



## CARINAL RESECTION: WHICH APPROACH



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## INTRODUCTION

THE MOST CHALLENGING AREA OF AIRWAY RESECTION AND RECONSTRUCTION.

VARIABILITY OF RESECTION AND RECONSTRUCTION ACCORDING TO THE EXTEND OF THE LESION.

NO SINGLE IDEAL TECHNIQUE FOR RECONSTRUCTION.

Hermes C. Grillo

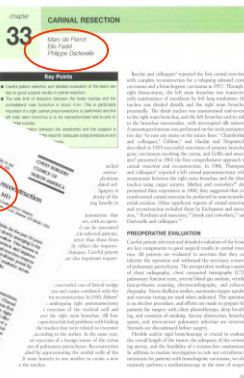
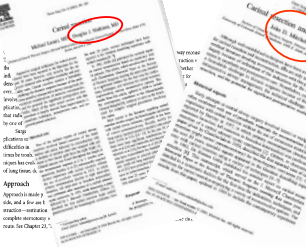


### CHAPTER TWENTY-NINE

#### Carinal Reconstruction

Hermes C. Grillo MD

Approach  
Anastomosis  
Resection  
Reconstruction

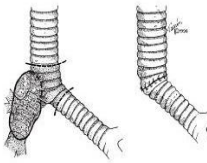


and others...

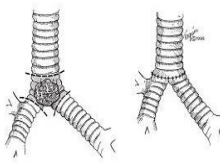
## DEFINITION

“Resection of the trachea-bronchial bifurcation”

With lung resection



Without lung resection



## INDICATION

NSCLC (N0 or single N2 post induction CT)  
Primitive airway tumors  
Benign lesions invading the carina

### TENSION FREE ANASTOMOSIS

the tumor should not extend beyond 2 cm of the lower trachea or more than 1.5 cm of the opposite main bronchus or the distance between the lower trachea and the opposite bronchus is not more than 4 cm



## CONTRAINDICATION

Impairment respiratory or cardiac function  
Extension of the tumor that hamper a tension free anastomosis  
Multiple N2 or N3 lymph node stations  
Distant metastasis  
Preoperative RT more than 45 Gy



## WORK UP

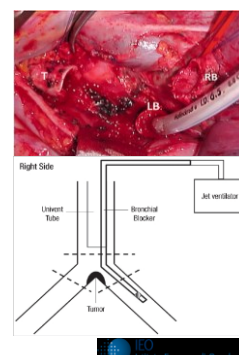
CT scan  
Pet scan fdg  
FBS  
EBUS TBNA and/or Mediastinoscopy for NSCLC

## MULTIDISCIPLINARY MEETING



## ANESTHESIA

Cross-field ventilation  
HFJV  
ECMO  
Spontaneous ventilation



## APPROACH

Right thoracotomy (IV space) → Right-sided lesions requiring a CR with pulmonary resection

Left thoracotomy → left tracheal sleeve PN (only for very limited tracheal resection)

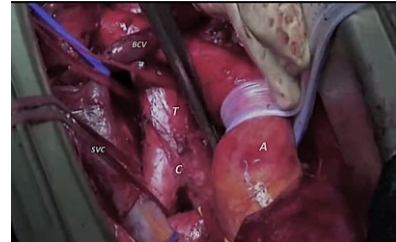


Sub-aortic dissection



## APPROACH

Sternotomy → CR without pulmonary resection and left tracheal sleeve PN



## APPROACH

VATS or RATS → only few cases in literature

J Thorac Cardiovasc Surg 2018

### Thoracoscopic surgery for tracheal and carinal resection and reconstruction under spontaneous ventilation

Long Jiang, MD, PhD,\* Jun Liu, MD, PhD,\* Diego Gonzalez-Rivas, MD,\* Yuesi Shupaili, MD,\* Martin Kohn, MD, PhD,\* Weiming Shao, MD, PhD,\* Qingling Dong, MD,\* Lixia Lang, MD,\* and Jianting He, MD, PhD\*

