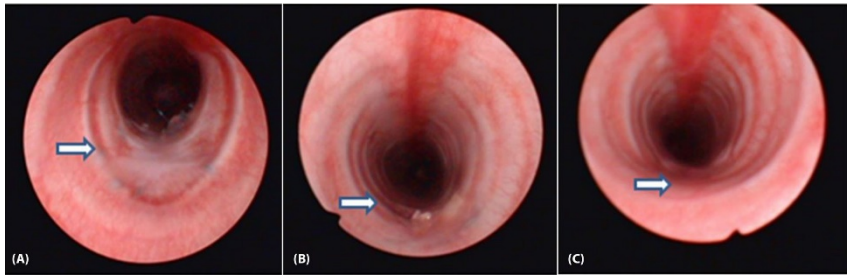
First published:22 February 2019 | https://doi.org/10.1002/term.2828 | Citations: 1



Pig tracheal patchy xenotransplantation in the dog

Tae-Ki Lee, Jong-Min Kim, Seok Hwa Choi

First published:17 August 2018 | https://doi.org/10.1111/xen.12452



Tracheal Stenting

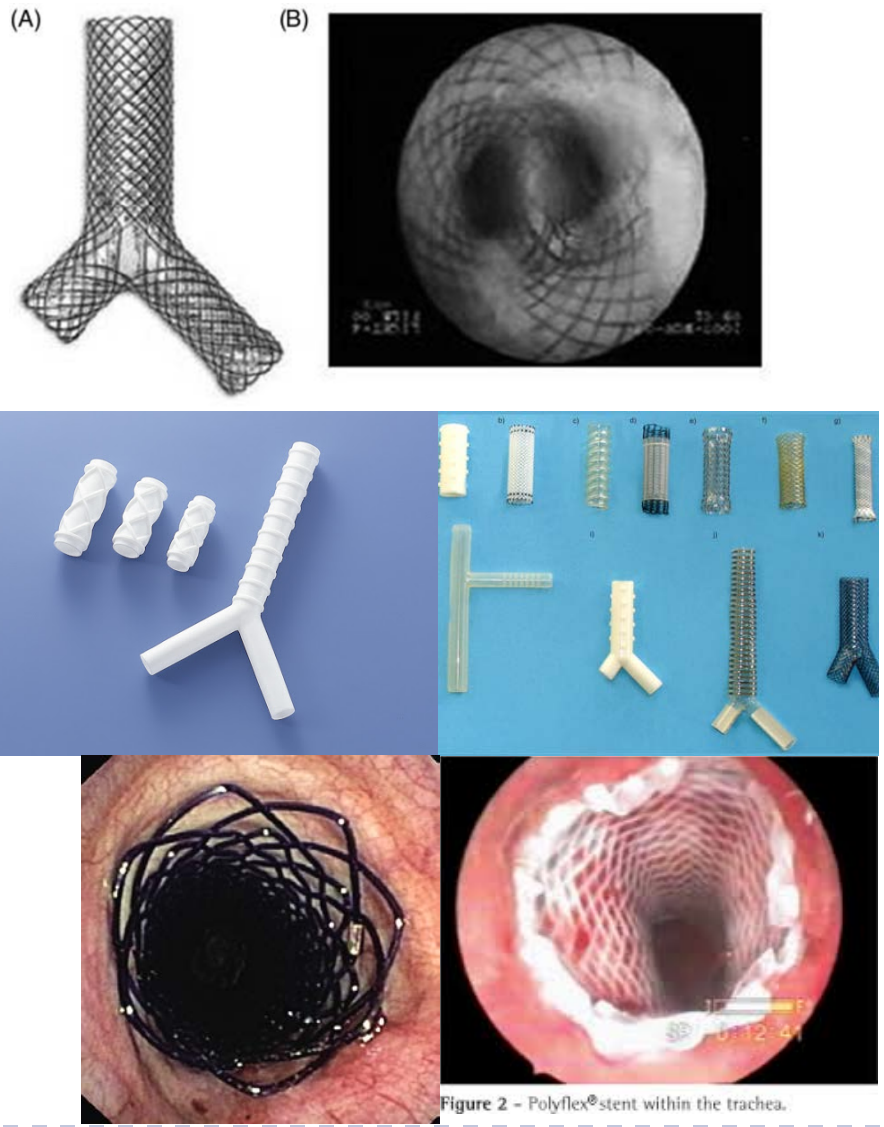
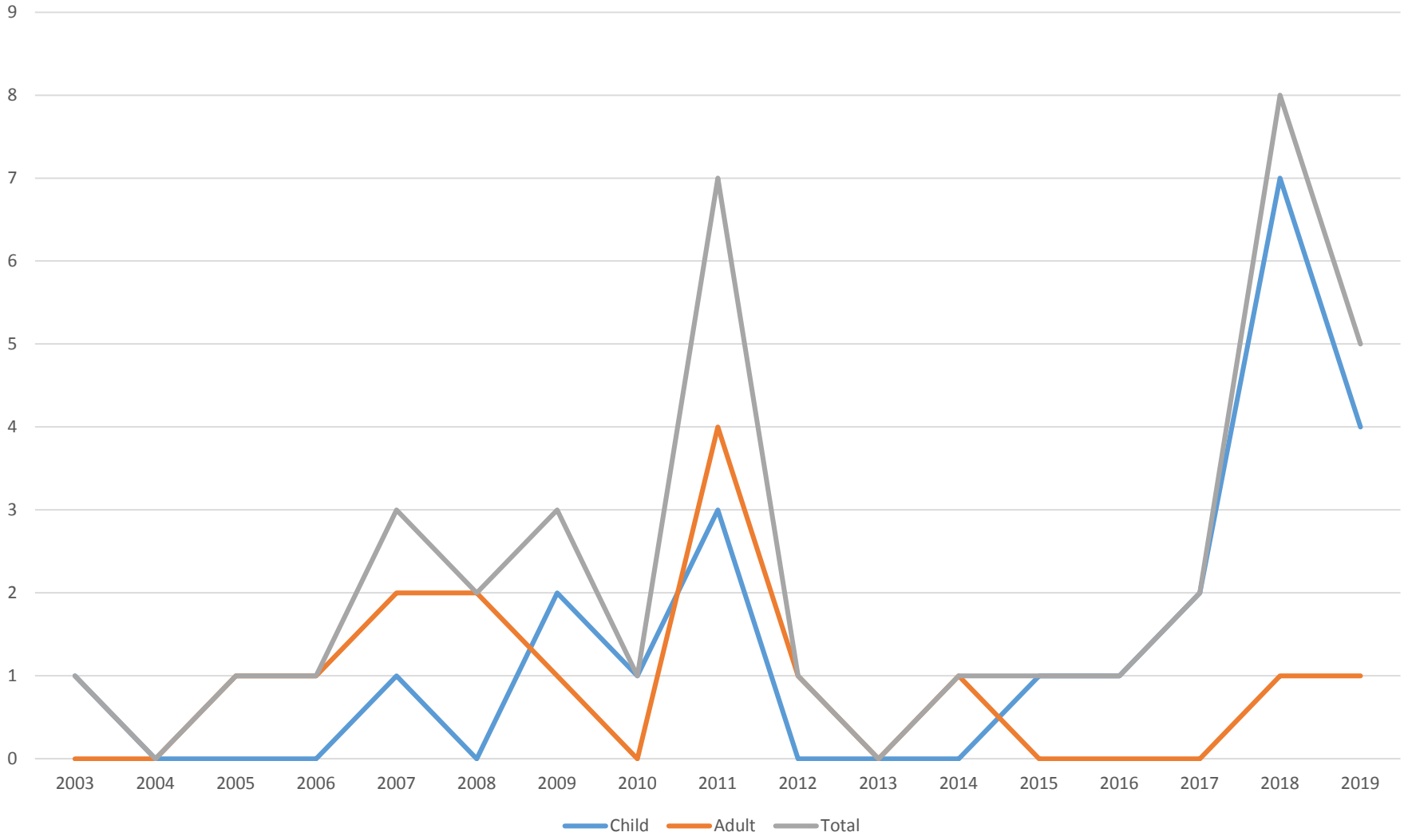


Figure 2 – Polyflex® stent within the trachea.

