

# Subglottic Stenosis and Cricotracheal Resection/ The Toronto General Experience and Approach

Dr Ralph W Gilbert MD, FRCSC

Gullane/O'Neil Chair of Otolaryngology/H&N Surgery University Health Network  
Department of Otolaryngology/Head and neck University of Toronto

Wharton Head and Neck Centre



Presented by the Division of Thoracic Surgery,  
Department of Surgery, University of Toronto



Surgery  
UNIVERSITY OF TORONTO

48<sup>th</sup> Annual

Toronto Thoracic Surgery Refresher Conference

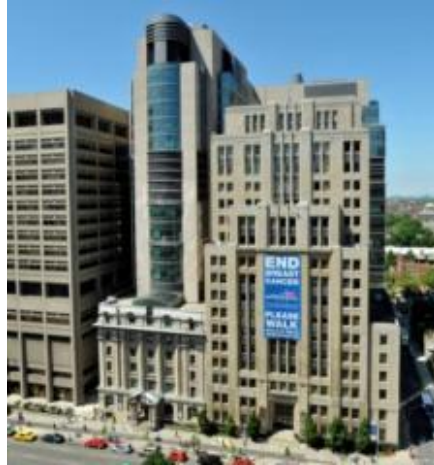
June 7 - 8, 2024 | Windsor Arms Hotel, 18 St. Thomas Street



# University Health Network



Princess Margaret Hospital



# UHN

Toronto General  
Toronto Western  
Princess Margaret  
Toronto Rehab

**COURAGE LIVES HERE**

# Purpose of the Presentation



Princess Margaret Hospital

Review of the History of CTR and airway surgery at UHN/TGH

Review the Classification/Etiology and Management of Subglottic Stenosis

Illustrate our current technique for CTR

Review our most recent outcome data

Present some new concepts in complex airway reconstruction

# History



Princess Margaret Hospital

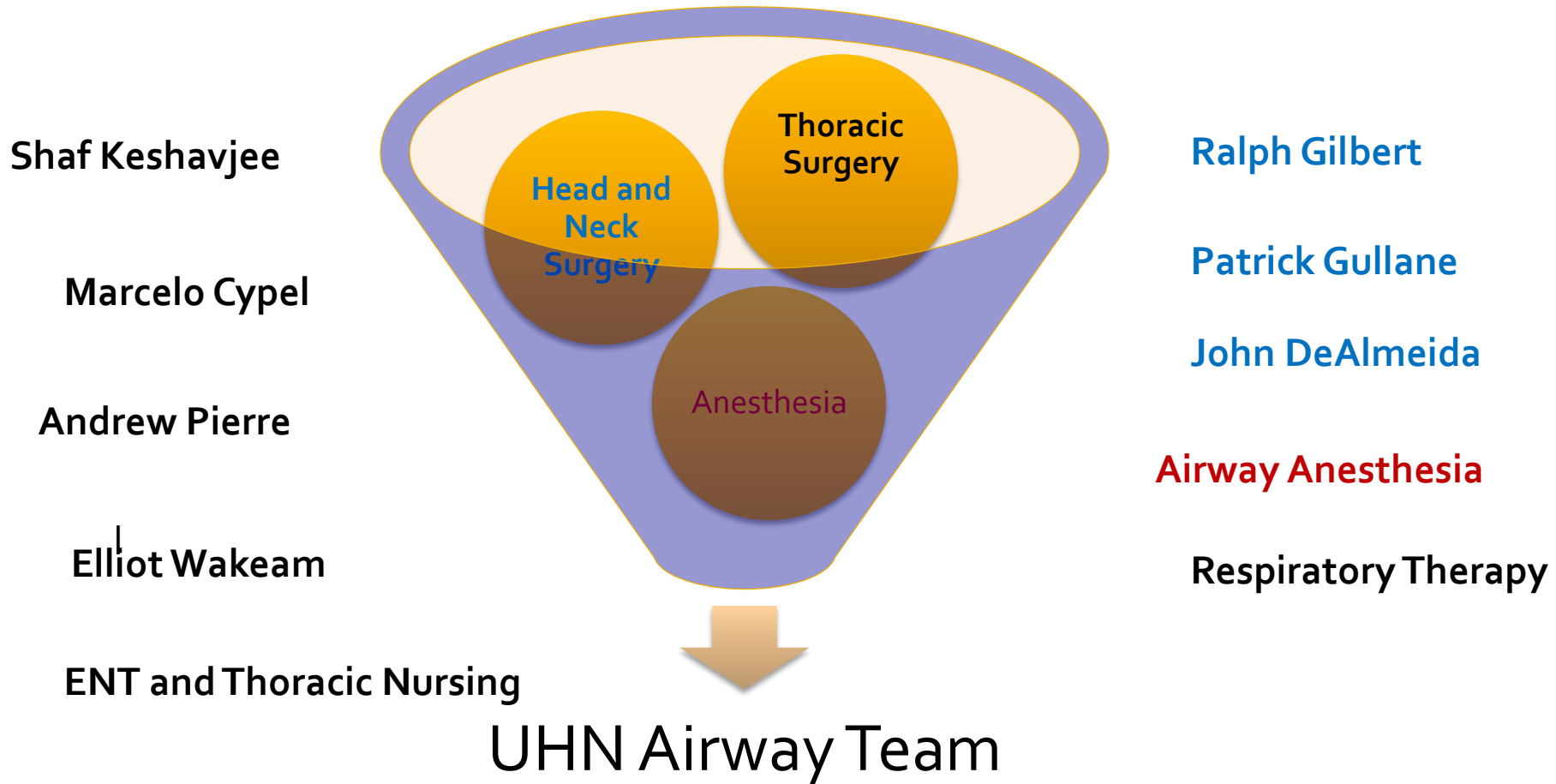
- Airway reconstruction at Toronto General Hospital
  - 50 year history
    - (Bryce, Pearson,)
  - Along with Grillo popularized



# UHN Airway Team













Princess Margaret Hospital



# Classification of Subglottic Stenosis



Princess Margaret Hospital

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

Myer/Cotton Classification

# Subglottic Stenosis-Etiology



Princess Margaret Hospital

Trauma(Intubation/Other)

```
graph TD; A[Trauma(Intubation/Other)] --> B[Idiopathic iSGS]; B --> C[Auto Immune]
```

Idiopathic iSGS

Auto Immune

# Idiopathic SGS-Etiology-Unknown



Princess Margaret Hospital

95% of patients are perimenopausal or menopausal females-Is there a relation to Estrogen or other Hormonal etiology

Inflammatory condition of subglottis appears to be a role of regulators of inflammation including dysregulation of T cells, evidence that IL-27 and IL 17A upregulated

Mediators and Regulation of Inflammation including upregulation of PD-1 and CD4+ Tcells



# Autoimmune Disorders



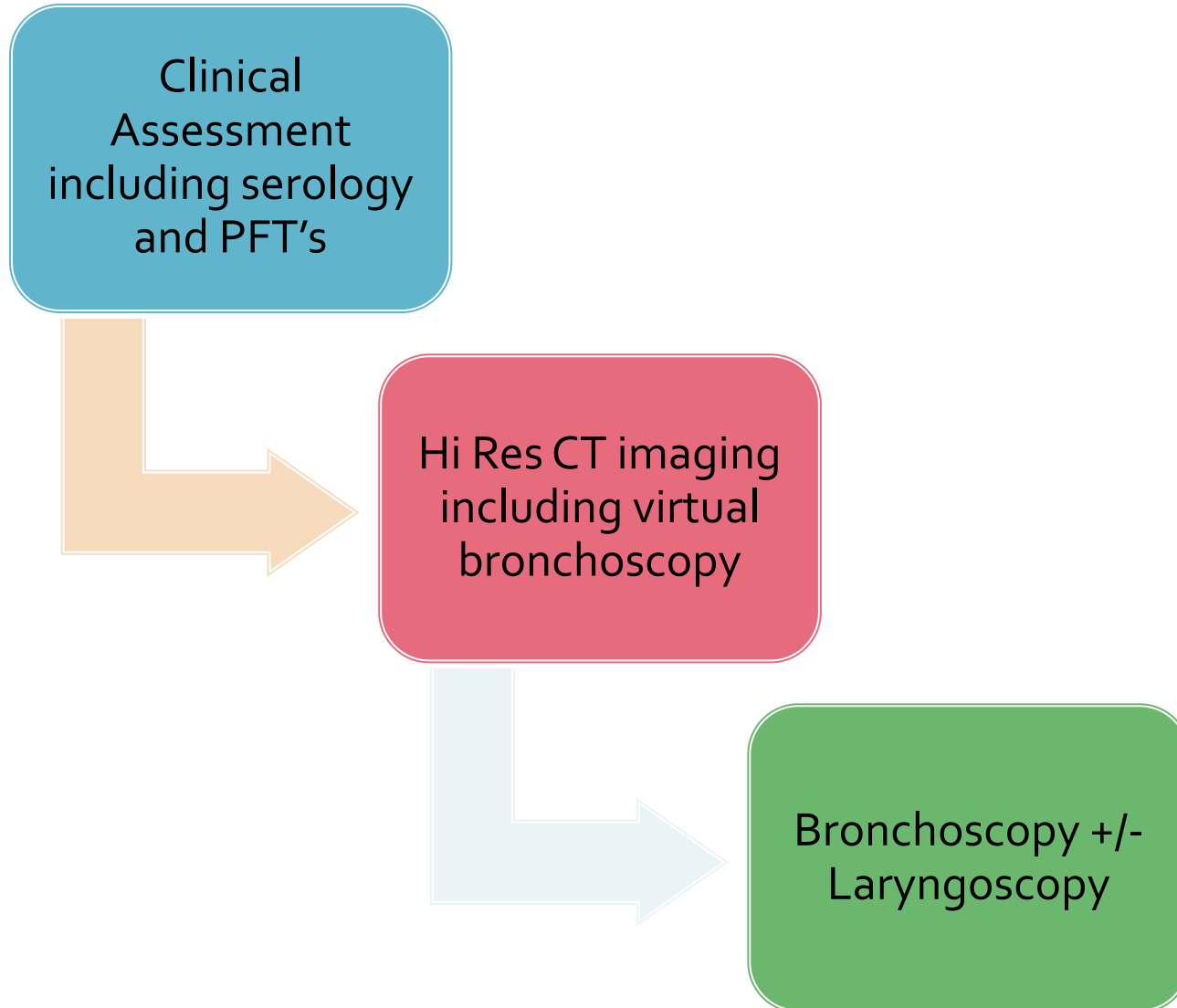
Princess Margaret Hospital

- Granulomatosis with Polyangitis(GPA)
  - Work up with ANCA and other inflammatory markers
  - Clinical History
- Relapsing Polychondritis
  - Clinical History

# Initial Management



Princess Margaret Hospital



# Surgical Management(options)



Princess Margaret Hospital

Dilation(Rigid or Balloon) +/-  
Intralesional Steroid or Mitomycin-C

Laser + Above

Cricotracheal Resection

# What are the reported results?



Princess Margaret Hospital

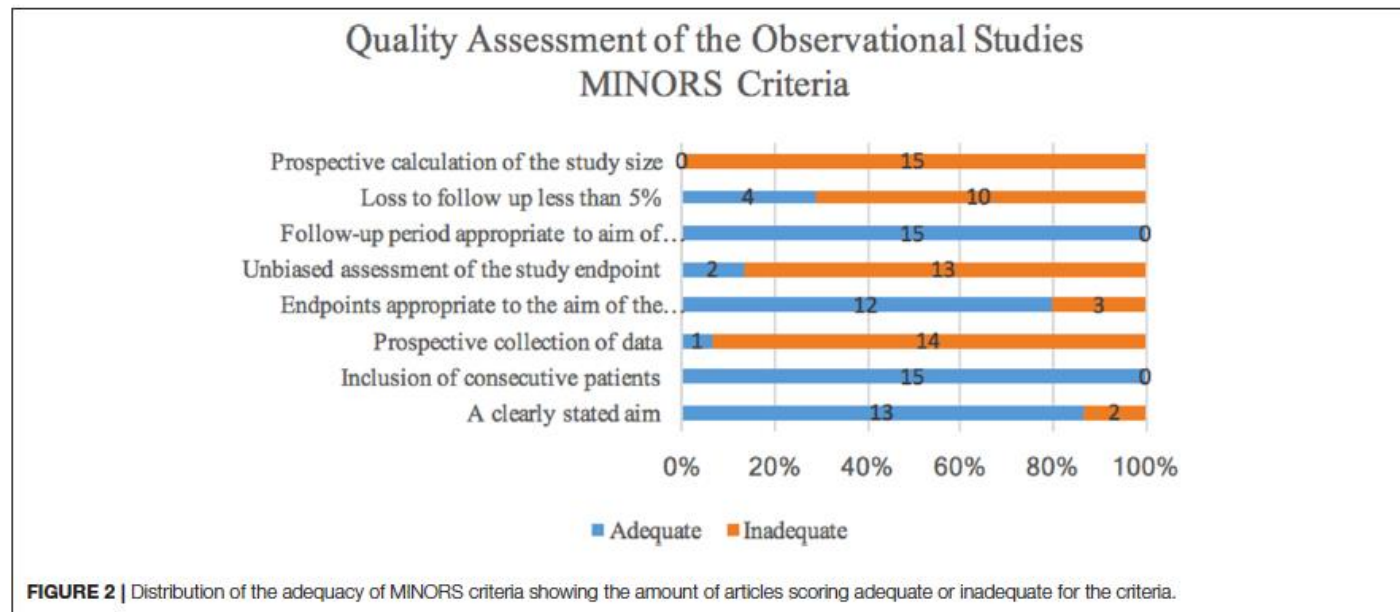
SYSTEMATIC REVIEW  
published: 10 January 2020  
doi: 10.3389/tsurg.2019.00075