**OBJECTIVE:** To describe and assess the technique of spontaneous ventilation video-assisted thoracoscopic surgery (SV-VATS) for mediastinal intratumoral resection and reconstruction of the trachea and carina. **DESIGN:** Retrospective analysis. **SETTING:** Thoracic Surgery Department, West China Hospital, Chengdu, China. **PATIENTS:** 12 patients with tracheal and carinal lesions. **INTERVENTIONS:** SV-VATS for tracheal and carinal resection and reconstruction. **MEASUREMENTS AND MAIN RESULTS:** The median time for tracheal and carinal resection was 122.5 minutes (range 47–180 minutes) and the median time for reconstruction was 110.5 minutes (range 75–200 minutes). The median time for tracheal and carinal resection and reconstruction was 122.5 minutes (range 47–180 minutes) and the median time for reconstruction was 110.5 minutes (range 75–200 minutes). The median time for tracheal and carinal resection and reconstruction was 122.5 minutes (range 47–180 minutes) and the median time for reconstruction was 110.5 minutes (range 75–200 minutes). **CONCLUSIONS:** SV-VATS is a feasible procedure in tracheal and carinal resection and reconstruction in highly selected patients. It can be a valid alternative to conventional open VATS for airway surgery. © Thoracic Cardiovascular Surgery 2018;132:276–282.



6 carinal resections

Ann Thorac Surg 2016

### Video-Assisted Thoracic Surgery Resection and Reconstruction of Carina and Trachea for Malignant or Benign Disease in 12 Patients: Three Centers' Experience in China

Jingpei Li, MD,\* Wei Wang, MD,\* Long Jiang, MD,\* Weiqiang Yin, MD, Jun Liu, MD, Weiming Shao, MD, Handong Chen, MD, Kang-Liang Jeng, PhD (FRCSC) (C-7), Weijie Jiao, MD, Mingqiang Kang, MD, and Jianting He, MD, PhD

**OBJECTIVE:** To describe and assess the technique of video-assisted thoracoscopic surgery (VATS) for mediastinal intratumoral resection and reconstruction of the trachea and carina. **DESIGN:** Retrospective analysis. **SETTING:** Thoracic Surgery Department, West China Hospital, Chengdu, China. **PATIENTS:** 12 patients with tracheal and carinal lesions. **INTERVENTIONS:** VATS for tracheal and carinal resection and reconstruction. **MEASUREMENTS AND MAIN RESULTS:** The median time for tracheal and carinal resection was 122.5 minutes (range 47–180 minutes) and the median time for reconstruction was 110.5 minutes (range 75–200 minutes). The median time for tracheal and carinal resection and reconstruction was 122.5 minutes (range 47–180 minutes) and the median time for reconstruction was 110.5 minutes (range 75–200 minutes). **CONCLUSIONS:** VATS is a feasible procedure in tracheal and carinal resection and reconstruction in highly selected patients. It can be a valid alternative to conventional open VATS for airway surgery. © Thoracic Cardiovascular Surgery 2016;132:276–282.

8 carinal resections

## Editorial

### Awake minimal invasive carinal resection—tightrope walking in thoracic surgery?

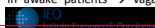
Thomas Schweiger, Walter Klepetko, Konrad Hoetzenecker

Almost 4 hours operation time, three incisions, 12 days of postoperative fixation of the chin → **real benefit?**

No clear evidence that the technique itself results in more precise surgical performance, enhanced oncological radicality or improved bronchial healing.

How much of tension between the tracheal and bronchial stump in a long distance carinal resection could still be handled with this technique?

Ventilation is limited to the delivery of high-flow oxygen through a laryngeal mask → what if this ventilation is insufficient? Blood and secretions collecting in the airways cannot be suctioned in awake patients → vagal stimulation



## CARINAL RESECTION WITH LUNG

Performed in case of NSCLC involving the origin of the main bronchus (right or left) and/or the carina

Author	Year	Number of patients	Morbidity (%)	Mortality (%)	5-year survival (%)
Darleville	1995	55	10.8	7.3	40
Mitchell	2001	35	46	20	38
Porhanov	2002	231	35.4	16	19
Regnard	2005	60	54	8.5	26
Rovaro	2006	53	11.3	7.5	33.4
da Pemet	2006	119	47	7.6	44
Maschiarini	2006	34	16	2	51
Rea	2008	49	28.6	6.1	27.5
Eichhorn	2013	64	40	3	31
Galetta	2018	32	21.8	9	30.3

10.8-47%

2-20%

16-44%

Weder, J Thorac Dis 2016

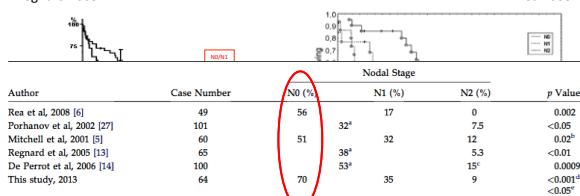


## FACTOR AFFECTING SURVIVAL

*pN0 > 50% 5 years*

Regnard 2005

Rea 2008



\* N0 and N1.

