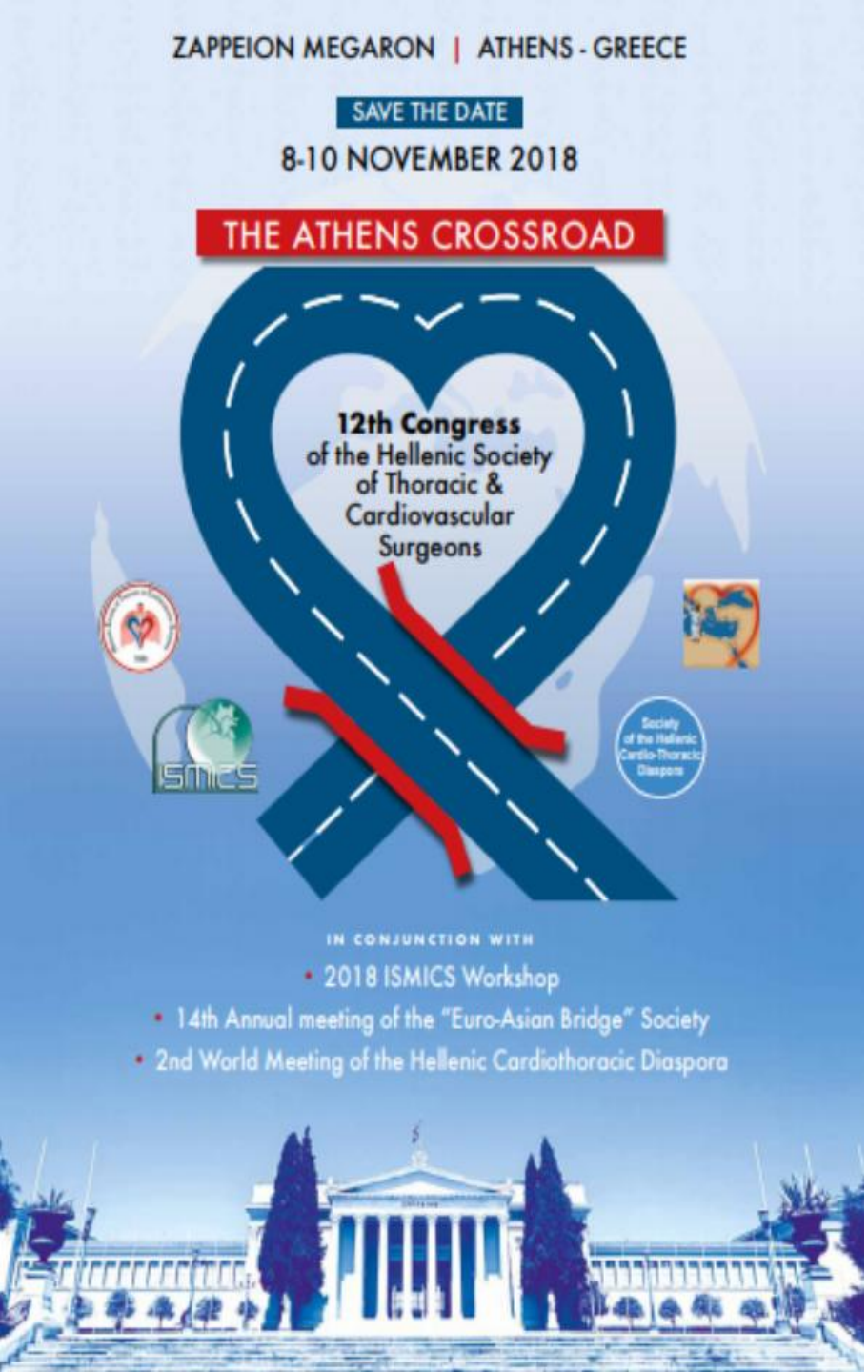

Complex Thoracic Tumor Surgery

Surgical Resections of T3 & T4 Lung Tumors

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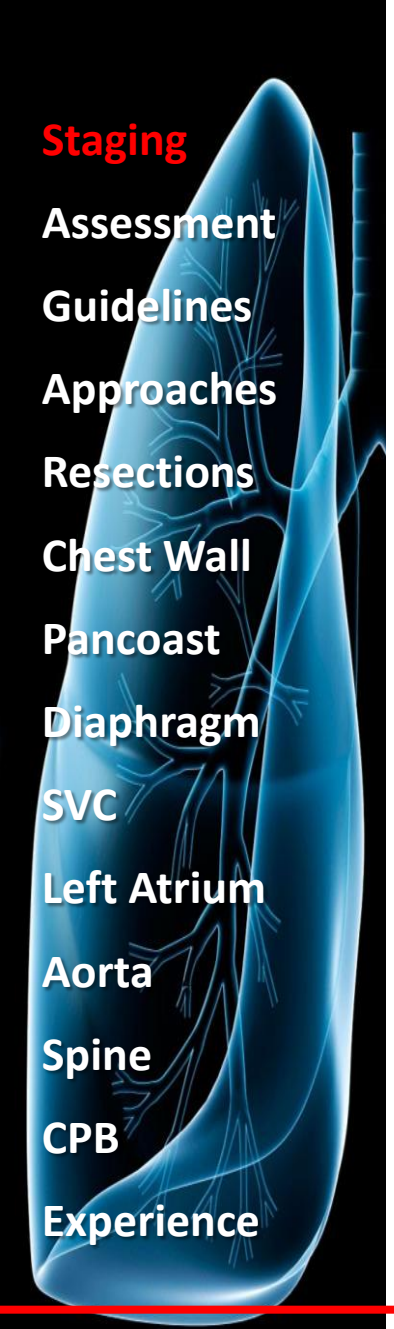