## Endoscopic Treatment of Idiopathic Subglottic Stenosis: A Systematic Review

Emilie Lavrysen, Greet Hens, Pierre Delaere and Jeroen Meulemans\*

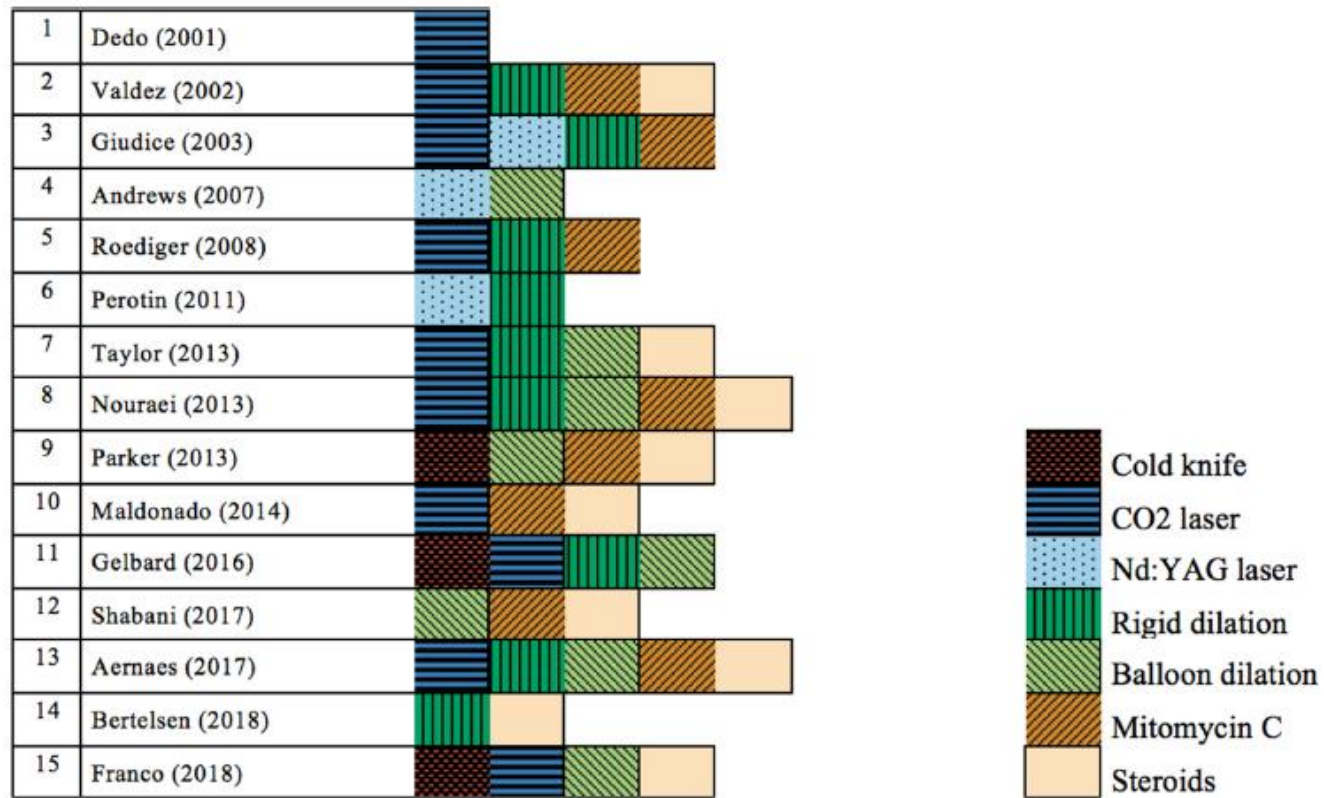
Otorhinolaryngology-Head and Neck Surgery, University Hospital Leuven, Leuven, Belgium



# Systematic Review



Princess Margaret Hospital



**FIGURE 4 |** Distribution of the used techniques for treatment of patients with idiopathic subglottic stenosis in the different selected trials, coded by color. CO<sub>2</sub> laser, carbon dioxide laser; Nd:YAG laser, neodymium-doped yttrium aluminum garnet laser.

# Results of the North American Airway Collaborative



Princess Margaret Hospital

Scientific Briefing

## Comparative Treatment Outcomes for Idiopathic Subglottic Stenosis: 5-Year Update



Otolaryngology-Head and Neck Surgery  
2023, Vol. 168(6) 1570-1575  
© 2023 American Academy of Otolaryngology-Head and Neck Surgery Foundation.  
DOI: 10.1002/ohn.190  
<http://otojournal.org>

WILEY



- Department of Otolaryngology-Head and Neck Surgery, Mercy Health-St. Rita's Ear, Nose and Throat, Lima, Ohio, USA  
Department of Otolaryngology-Head and Neck Surgery, University of Colorado School of Medicine, Denver, Colorado, USA  
Department of Surgery, Division of Otolaryngology-Head and Neck Surgery, Duke University, Durham, North Carolina, USA  
Department of Otolaryngology-Head and Neck Surgery, Loma Linda University Health, Loma Linda, California, USA  
<sup>0</sup>Department of Surgery, Division of Otolaryngology-Head and Neck Surgery, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, USA  
<sup>1</sup>Department of Otolaryngology-Head and Neck Surgery, University of Virginia, Charlottesville, Virginia, USA  
<sup>2</sup>Department of Otolaryngology-Head and Neck Surgery, University of Cincinnati, Cincinnati, Ohio, USA  
<sup>3</sup>Department of Otolaryngology-Head and Neck Surgery, Baylor University, Houston, Texas, USA  
<sup>4</sup>Department of Pulmonology, Mayo Clinic, Rochester, Minnesota, USA  
<sup>5</sup>Department of Otolaryngology-Head and Neck Surgery, Mayo Clinic, Rochester, Minnesota, USA  
<sup>6</sup>Department of Otolaryngology-Head and Neck Surgery, Harvard University, Boston, Massachusetts, USA  
<sup>17</sup>Department of Otolaryngology-Head and Neck Surgery, University of Maryland, Baltimore, Maryland, USA  
<sup>18</sup>Department of Otolaryngology-Head and Neck Surgery, Johns Hopkins University, Baltimore, Maryland, USA  
<sup>19</sup>Department of Otolaryngology-Head and Neck Surgery, University of Iowa, Iowa City, Iowa, USA  
<sup>20</sup>Department of Otolaryngology-Head and Neck Surgery, University of Michigan, Ann Arbor, Michigan, USA  
<sup>21</sup>Department of Otolaryngology-Head and Neck Surgery, University of Southern California, Los Angeles, California, USA  
<sup>22</sup>Department of Medicine, Division of Pulmonology, Vanderbilt University Medical Center, Nashville, Tennessee, USA  
<sup>23</sup>Department of Otolaryngology-Head and Neck Surgery, Mayo Clinic, Phoenix, Arizona, USA  
<sup>24</sup>Scripps Health, Coastal Pulmonary Associates, Encinitas, California, USA  
<sup>25</sup>Department of Otolaryngology-Head and Neck Surgery, Ohio State University, Columbus, Ohio, USA  
<sup>26</sup>Department of Otolaryngology-Head and Neck Surgery, Louisiana State University, Baton Rouge, Louisiana, USA  
<sup>27</sup>Department of Otolaryngology-Head and Neck Surgery, University of Washington, Seattle, Washington, USA  
<sup>28</sup>Department of Otolaryngology-Head and Neck Surgery, Mount Sinai, New York, New York, USA  
<sup>29</sup>Department of Otolaryngology-Head and Neck Surgery, Augusta University Health, Augusta, Georgia, USA  
<sup>30</sup>Department of Otolaryngology-Head and Neck Surgery, Bastian Voice Institute for Voice, Swallowing, and Airway Disorders, Downers Grove, Illinois, USA  
<sup>31</sup>Department of Otolaryngology-Head and Neck Surgery, University of California-San Francisco, San Francisco, California, USA  
<sup>32</sup>Department of Otolaryngology-Head and Neck Surgery, The London Clinic, London, England  
<sup>33</sup>Department of Otolaryngology-Head and Neck Surgery, Oregon Health Sciences University, Portland, Oregon, USA  
<sup>34</sup>Department of Otolaryngology-Head and Neck Surgery, University of Rochester Medical Center, Rochester, New York, USA  
<sup>35</sup>Department of Otolaryngology-Head and Neck Surgery, University of North Carolina, Chapel Hill, North Carolina, USA  
<sup>36</sup>Division of Otolaryngology-Head and Neck Surgery, University of Utah, Salt Lake City, Utah, USA  
<sup>37</sup>Department of Otolaryngology-Head and Neck Surgery, University of Pittsburgh, Pittsburgh, Pennsylvania, USA  
<sup>38</sup>Department of Otolaryngology-Head and Neck Surgery, Temple University, Philadelphia, Pennsylvania, USA  
<sup>39</sup>Department of Otolaryngology-Head and Neck Surgery, National University Hospital of Iceland, Reykjavik, Iceland, UK  
<sup>40</sup>Ear Nose and Throat, University of Sydney, Sydney, Australia  
<sup>41</sup>Department of Otolaryngology-Head and Neck Surgery, University of California-Irvine, Irvine, California, USA  
<sup>42</sup>Department of Otolaryngology-Head and Neck Surgery, Ark-La-Tex Center for Voice, Airway & Swallowing, Shreveport, Louisiana, USA  
<sup>43</sup>Department of Otolaryngology-Head and Neck Surgery, University of California-San Diego, San Diego, California, USA

# NoAAC-Tierney-2023



Princess Margaret Hospital

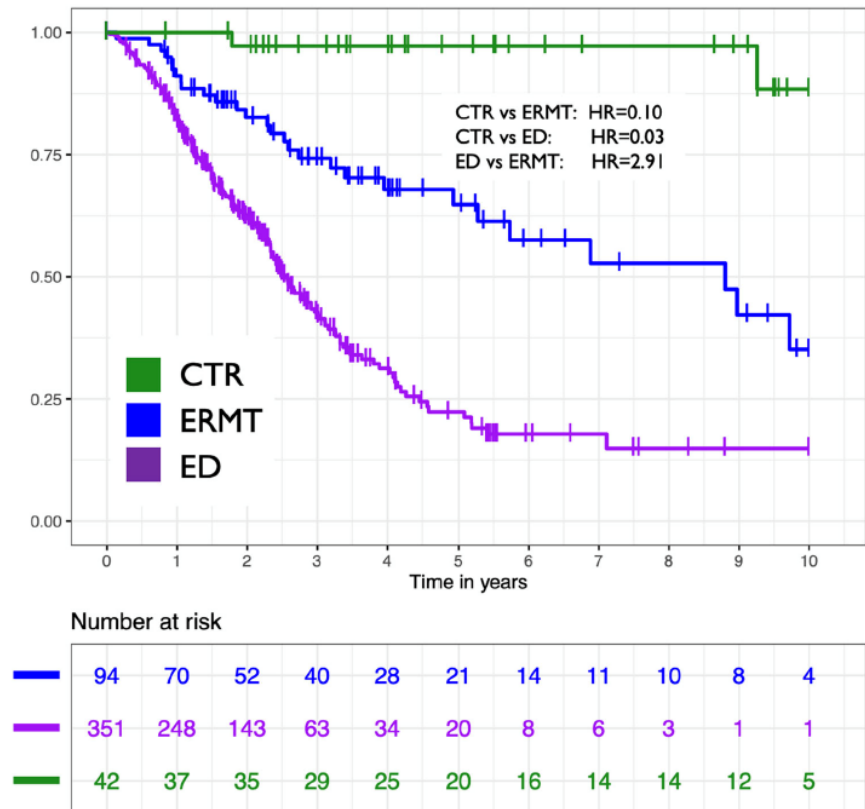
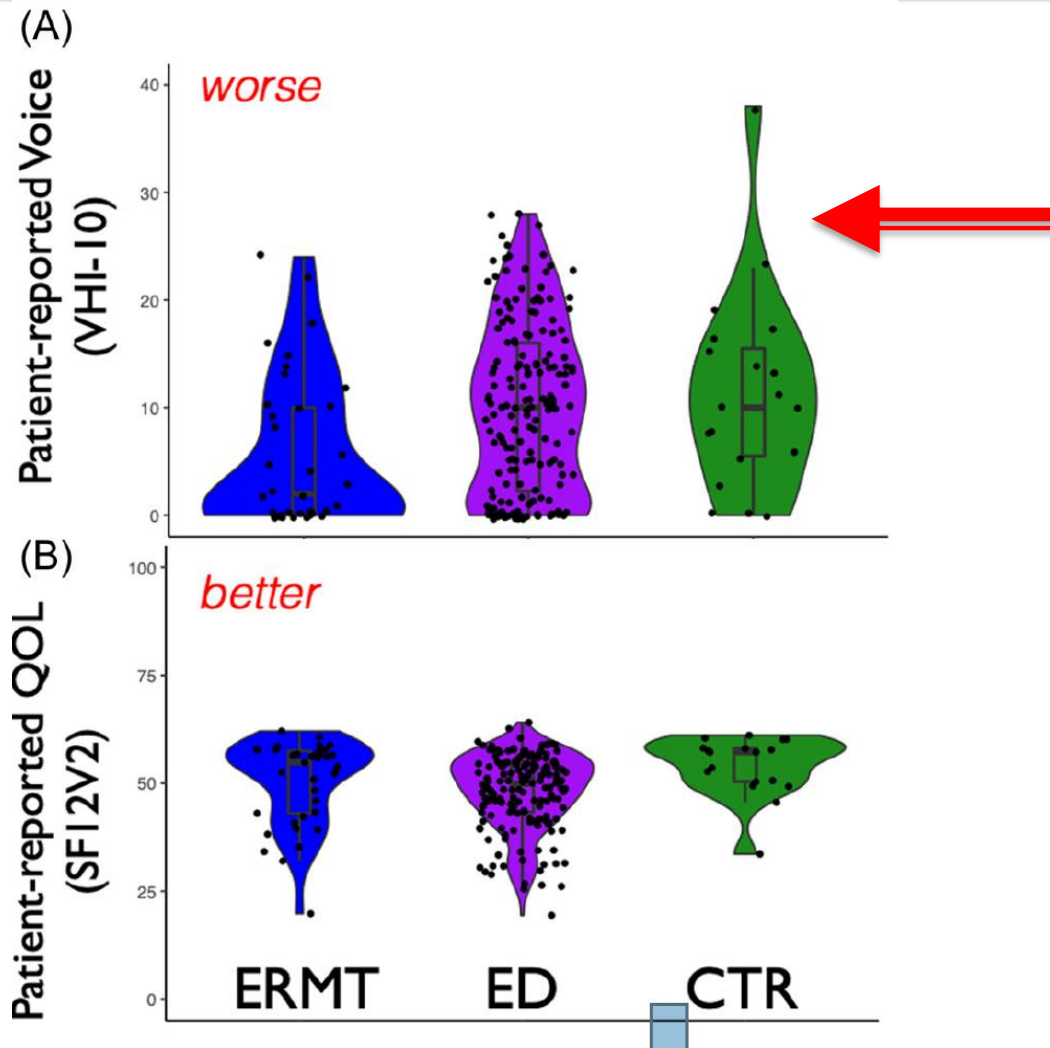


Figure 1. Primary treatment outcome Kaplan-Meier survival analysis showing the need for and the time to recurrent surgical procedure between treatment modalities. CTR, cricotracheal resection; ED, endoscopic dilation; ERMT, endoscopic resection with adjuvant medical therapy; IQR, interquartile range; iSGS, idiopathic subglottic stenosis.