\* N0/N1 vs N2.

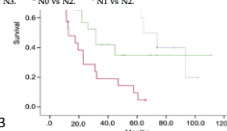
\* N2 and N3.

\* N0 vs N2.

\* N1 vs N2.

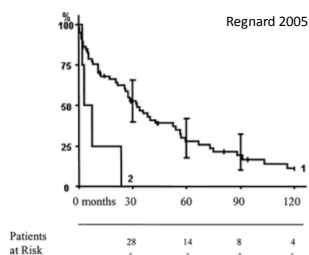
Eichhorn 2013

Eichhorn 2013



## FACTOR AFFECTING SURVIVAL

*Completeness of resection*

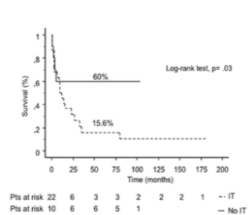
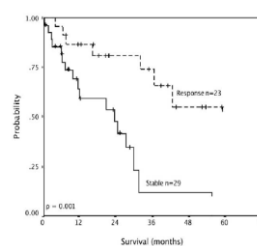


## FACTOR AFFECTING SURVIVAL

*Induction therapy*

Port 2005

Galetta 2018



INDUCTION THERAPY

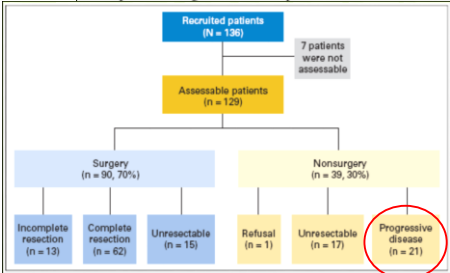
- Small number of extended resections for too advanced disease
- High rate of exploratory thoracotomy
- High rate of positive margins after resection
- High rate of systemic recurrences after extended resection
- Unsatisfactory survival outcomes



....BUT

Long-Term Survival Associated With Complete Resection After Induction Chemotherapy in Stage IIIA (N2) and IIIB (T4N0-1) Non-Small-Cell Lung Cancer Patients: The Spanish Lung Cancer Group Trial 9901

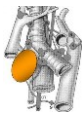
JCO 2008



INDUCTION THERAPY

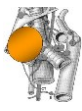
Personal experience

1) Less than 0.5 cm



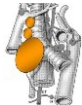
NOT

2) Carina and SVC



YES

3) Presence of N2 disease (excluding station 2)



YES



CARINAL RESECTION WITH LUNG

	YEAR	PERIOD	N	N/YEAR	CANCER
Grillo*	1999	'62 – '96 (35 years)	135 (143)	4.7	87.4%
Dartevelle**	2017	'81-2011 (30 years)	138	4.6	100%

\* Mitchell, JTCVS 1999

\*\* Dartevelle, Gen Thorac Cardiovasc Surg 2017



GRILLO, 1999

	WITH LUNG RESECTION	WITHOUT LUNG RESECTION
R pn	30.7% (1,25 pt/yr)	36.3% (1.5 pt/yr)
L pn	9% (0.37 pt/yr)	
Lob	7.7% (0.31 pt/yr)	

one left tracheal sleeve pn every 3 yr !!!  
one carinal lobectomy every 3 yr !!!

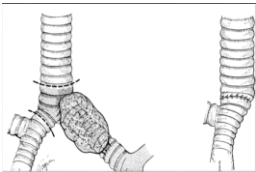
DARTEVELLE, 2017

	WITH LUNG RESECTION	WITHOUT LUNG RESECTION
R pn	89.1% (4.1 pt/yr)	2.2% (0.1 pt/yr)
L pn	2.8% (0.1 pt/yr)	
Lob	5.8% (0.3 pt/yr)	

one left tracheal sleeve pn every 10 yr !!!  
one carinal lobectomy every 3 yr !!!