- Different types of stents
  - Metal
  - Silicon
  - Biodegradable
  - Self-expanding
- Outgrowth in children
- Necrosis
- Migration
- Infection
- Complementary to other techniques
- Bail out

Tracheal Reconstruction in Rotterdam

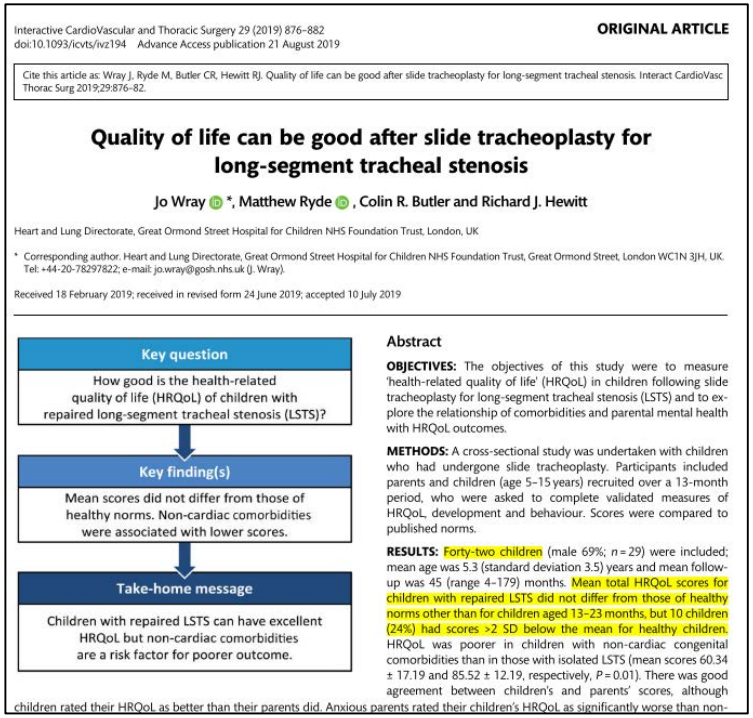


Results

- 31 Patients 33 Procedures
  - Male 19
  - Children 18
  - Median age 8y
- Surgery
  - Partial resection 2
  - Patch plasty 2
  - End-to-end anastomosis 27
    - Sliding plasty 15
  - ECC needed 18
- Survival 94%
  - Complications 35%

Literature

- Postoperative mortality 6-14%
- Frequent balloondilation
- Bad outcome in bronchus stenosis, preop ECMO and preop malacia
- Quality of life comparable with controls
- Prolonged ventilation related to concommitant procedures, age and weight
- Hospital stay associated with preop ventilation and smaller airways
- Stenting bail out option



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ORIGINAL ARTICLE

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Quality of life can be good after slide tracheoplasty for long-segment tracheal stenosis

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Key question

How good is the health-related quality of life (HRQoL) of children with repaired long-segment tracheal stenosis (LSTS)?

Key finding(s)

Mean scores did not differ from those of healthy norms. Non-cardiac comorbidities were associated with lower scores.

Take-home message

Children with repaired LSTS can have excellent HRQoL but non-cardiac comorbidities are a risk factor for poorer outcome.

Abstract

OBJECTIVES: The objectives of this study were to measure 'health-related quality of life' (HRQoL) in children following slide tracheoplasty for long-segment tracheal stenosis (LSTS) and to explore the relationship of comorbidities and parental mental health with HRQoL outcomes.

METHODS: A cross-sectional study was undertaken with children who had undergone slide tracheoplasty. Participants included parents and children (age 5–15 years) recruited over a 13-month period, who were asked to complete validated measures of HRQoL, development and behaviour. Scores were compared to published norms.

RESULTS: Forty-two children (male 69%; *n* = 29) were included; mean age was 5.3 (standard deviation 3.5) years and mean follow-up was 45 (range 4–179) months. Mean total HRQoL scores for children with repaired LSTS did not differ from those of healthy norms other than for children aged 13–23 months, but 10 children (24%) had scores >2 SD below the mean for healthy children. HRQoL was poorer in children with non-cardiac congenital comorbidities than in those with isolated LSTS (mean scores 60.34 ± 17.19 and 85.52 ± 12.19, respectively, *P* = 0.01). There was good agreement between children's and parents' scores, although children rated their HRQoL as better than their parents did. Anxious parents rated their children's HRQoL as significantly worse than non-

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Manning, P. B., et al. (2008). "Slide tracheoplasty in infants and children: risk factors for prolonged postoperative ventilatory support." Ann Thorac Surg **85**(4): 1187-1191; discussion 1191-1182.

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Summery

- Complete rings are rare but challenging
- Check for associated lesions and genetics
- Teamwork is needed, ENT, pulmonologist, pediatric cardiology, imaging, general surgery, ECMO, etc
- Sliding tracheoplasty best option also for long segment lesions
- Stenting sometimes necessary, restrictive in children
- Building experience by concentrating cases to dedicated teams
- Thank you!