# NoAAC-Tierney-2023



Princess Margaret Hospital





# When Consider CTR in iSGS



Princess Margaret Hospital

- Patient Dependent
  - Most patients favour conservative approach initially
  - Individuals with high performance needs –low threshold to move to CTR
  - Time between dilations affects our recommendations on timing

# Our Technique



Princess Margaret Hospital

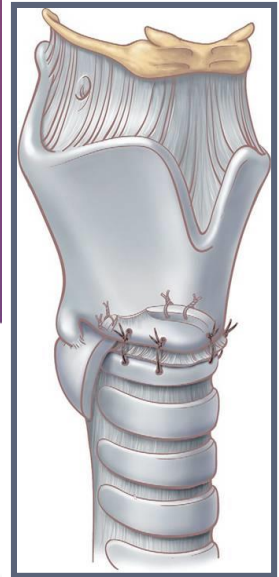


CATEGORIES ▾ ABOUT ▾ BLOG CONTACT SUBSCRIBE 🔍 ☰



## HEAD AND NECK

Surgical procedures related to flap harvests for head and neck reconstructions







*The Laryngoscope*  
© 2019 The American Laryngological,  
Rhinological and Otological Society, Inc.

---

## Cricotracheal Resection for Adult Subglottic Stenosis: Factors Predicting Treatment Failure

---

Ashok R. Jethwa, MD ; Wael Hasan, MBBCh, MCh; Carsten E. Palme, MD; Antti A. Mäkitie, MD, PhD; Osvaldo Espin-Garcia; David P. Goldstein, MD, MSc ; Ralph W. Gilbert, MD; Shaf Keshavjee, MD, MSc; Andrew Pierre, MD, MSc; Patrick J. Gullane, MB

# Recent Series



Princess Margaret Hospital

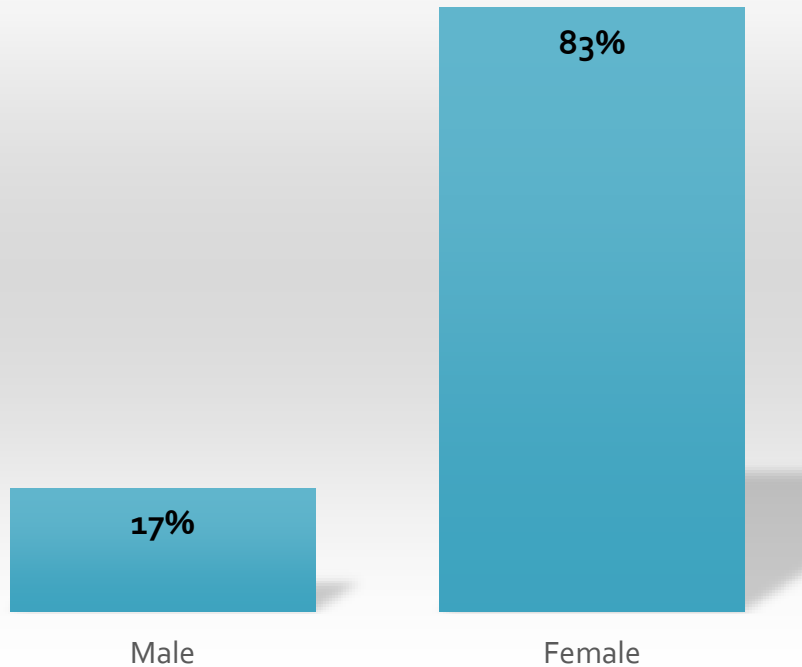
- 1988- 2023 -165 patients
- Review represents a subset of 114 from 1988-2017
- Retrospective