CARINAL RESECTION WITH LUNG

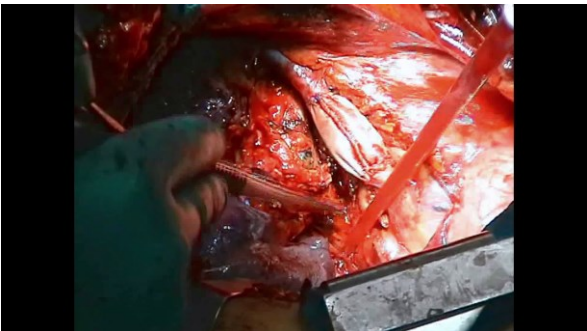
Left tracheal sleeve pneumonectomy



	Year	N	L/R	pt/year	Mortality %
Mitchell	1999	57	13/44	0.37	16R;31L
Regnard	2005	60	2/58	0.1	8.5
Roviaro	2006	53	1/52	0.47	7.5
De Perrot	2006	103	7/96	0.3	3R;0L
Rea	2008	49	1/48	0.43	6.1
Eichhorn	2013	64	3/61	0.27	3

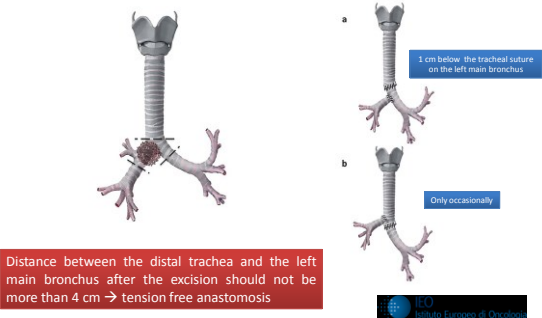
CARINAL RESECTION WITH LUNG

Right tracheal sleeve pneumonectomy



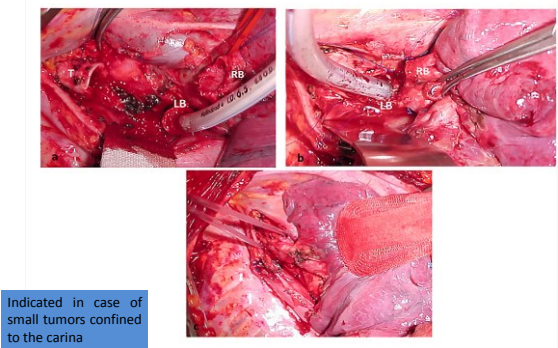
CARINAL RESECTION WITH LUNG

Carinal resection with right upper lobectomy or bilobectomy



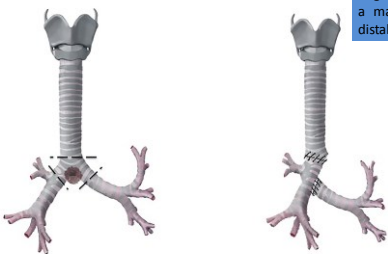
CARINAL RESECTION WITHOUT LUNG

NEO-CARINA



CARINAL RESECTION WITHOUT LUNG

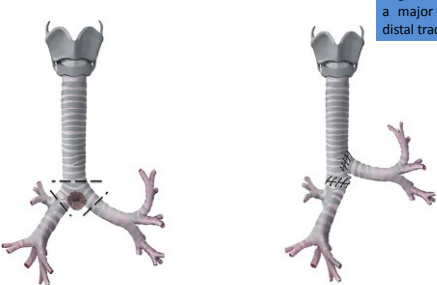
BARCLAY TECHNIQUE



only if the right main bronchus is sufficiently long to allow an adequate cross-field ventilation during the end-to-side anastomosis

CARINAL RESECTION WITHOUT LUNG

GRILLO TECHNIQUE



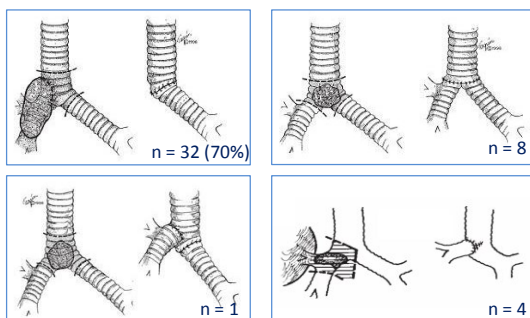
Technically more challenging and only rarely indicated

## CARINAL RESECTION WITHOUT LUNG

### ESCHAPASSE OR REVERSE BARCLAY TECHNIQUE



## OUR EXPERIENCE

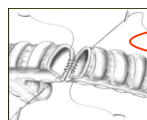


45 pts/ 20 yrs (2.3/yr)



