Tracheal Allotransplantation after Heterotopic Revascularization

D. Van Raemdonck, et al
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The Trachea

‘The trachea is a relative simple conduit for air passage to and from the lungs’
Primary Resection & Anastomosis

< 5 cm
Difficult Tracheal Defects

Stenosis

Tracheal allotransplant

Tumor

Tracheal Allotransplant

> 5 cm
Problems in Tracheal Transplantation

- Segmental microvascular blood supply
- Immuno-suppression
- Direct Tracheal Tx ≠ safe

“a potentially life-threatening surgical procedure to treat a non-life-threatening condition”
Problems in Tracheal AlloTransplantation

- Cartilagenous framework
- Poor blood supply
- Ischemic necrosis
- Fibrosis - stricture
- Narrowing of the lumen
- Elastic structure
- Low antigenicity
- No rejection
CARDIAC AND PULMONARY REPLACEMENT

Experimental tracheal allograft revascularization and transplantation

Pierre R. Delaere, MD, PhD, Zi Ying Liu, MD, Robert Hermans, MD, Raf Sciot, MD, PhD, Louw Feenstra, MD, PhD

Leuven, Belgium

Revascularization of the trachea

research topic since 1991

- Orthotopic: tracheal autotransplantation
  - radial forearm subcutaneous & fascia flap
  - microvascular anastomosis radial A + V to neck vessels
  - to cover hemilaryngeal defects - tumor
  - 4 cm segment or revascularized trachea

- Heterotopic: tracheal allotransplantation
  - forearm: radial subcutaneous & fascia flap
  - omentum: omentoplasty
  - no swallowing, no coughing
  - viability allograft inspected
Orthotopic vascularization & Tracheal Autotransplantation

60 patients

Hemilaryngeal defect

Orthotopic revascularization

Tracheal autotransplant

Native larynx
Heterotopic Revascularization

Tracheal stenosis

Lung allotransplant

Tracheal Allotransplant-Heterotopic revascularization

Omentum

Tracheal Allotransplant-Orthotopic transplantation
Heterotopic Revascularization
Revascularization

Vascular induction & Angiogenesis

Donor vessels

Recipient vessels
Heterotopic Revascularization
Composite Tissue Transplantation

Recipient

- Forearm fascia
- Forearm skin
- Buccal mucosa
- Membranous trachea

Donor

- Cartilage rings
- Respiratory epithelium

Chimera

Preservation of normal airway
Preservation of normal voice
Orthotopic Allotransplantation

Tracheal low-grade chondrosarcoma
Concept of Tracheal Allotransplantation

Video
History of tracheal (allo)transplantation

1. Rose 1979, Cologne (hetero- + orthotopic)
2. Levashov 1993, St Petersburg (orthotopic)
3. Klepetko 2004, Vienna (heterotopic, no Tx)
4. Delaere 2010, Leuven (hetero- + orthotopic)
Letters to the Editor

TRACHEAL ALLOTRANSPLANTATION IN MAN

Sir,—We would like to present a preliminary report of the first allogeneic tracheal transplantation in man. There are several established surgical procedures available for resection and plastic reconstruction of limited tracheal stenoses. Bridging extensive circular defects of the trachea, however, has proved a problem. Denatured implants and those of foreign material have proved unsatisfactory, and most surgeons feel that allogeneic tracheal transplantation is not possible because the allotransplant will usually become necrotic within 2 months. In our experiments, we also found that circularly

Rose KG et al. Lancet 1979; 1:433
One-stage allotransplantation of thoracic segment of the trachea in a patient with idiopathic fibrosing mediastinitis and marked tracheal stenosis

Yu. N. Levashov, P. K. Yablonsky, S. M. Cherny, S. V. Orlov, B. B. Shafirovsky, I. M. Kuznetsov
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Heterotopic tracheal transplantation with omentum wrapping in the abdominal position preserves functional and structural integrity of a human tracheal allograft

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Enrico Melis, MD
Alfred Kocher, MD
Gernot Seebacher, MD
Clemens Aigner, MD
Samy Mazhar, MD

Figure 1. Donor trachea wrapped in the distal part of the great omentum.

J Thorac Cardiovasc Surg 2004; 127:862-7
Tracheal Allotransplantation after Withdrawal of Immunosuppressive Therapy

Pierre Delaere, M.D., Ph.D., Jan Vranckx, M.D., Ph.D., Geert Verleden, M.D., Ph.D., Paul De Leyn, M.D., Ph.D., and Dirk Van Raemdonck, M.D., Ph.D., for the Leuven Tracheal Transplant Group*

First Successful Case

B April 2008: Extent of Airway Collapse after Stent Removal

First Successful Case

First Succesfull Case

Axial CT scan of forearm

First Successfull Case

The ‘Leuven’ Experience

• Five clinical cases (since 2007)
  • 5 successfully revascularized heterotopically
  • 4 successfully transplanted to tracheal defect
  • 2 transplants (partially) lost after withdrawal I.S.
    Both patients had second allograft
    - implanted for heterotopic revascularization
    - orthotopic transplantation awaited
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The ‘Leuven’ Experience

Gradual withdrawal of I.S. medication

- Tacrolimus
- Azathioprine
- Methylprednisolone

Recipient blood vessels

Recipient epithelium
The ‘Leuven’ Experience

Incision intercartilagenous ligaments
64 y old male – recurrent chondrosarcoma

March 2011

Tracheal low-grade chondrosarcoma
64 y old male – recurrent chondrosarcoma
64 y old male – recurrent chondrosarcoma
Two months after Orthotopic Tracheal Allograft Transplantation
Tracheal Allotransplantation - Conclusion

Incision tyrohyoid ligament
Incision cricothyroid membrane
Posterior section line
Anterior section line
CT forearm
CT native trachea
Tracheal Allotransplantation - Conclusion

1. Safe transplantation after heterotopic revascularization under protection of I.S.

2. Search for optimal mucosal healing after withdrawal of immunosuppressive drugs.
Tracheal transplantation

Pierre R. Delaere

Learning Curve in Tracheal Allotransplantation (in press)
Tracheal Replacement with Aortic Allografts

TO THE EDITOR: We report tracheal replacement with fresh aortic allografts in two patients with large, chemotherapy-resistant and radiotherapy-resistant, bulky cervical metastases. Intubation failed by conventional T-tube. A silicone stent was interposed with end-to-end proximal and distal anastomoses (Fig. 1). To protect the large vessels from the stent-splinted graft, the cervical wound was covered by a mesh graft.

TO THE EDITOR: We report tracheal replacement with a bifurcated silicone stent was interposed with end-to-end anastomosis of the second tracheal ring.
Construction of a tube-shaped tracheal substitute using fascial flap-wrapped revascularized allogenic aorta

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