# Demographics



Princess Margaret Hospital

CTR 1988-2017

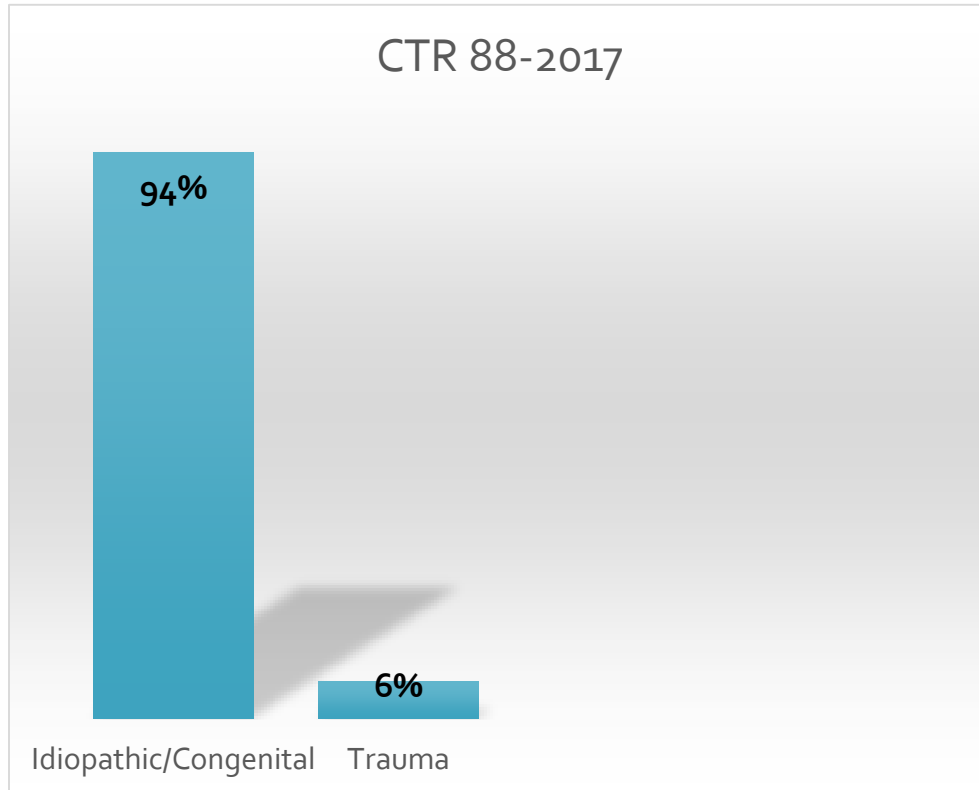


Mean Age = 46.3

# Etiology/Comorbidities



Princess Margaret Hospital

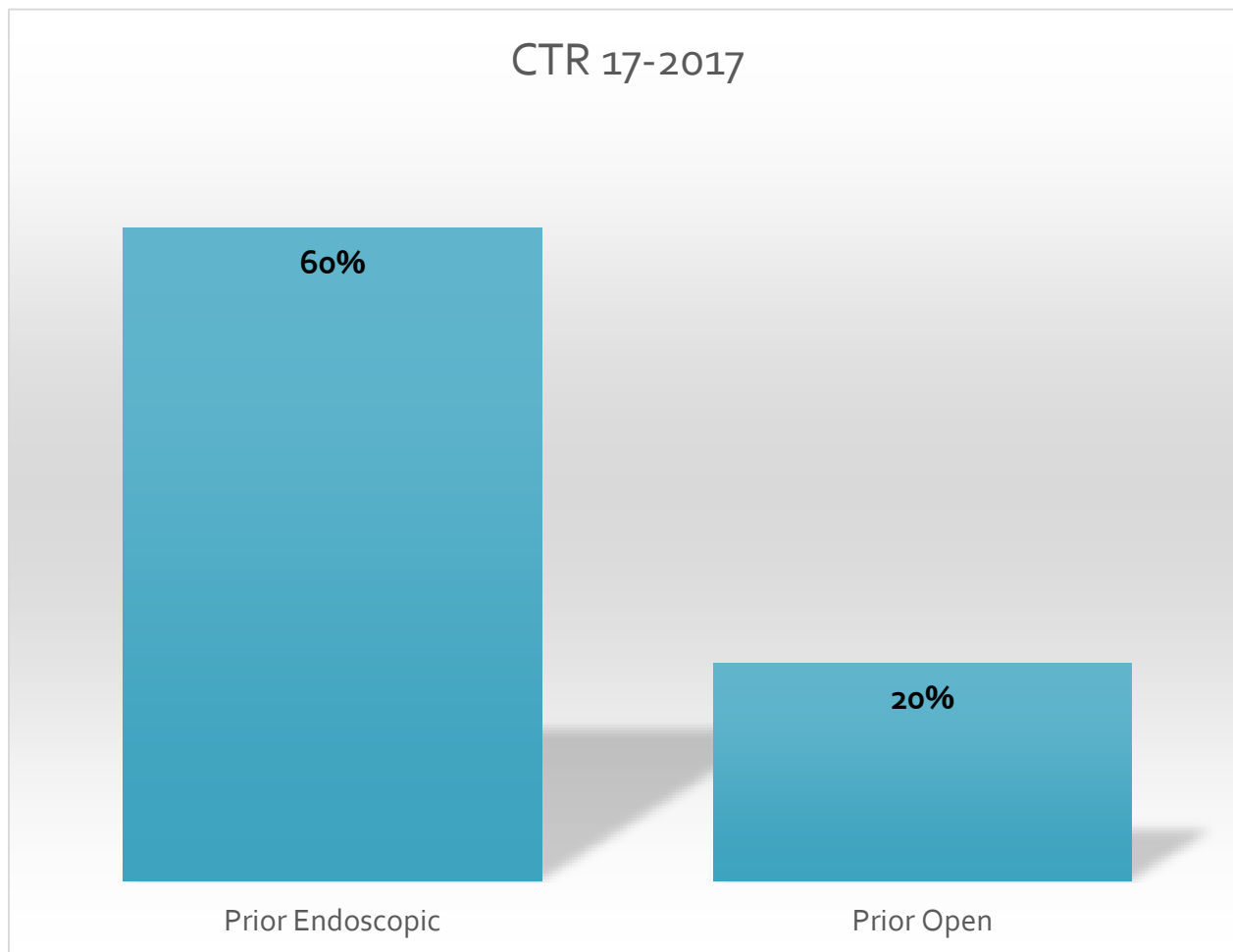


Medical Comorbidity-30%

# Previous Tx



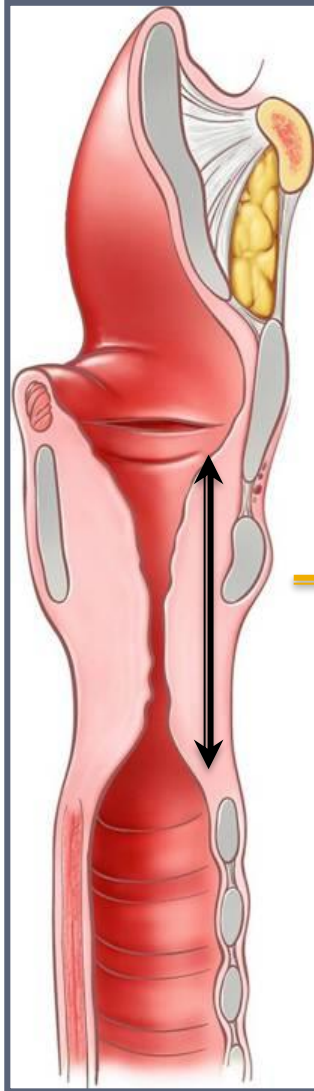
Princess Margaret Hospital



# Stenosis Length



Princess Margaret Hospital



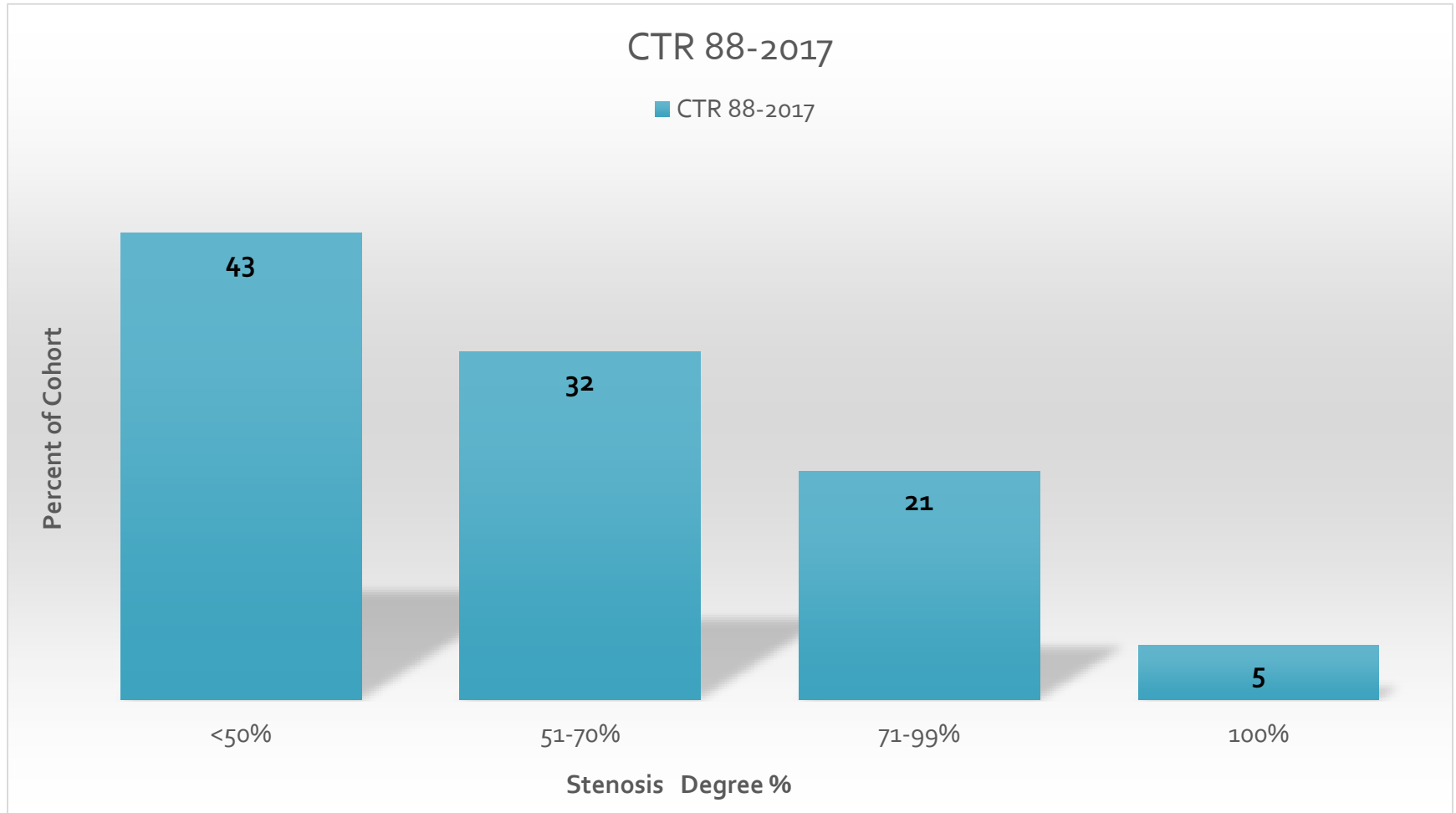
Mean 2.9 cm  
Range 1-4.5



# Grade of Stenosis



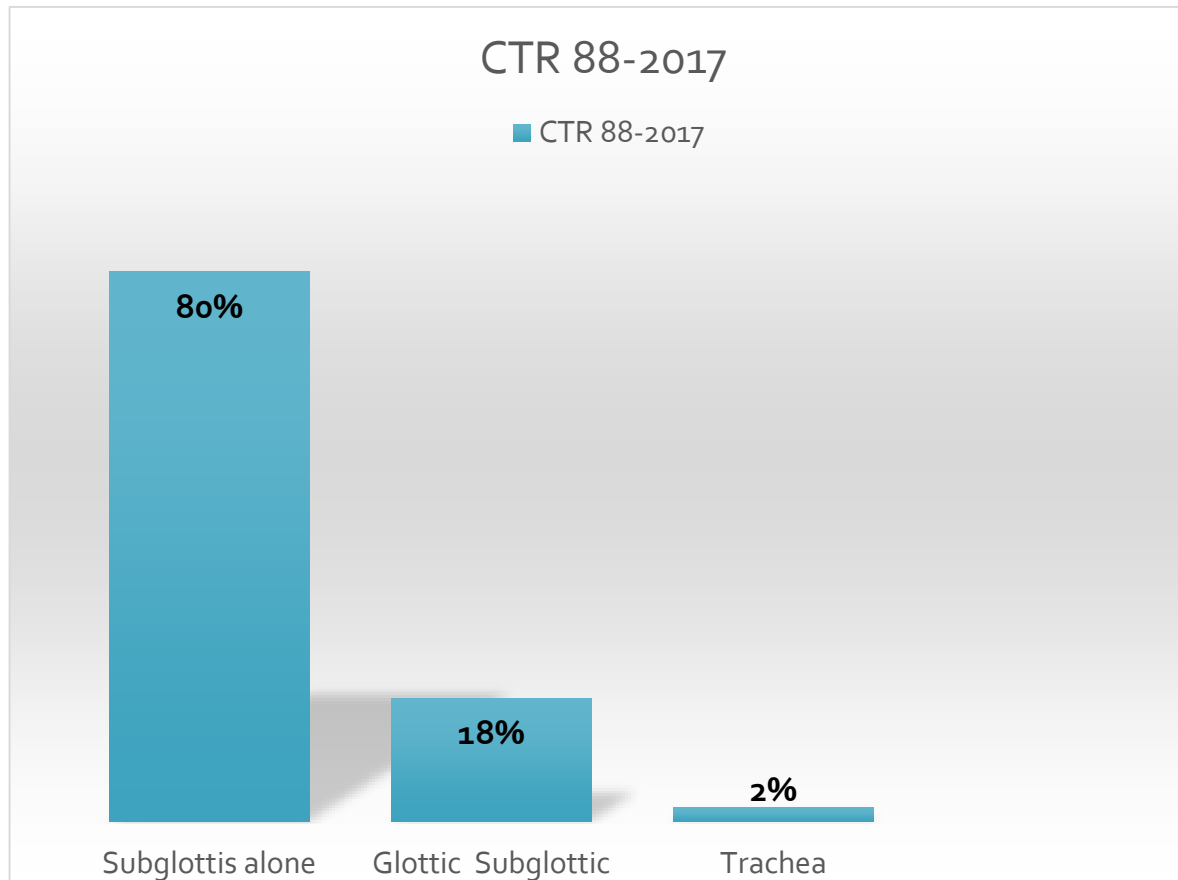
Princess Margaret Hospital



# Stenosis Location



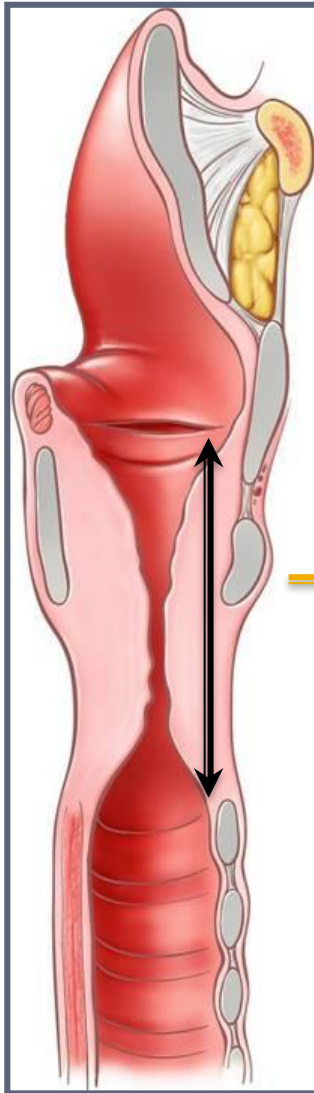
Princess Margaret Hospital



# Resection Length



Princess Margaret Hospital

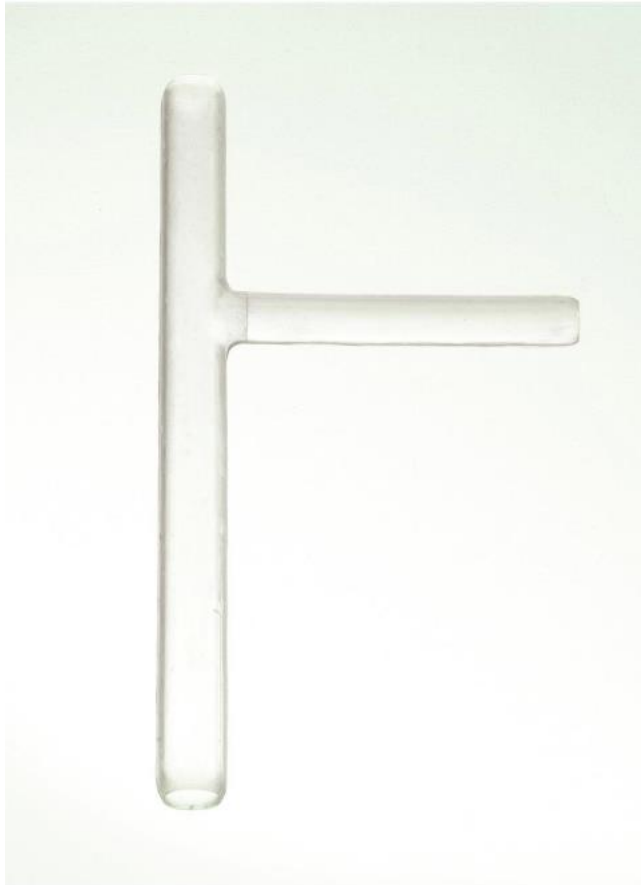


Mean 2.9cm  
Range 1-5

# Duration of T-tube



Princess Margaret Hospital

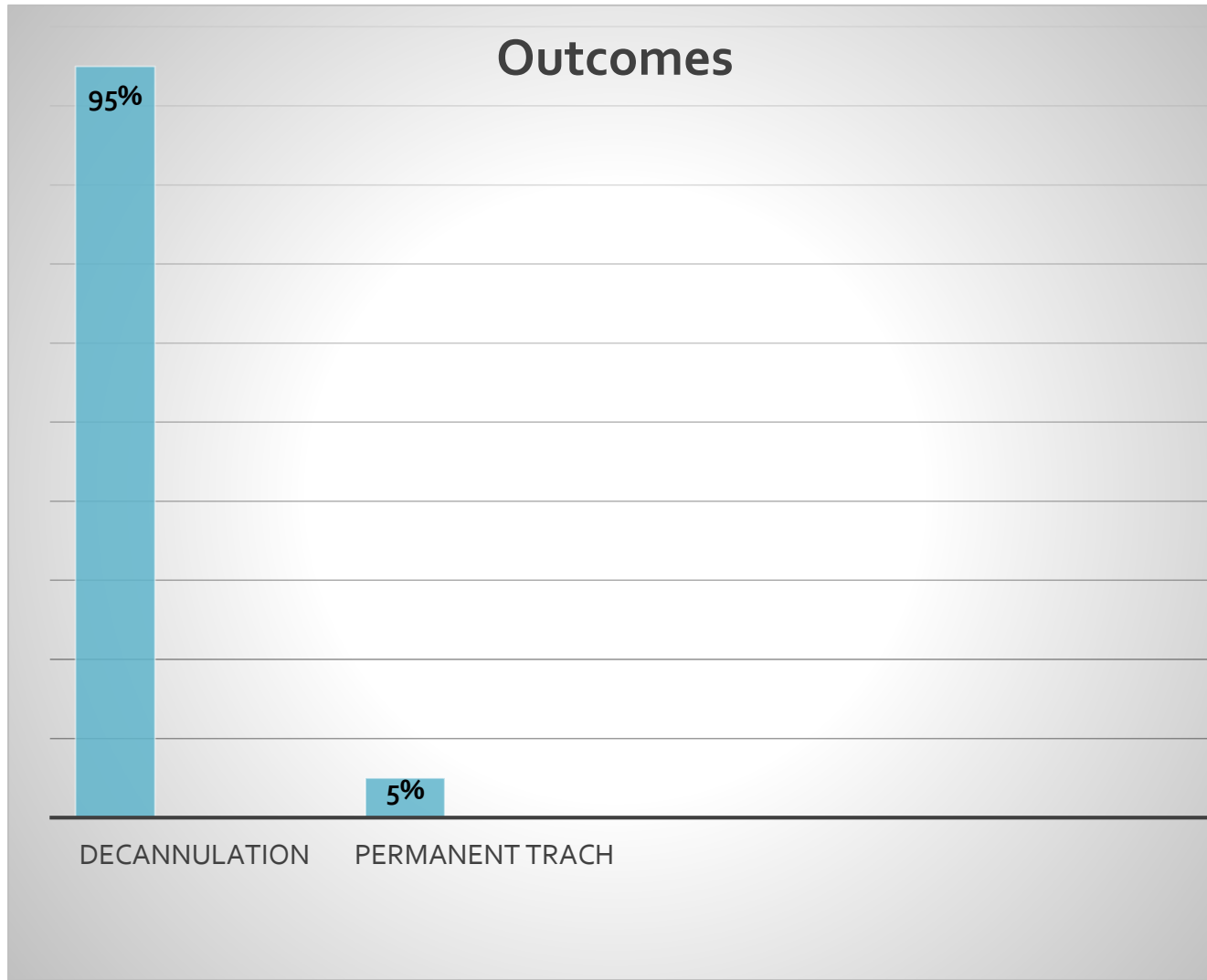


Average T-Tube Duration=65.1  
days/Range 1-451  
Current Target for removal 21  
days

# Outcomes Decannulation



Princess Margaret Hospital



# Univariate analysis: Restenosis



Princess Margaret Hospital

Predictor	OR	P-value
Medical Co-Morbidity	3.2	.039
Prior Open Procedure	3.2	.048
Post Operative Complication	7.9	.002

# Univariate analysis: Failure Decannulation



Princess Margaret Hospital

Predictor	OR	P-value
Traumatic Stenosis	10.3	.017
Combined Glottic/Subglottic	10.4	.010
Revision Surgery following CTR	44.1	.001

# Conclusions



Princess Margaret Hospital

CTR has predictable results in our institution with a 95% Decannulation Rate

Predictors of Poor Outcomes - Combined Stenoses, Medical Co-Morbidity, Revision Surgery- Patient Selection is Critical

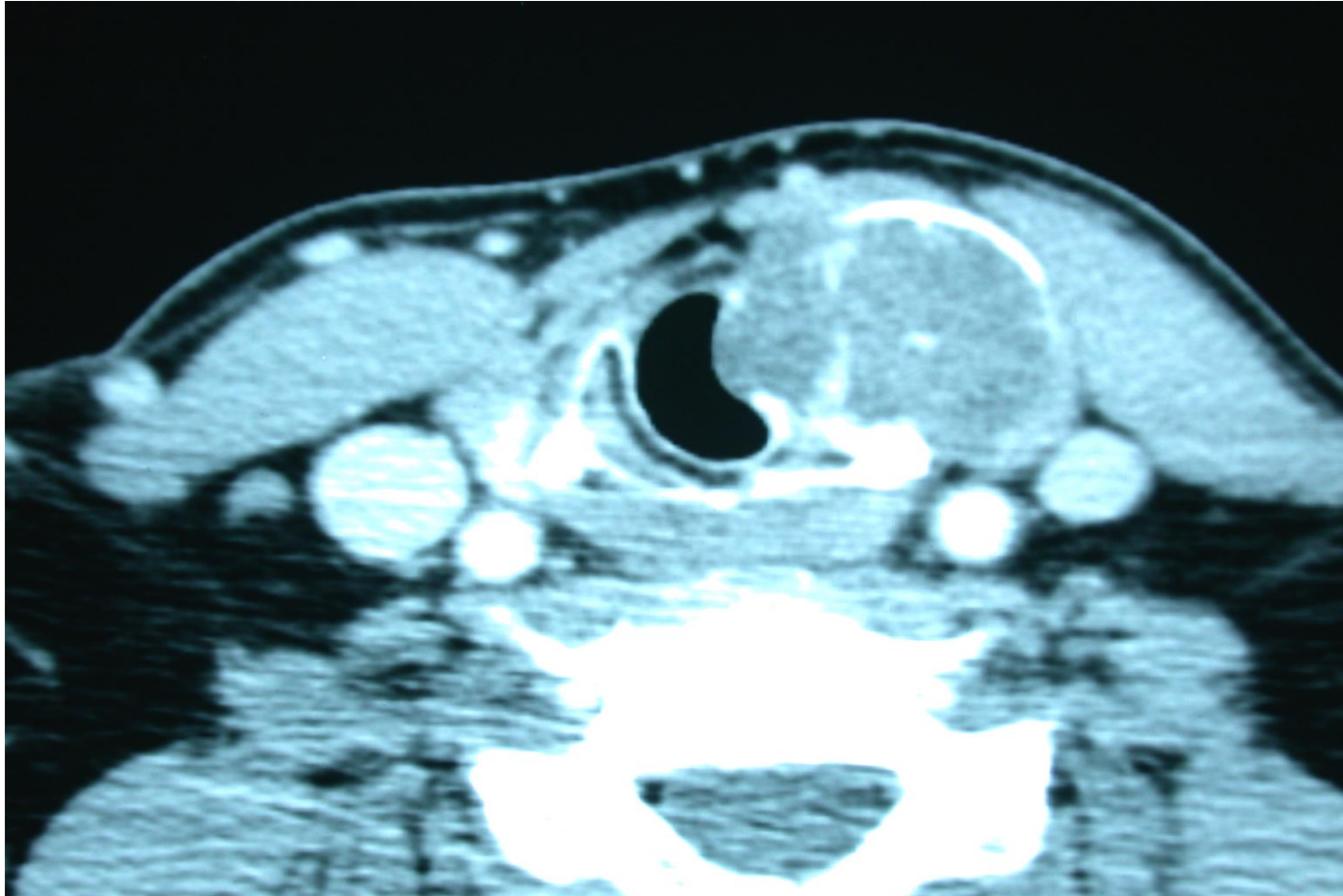
CTR in our Jurisdiction is best managed by a multidisciplinary Team including Otolaryngology/H&N Surgery, Thoracic Surgery and Airway Expertise in Anesthesia