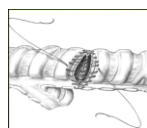
## ANASTOMOSIS - SUTURE

### Two running 3/0 polipropylene sutures



#### TRACHEOBRONCHIAL SLEEVE RESECTION WITH THE USE OF A CONTINUOUS ANASTOMOSIS: RESULTS OF ONE HUNDRED CONSECUTIVE CASES

Central Asia, MD, PhD  
Peter Goldmann, MD, FRCGS



**Objective:** We have used a continuous suture technique for all tracheal and bronchial anastomoses with satisfactory results in our institution. The objective of this article is to review our experience with sleeve resections using this technique and report the associated morbidity and mortality in 100 consecutive cases. **Methods:** Our experience with sleeve resection using a continuous suture (3-0 polypropylene) technique was reviewed in 100 consecutive cases. The median age of the patients was 53.3 years with a range of 21 to 81 years. There were 51 male patients and 49 female patients. Resection was undertaken for malignant disease in 81 patients, acquired stricture in 14 patients, benign tumor in 4 patients, and trauma in 1 patient. Among 28 patients in whom lung parenchyma was not resected, 16 patients had tracheal resection and 12 had bronchial sleeve resection. Sleeve pneumonectomy was undertaken in 2, sleeve lobectomy in 46, and sleeve segmentectomy in 4. **Results:** There were 12 postoperative complications (12%) and 2 postoperative deaths resulting from bronchovascular fistula and pneumonia (2%). Stricture as a late complication occurred in 5 patients, 2 of whom required a bronchial stent. Other late complications were bronchopleurocutaneous, and completion pneumonectomy (1 each). **Conclusion:** Our experience suggests that the results of continuous suture technique are comparable with those from reported series using interrupted suture technique for tracheal and bronchial anastomosis. (J Thorac Cardiovasc Surg 1999;117:1112-7)



## ANASTOMOSIS - OUTCOME

*Personal experience*



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## COMPLICATIONS

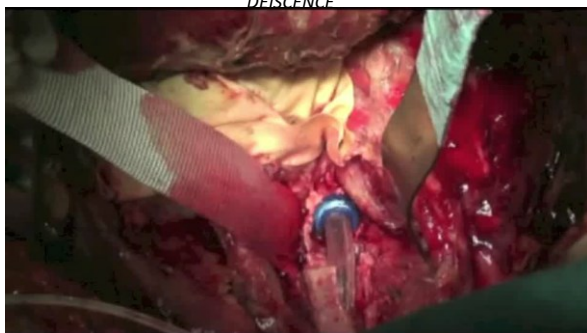
Tapias 2015

Author, Year	n	Mortality, %	Morbidity, %	Anastomotic Complications, %					Empyema, %	5-y Survival, %
				Bronchopleural Fistula/Dehiscence/Ischemia	Bronchovascular Fistula	Stenosis	Local Recurrence			
Carinal resection										
Tobler et al. <sup>10</sup> 1992	1915	20.9	—	10.1	2.9	—	4.2	8.6	—	—
Mitchell et al. <sup>11</sup> 1992	194	12.7	38.8	17.2*	—	—	—	2.2	—	—
Mitchell et al. <sup>12</sup> 2011	60	15.0	45.0	16.7*	—	—	3.3	—	—	42
Porhanov et al. <sup>13</sup> 2002	231	16.0	35.5	21.6	—	7.4	5.0	14.7	—	25
Reynard et al. <sup>14</sup> 2005	65	7.7	50.8	10.8	—	4.6	—	7.7	—	27
de Perrot et al. <sup>15</sup> 2006	119	7.6	47.1	10.1	—	2.5	4.2	5.0	—	44
Roviaro et al. <sup>17</sup> 2006	53	7.5	11.3	3.8	—	—	—	1.9	—	33
Eichhorn et al. <sup>18</sup> 2013	64	3.1	40.6	10.9	—	—	—	10.9	—	31

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## COMPLICATIONS

*"MASSIVE TRACHEAL ISCHEMIA WITH ANASTOMOSIS" DEISCENCE*



## CONCLUSIONS

**Carinal resection is feasible but challenging**

**Low rate of postoperative morbidity and mortality**

> in specialized center with high experience

**Excellent survival results**

> best candidate N0-N1

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## CONCLUSIONS

*ONCOLOGICAL PRINCIPLES IN LUNG  
CANCER TREATMENT MUST BE  
RESPECTED...*

*...PATIENT MUST SURVIVE SURGICAL  
RESECTION !!!*