# What about managing failures or unusual problems?



Princess Margaret Hospital

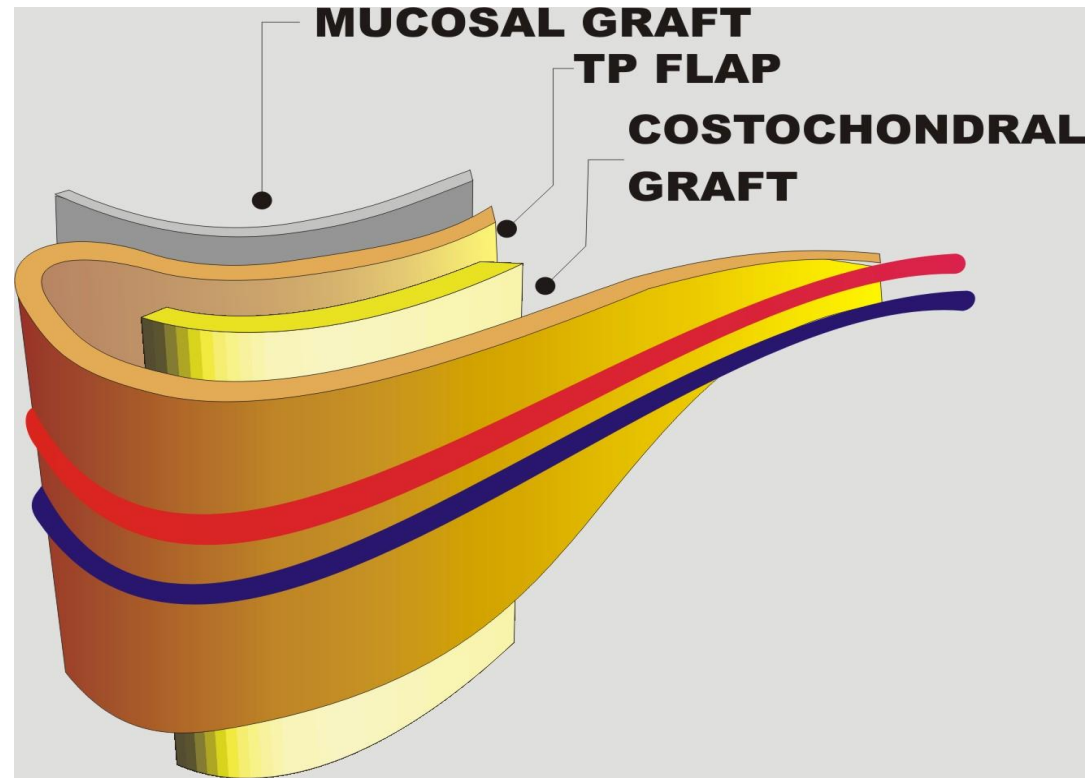


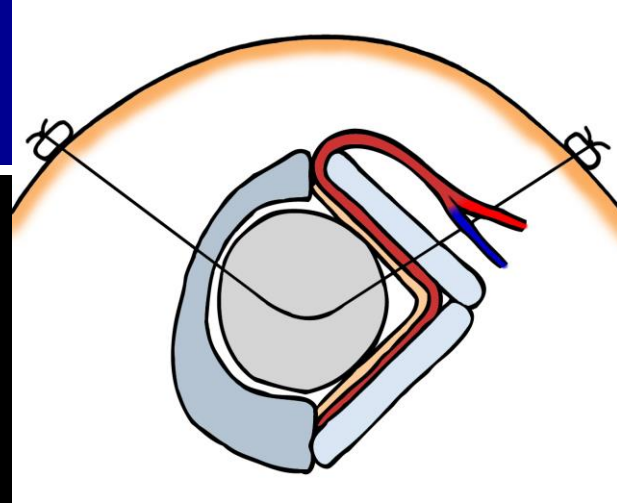
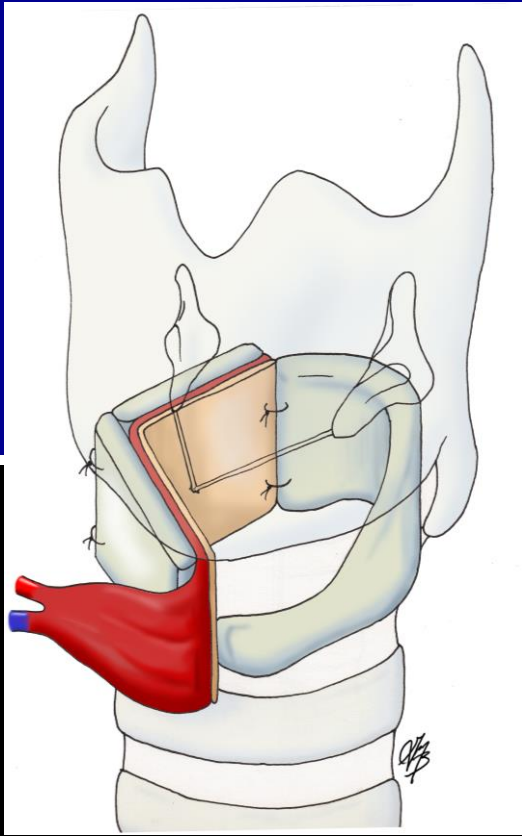
# Concept: Vascularized Composite Autografts (VCAG)

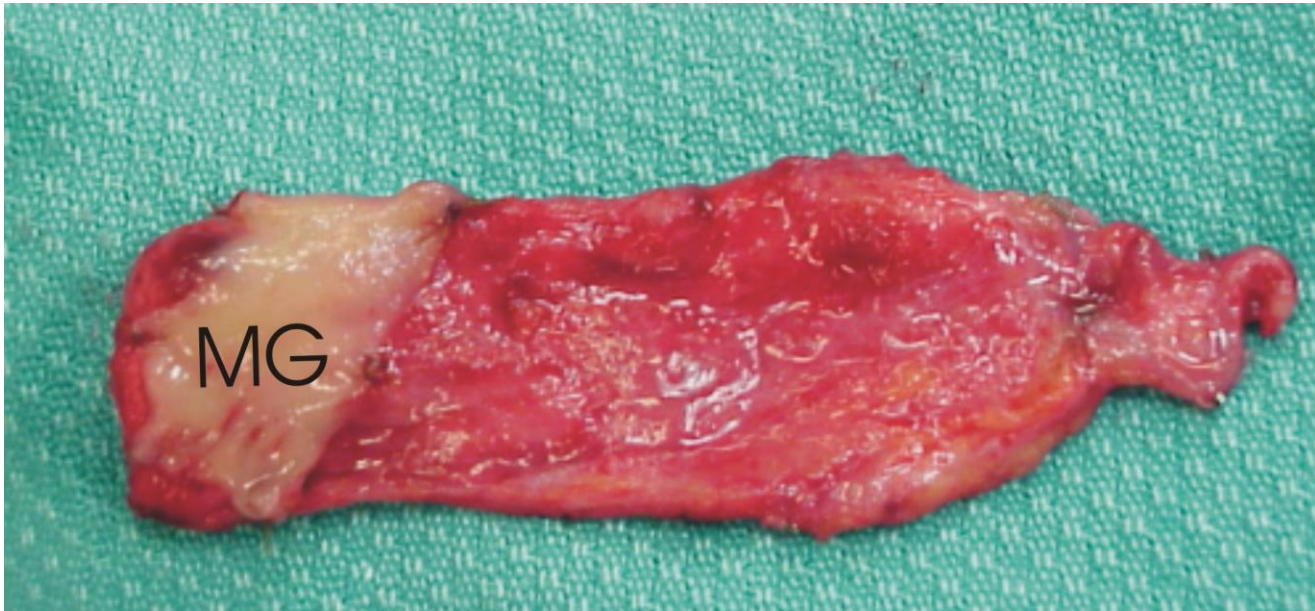
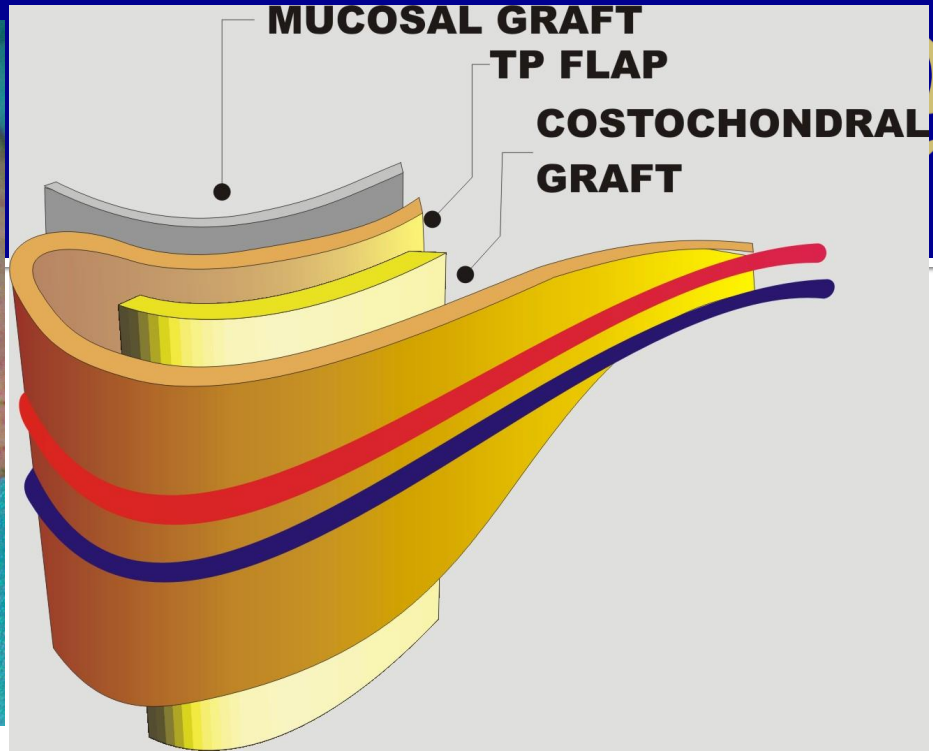


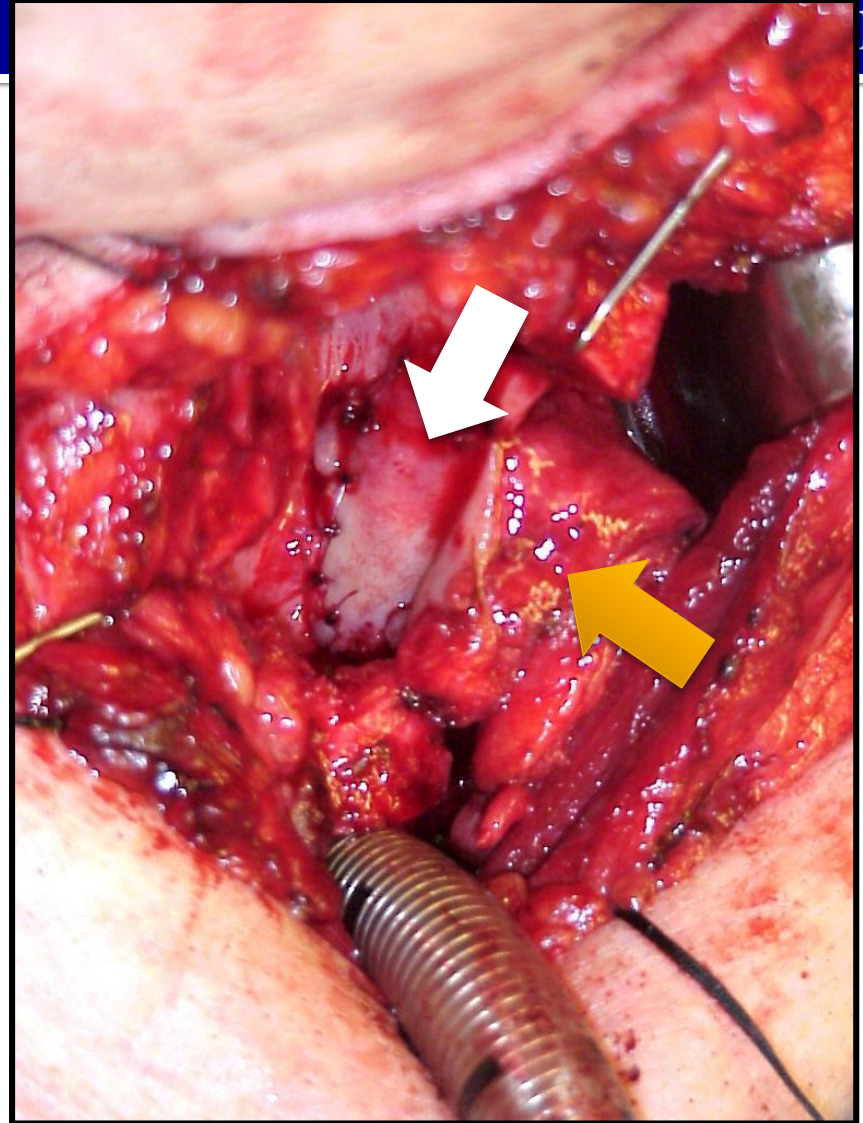
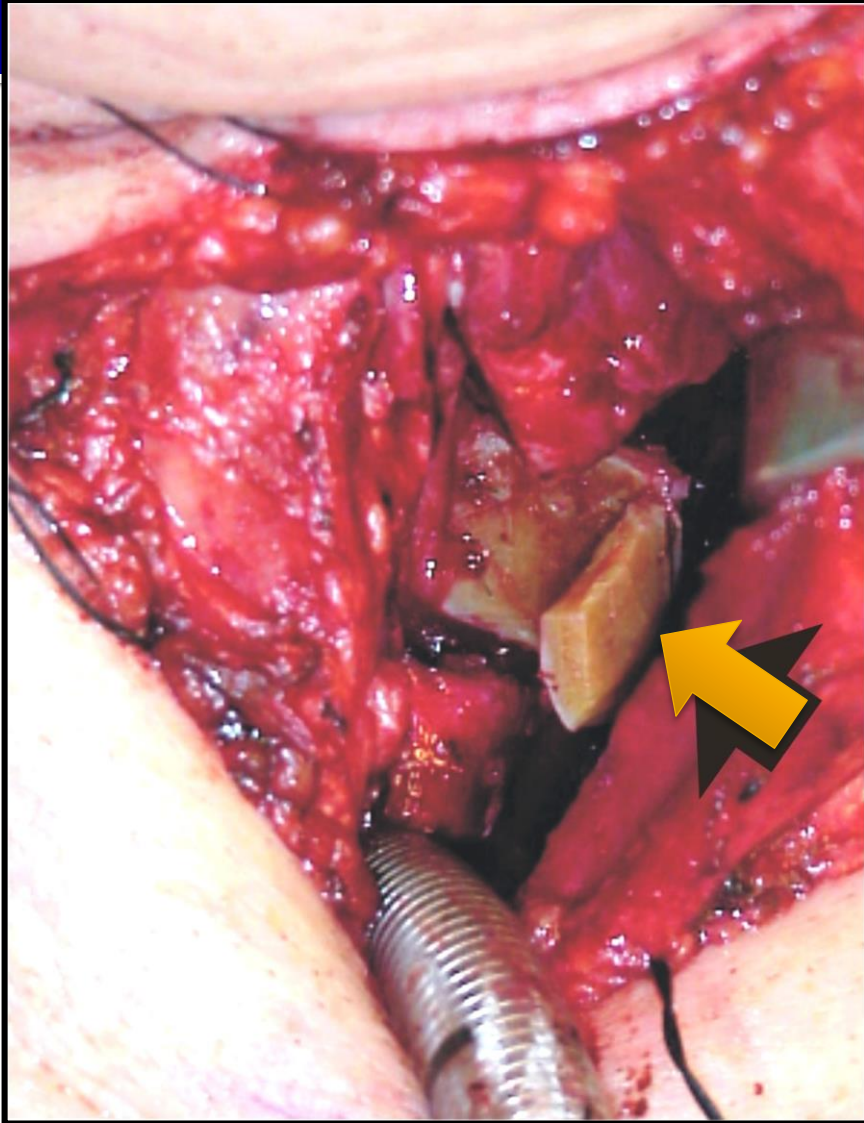
Princess Margaret Hospital

- Rigid airway support
- Mucosal lining
- Wrapped with vascularized carrier
- Used in a select patient population (salvage)









# Endoscopic Views of VCAG for LTR



Princess Margaret Hospital

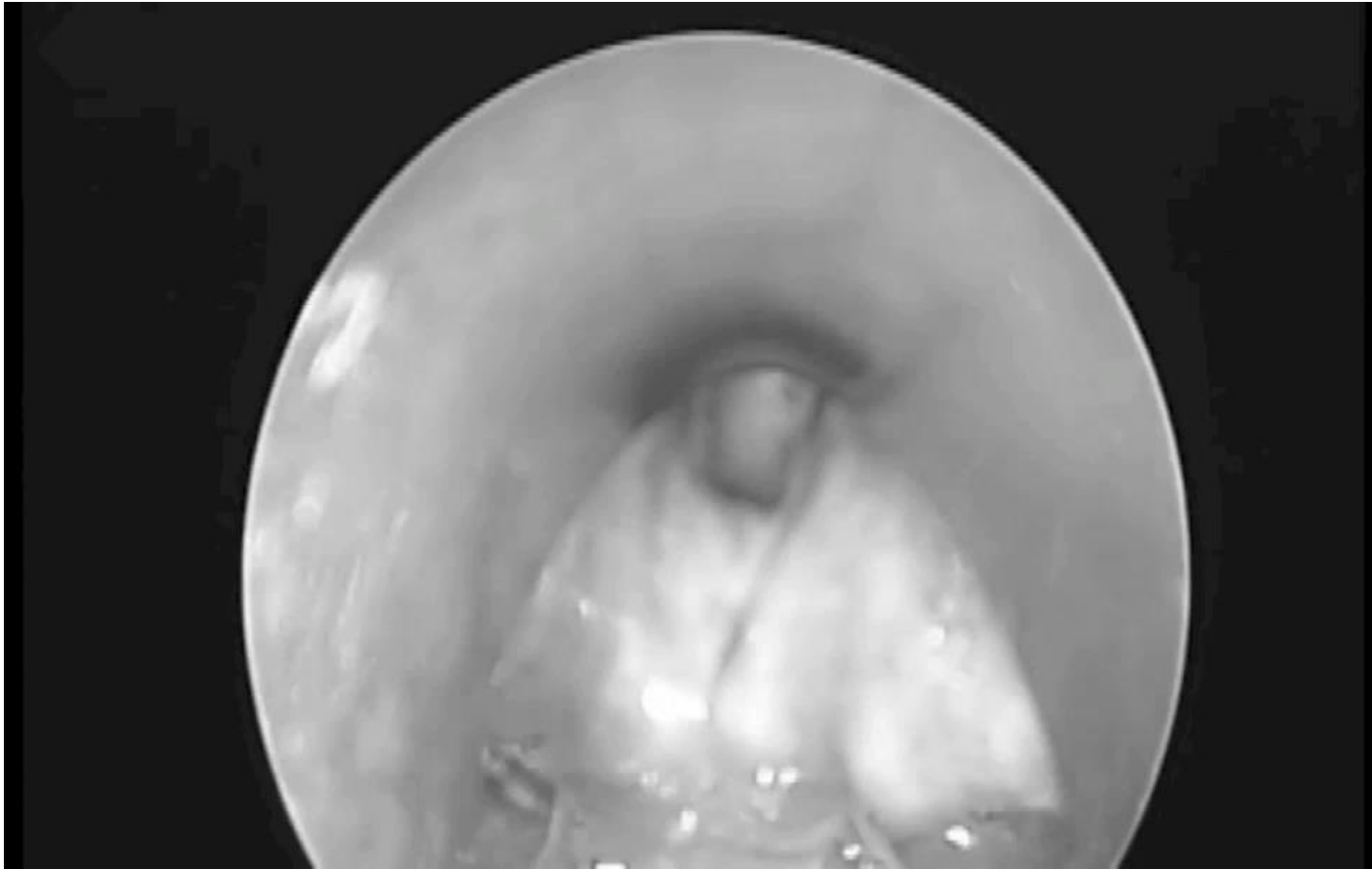
## Chondrosarcoma



# Endoscopic Views of VCAG for LTR

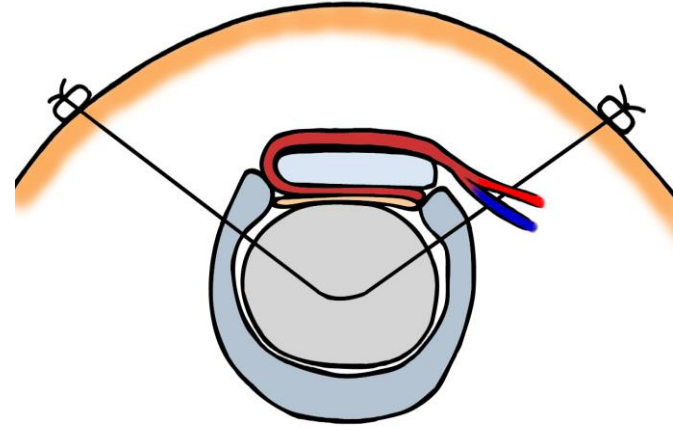
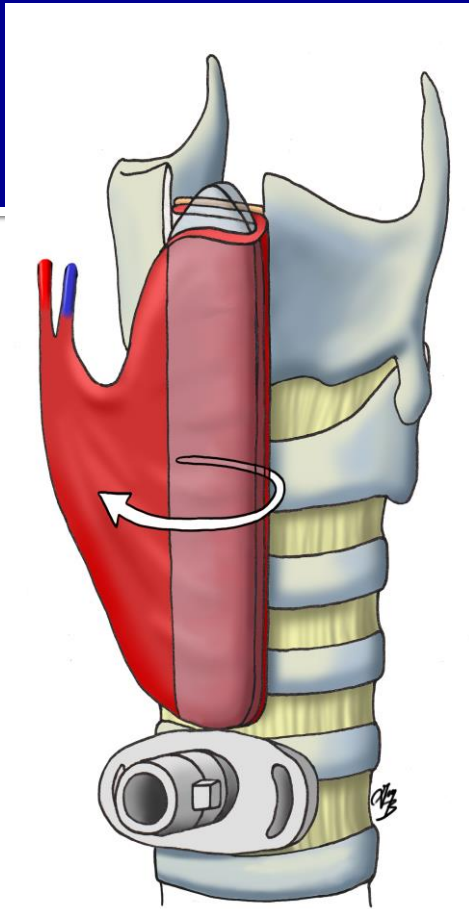


Princess Margaret Hospital

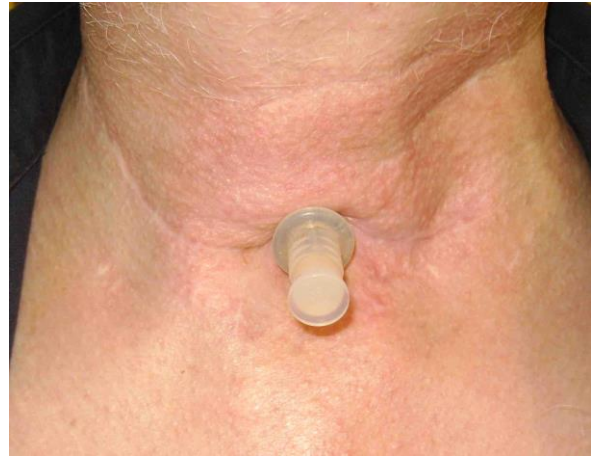
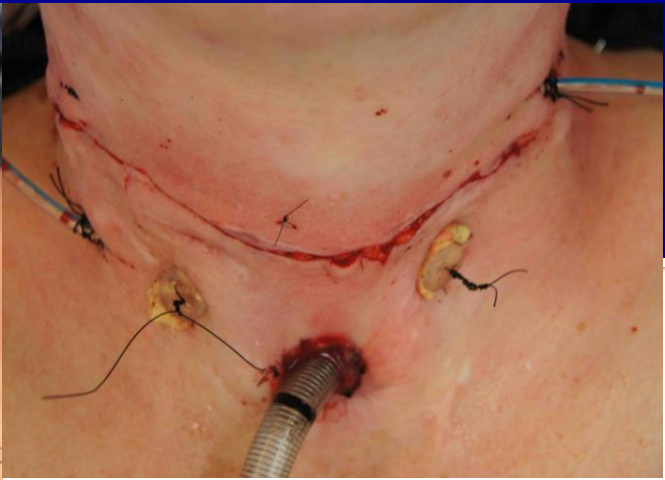
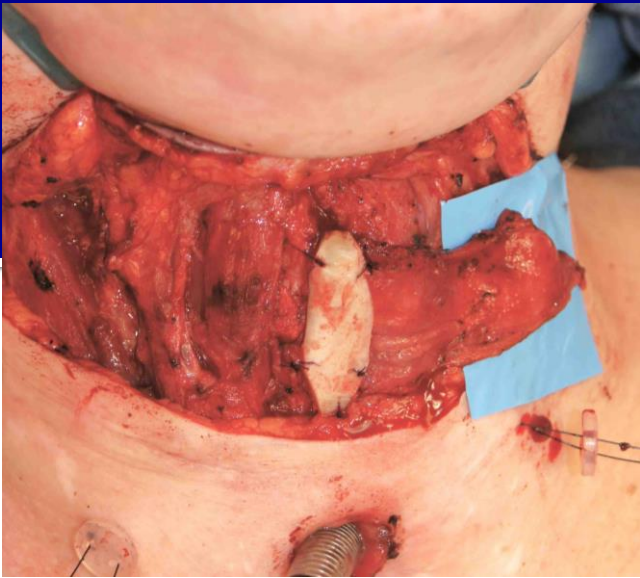
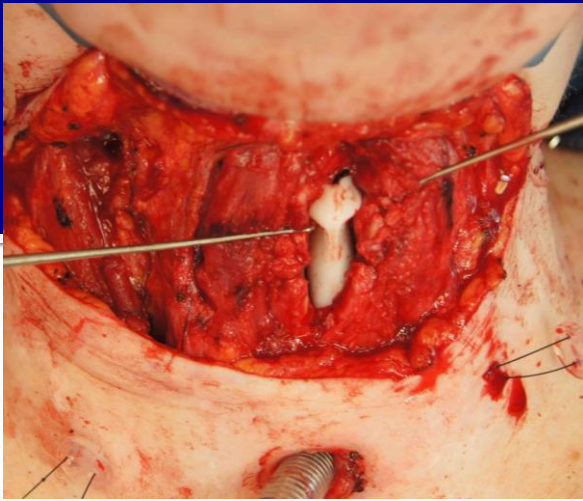




Princess Margaret Hospital







# Endoscopic Views of VCAG for LTR



Princess Margaret Hospital

## Failed Cricotracheal Resection



# Research Design



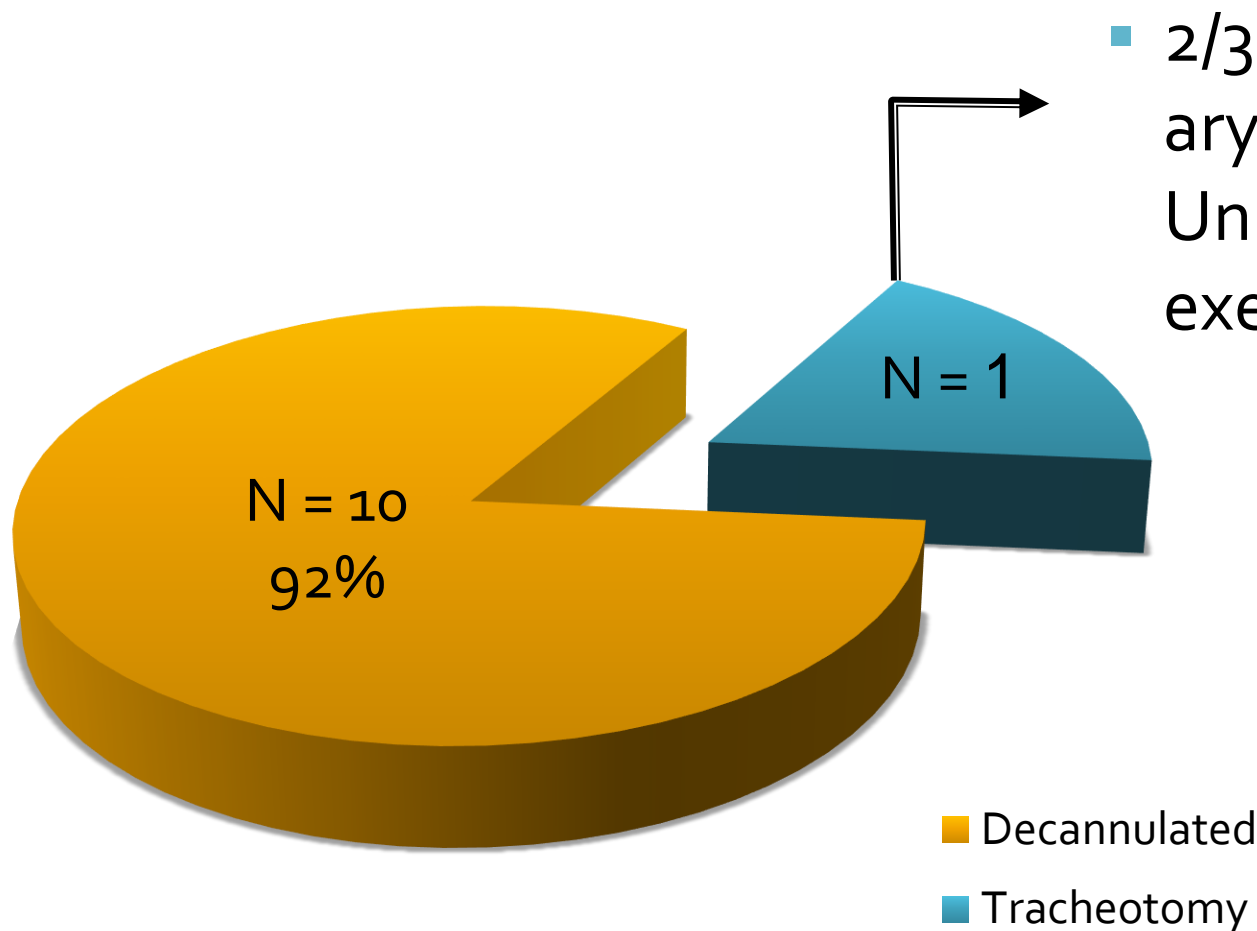
Princess Margaret Hospital

- Retrospective case series of VCAG for LTR
- Outcomes:
  - **Airway patency**
    - Decannulation (primary outcome)
    - Pulmonary Function Test (PFT)
    - UCSD Shortness of Breath Questionnaire (SOBQ)
  - **Voice**
    - Voice Handicap Index (VHI)
  - **Swallowing function**
    - M.D. Anderson Dysphagia Inventory (MDADI)

# Results: Decannulation



Princess Margaret Hospital



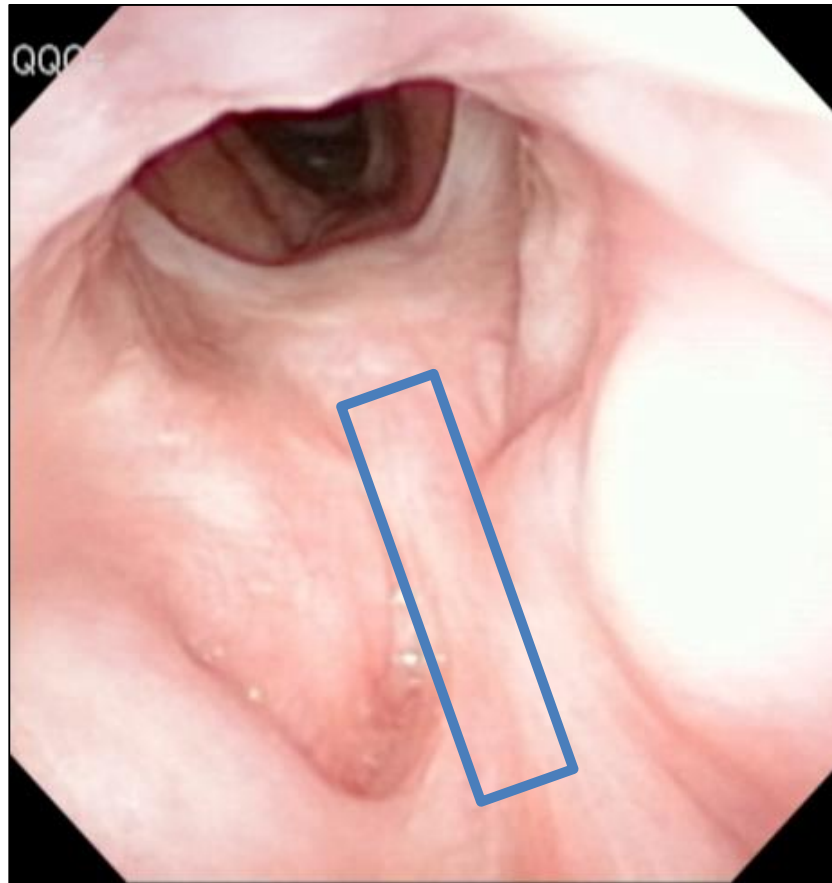
- 2/3 cricoid resected  
arytenoid fixation  
Unplug only for  
exercise

# Results: Vocal Function



Princess Margaret Hospital

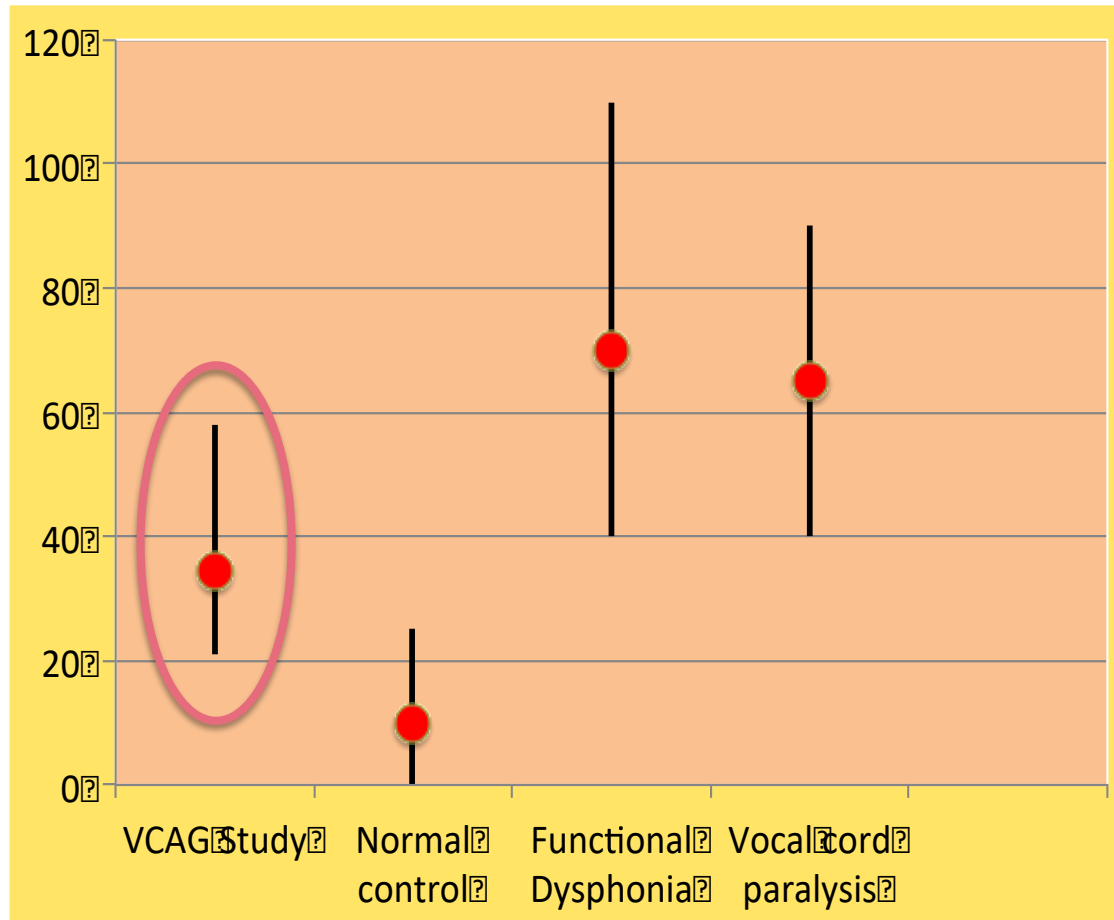
Widening of Anterior Commissure: "Trading voice quality for breathing"



# Results: Vocal Handicap Index



Princess Margaret Hospital



N = 5

# Proof of Principle



Princess Margaret Hospital

- Vascularized Composite Autografts
  - Reserved for select subset of patients
  - High decannulation rate
  - Only at experienced centers
    - Microvascular, open airway techniques

*Proof of principle: Vascularized carriers along with structural elements (auto- or allografts) may be way forward in complex airway reconstruction*

# What about new MIS approaches



Princess Margaret Hospital

Published in final edited form as:

*Otolaryngol Head Neck Surg.* 2022 May ; 166(5): 917–926. doi:10.1177/01945998211028163.

## **Endoscopic Resection and Mucosal Reconstitution With Epidermal Grafting: A Pilot Study in Idiopathic Subglottic Stenosis**

**Ruth J. Davis, MD<sup>1</sup>, Ioan Lina, MD<sup>1</sup>, Kevin Motz, MD<sup>1</sup>, Alexander Gelbard, MD<sup>2</sup>, Robert R. Lorenz, MD<sup>3</sup>, Guri S. Sandhu, MD<sup>4</sup>, Alexander T. Hillel, MD<sup>1</sup>**

<sup>1</sup>Department of Otolaryngology–Head and Neck Surgery, School of Medicine, Johns Hopkins University, Baltimore, Maryland, USA

<sup>2</sup>Department of Otolaryngology, School of Medicine, Vanderbilt University, Nashville, Tennessee, USA

<sup>3</sup>Head and Neck Institute, Cleveland Clinic, Cleveland, Ohio, USA

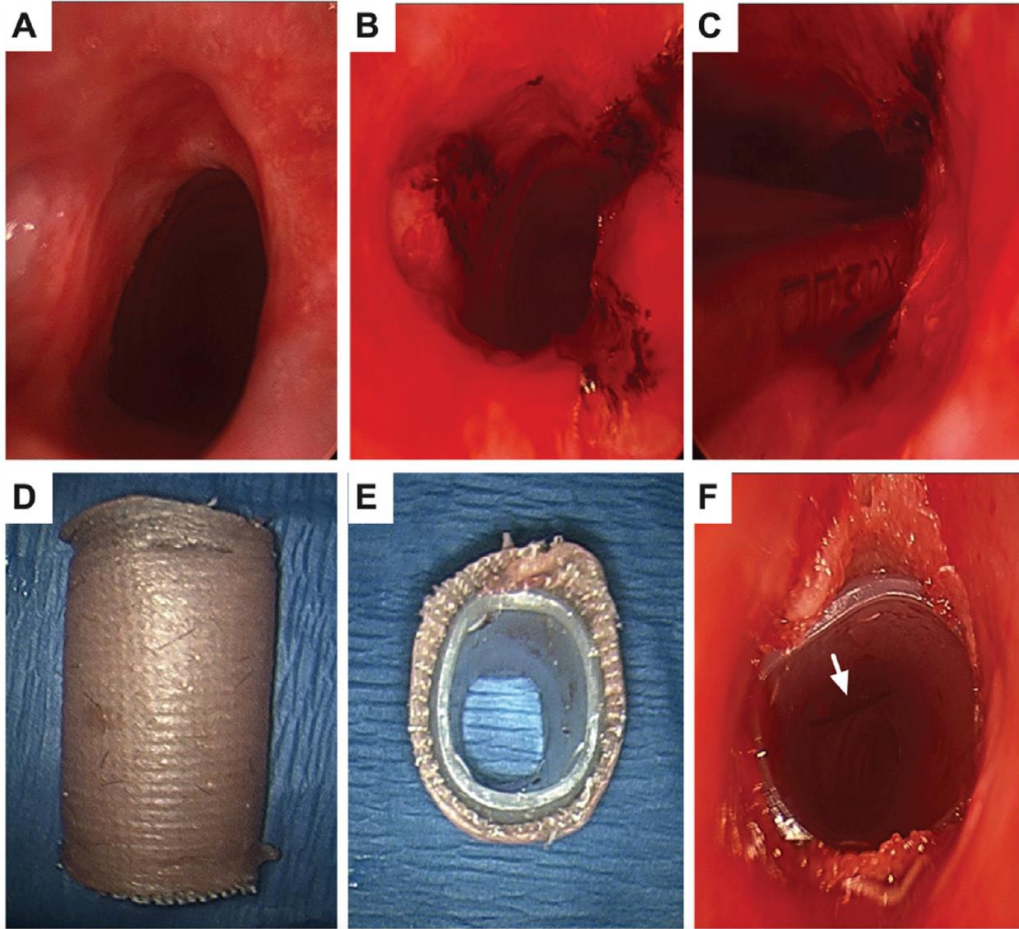
<sup>4</sup>National Center for Airway Reconstruction, Department of Otolaryngology, Charing Cross Hospital, London, UK



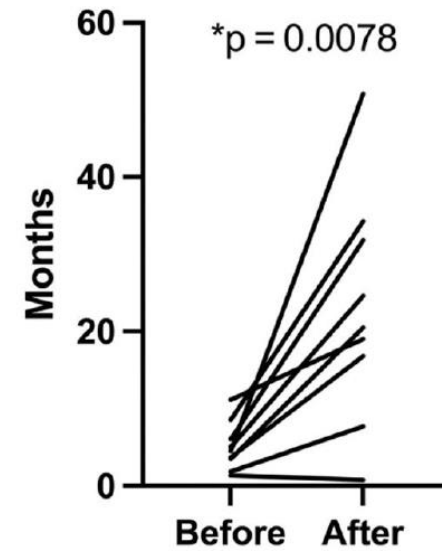
# Maddern technique



Princess Margaret Hospital



**B Surgery-Free Interval**



# The Future



Princess Margaret Hospital

Airway Stents-Need a Better Option than T-Tubes in every patient

Patients with combined injuries and Medical Co-Morbidity continue to be a challenge

Introduction of more MIS approaches

Improved understanding of pathogenesis of iSGS



Princess Margaret Hospital



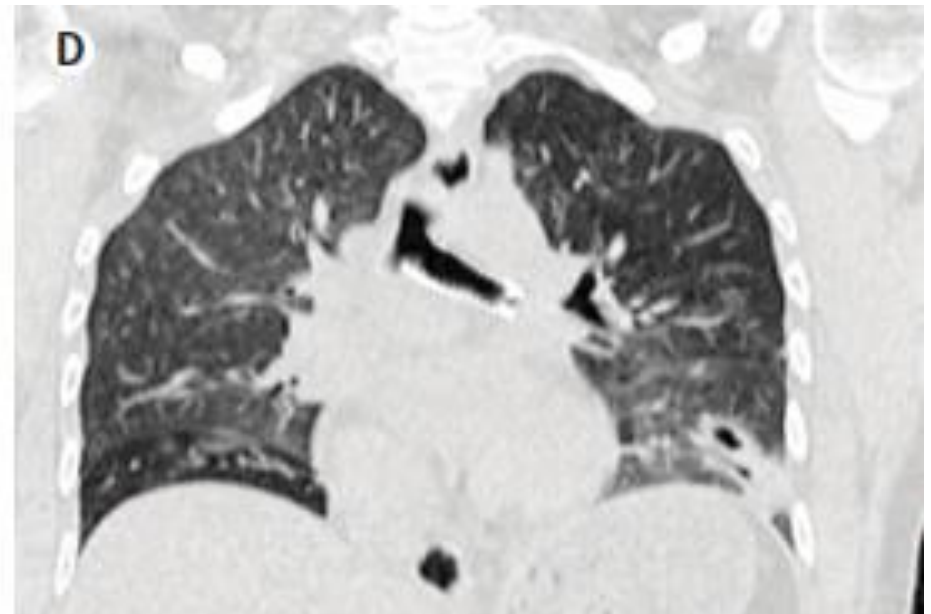
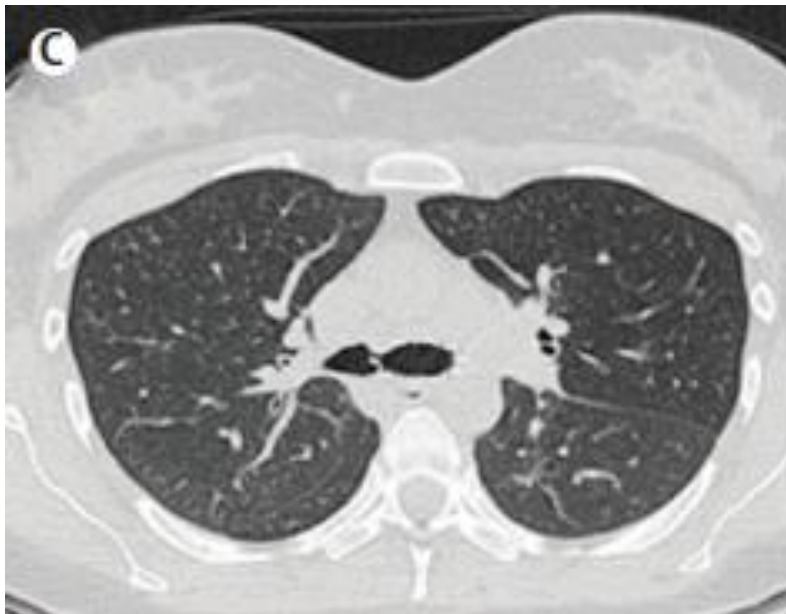
# What about Airway Transplantation



Princess Margaret Hospital

## The first tissue-engineered airway transplantation: 5-year follow-up results

*Alessandro Gonfotti, Massimo O Jaus, Daniel Barale, Silvia Baiguera, Camilla Comin, Federico Lavorini, Giovanni Fontana, Oriol Sibila, Giovanni Rombolà, Philipp Jungebluth, Paolo Macchiarini*



# De-cellularized Trachea with stem cells



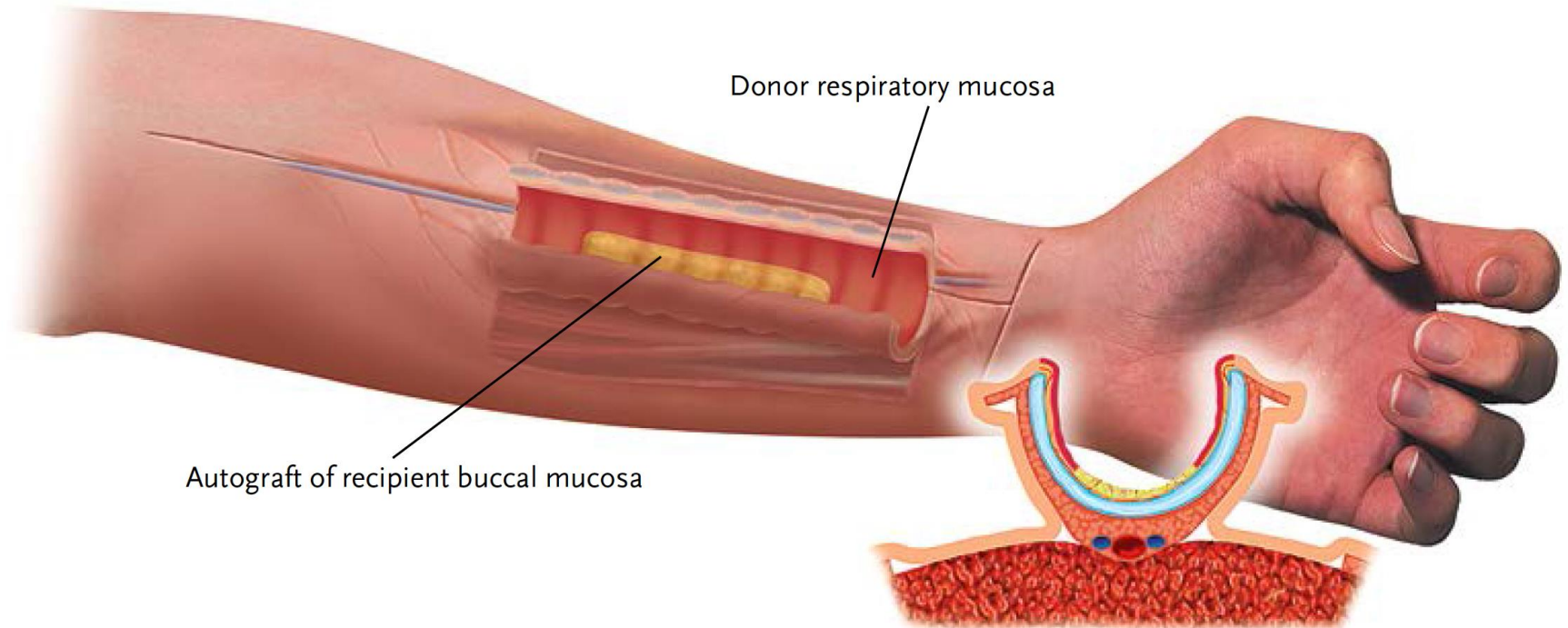
Princess Margaret Hospital

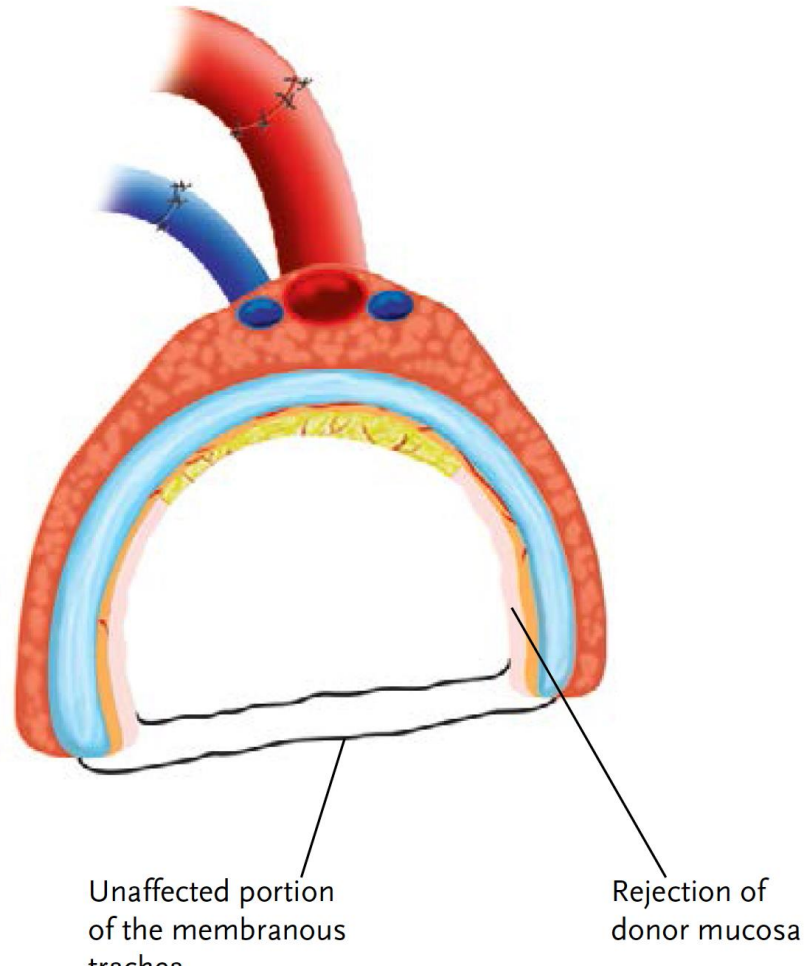
- 11 patients reported
- Published and unpublished data more than 50% mortality at 3 months
- Surviving patients are all stented

**The trachea: The first tissue-engineered organ?**

Pierre R. Delaere, MD, PhD,<sup>a</sup> and Dirk Van Raemdonck, MD, PhD<sup>b</sup>

A

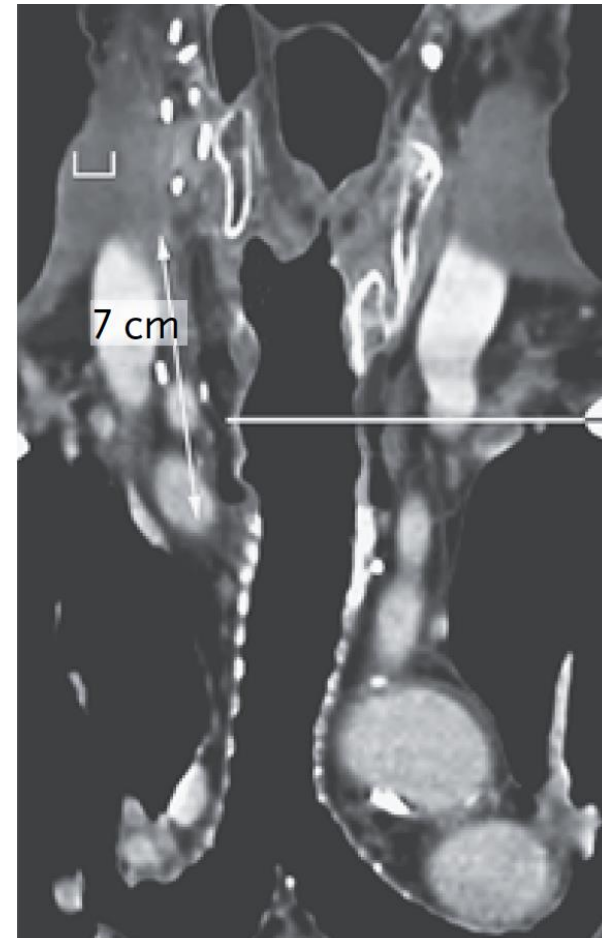
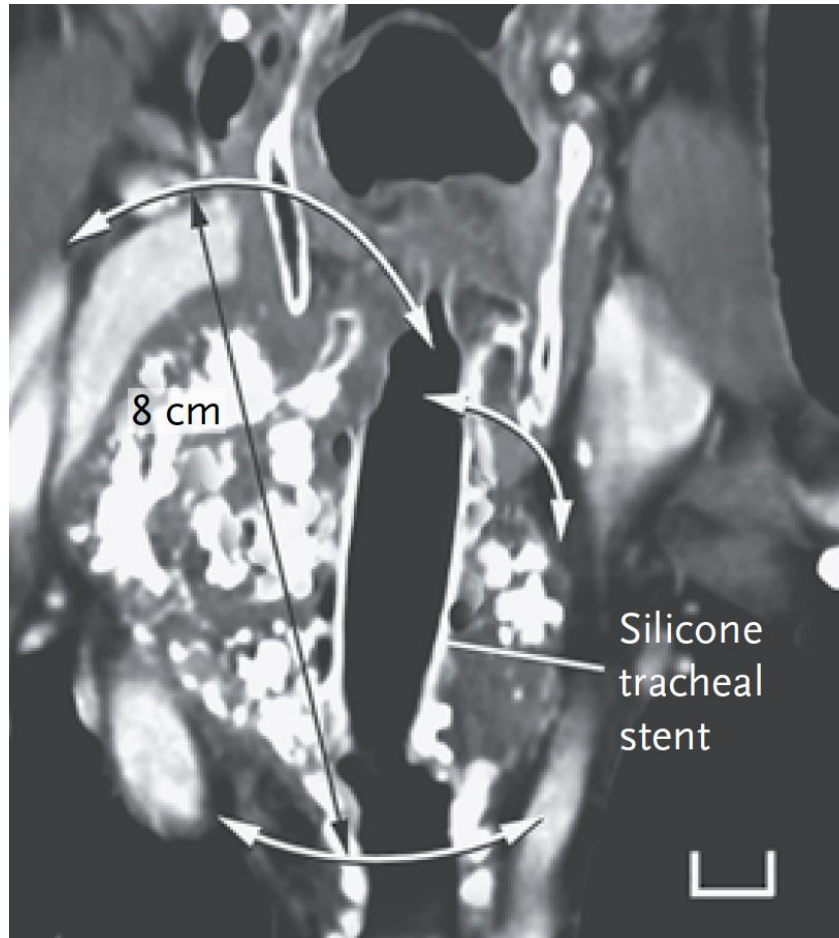




# Delaerre et al

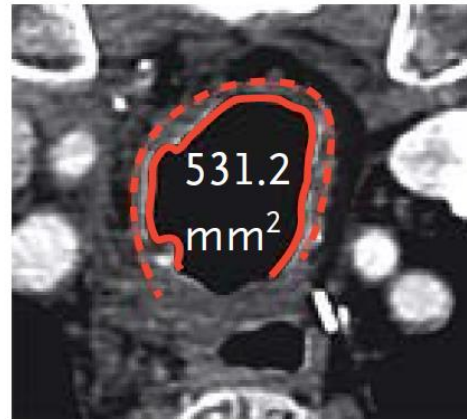


Princess Margaret Hospital





3 mo after transplantation



1 yr after withdrawal of  
immunosuppressive drugs