8th Lung Cancer Staging

TABLE 3] Definitions for T, N, and M Descriptors

T (Primary Tumor)		Label
T0	No primary tumor	
Tis	Carcinoma in situ (Squamous or Adenocarcinoma)	Tis
T1	Tumor ≤3 cm,	
T1a(mi)	Minimally Invasive Adenocarcinoma	T1a*(mi)*
T1a	Superficial spreading tumor in central airways[a]	T1a *SS*
T1a	Tumor ≤1 cm	T1a *≤1*
T1b	Tumor >1 but ≤2 cm	T1b *>1-2*
T1c	Tumor >2 but ≤3 cm	T1c *>2-3*
T2	Tumor >3 but ≤5 cm or tumor involving:	
	visceral pleura[b],	T2 *Visc Pl*
	main bronchus (not carina), atelectasis to hilum[b]	T2 *Centr*
T2a	Tumor >3 but ≤4 cm	T2a *>3-4*
T2b	Tumor >4 but ≤5 cm	T2b *>4-5*
T3	Tumor >5 but ≤7 cm	T3 *>5--7*
	or invading chest wall, pericardium, phrenic nerve	T3 *Inv*
	or separate tumor nodule(s) in the same lobe	T3 *Satell*
T4	Tumor >7 cm	T4 *>7*
	or tumor invading: mediastinum, diaphragm, heart, great vessels, recurrent laryngeal nerve, carina, trachea, esophagus, spine;	T4 *Inv*
	or tumor nodule(s) in a different ipsilateral lobe	T4 *Ipsi Nod*

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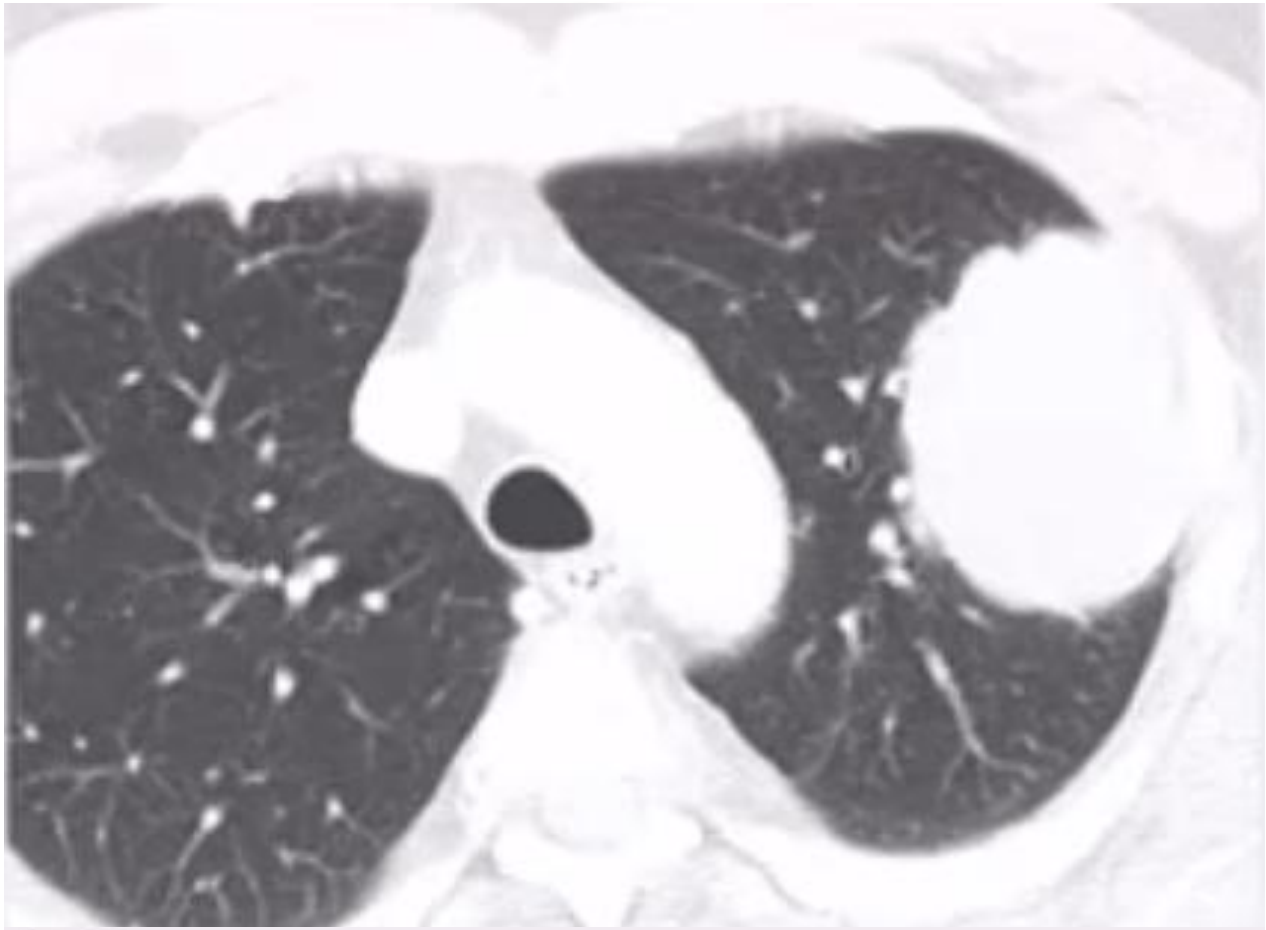
F. Dettterbeck, D.Boffa, A. Kim, L.Tanoue
CHEST 2017; 151(1):193-203

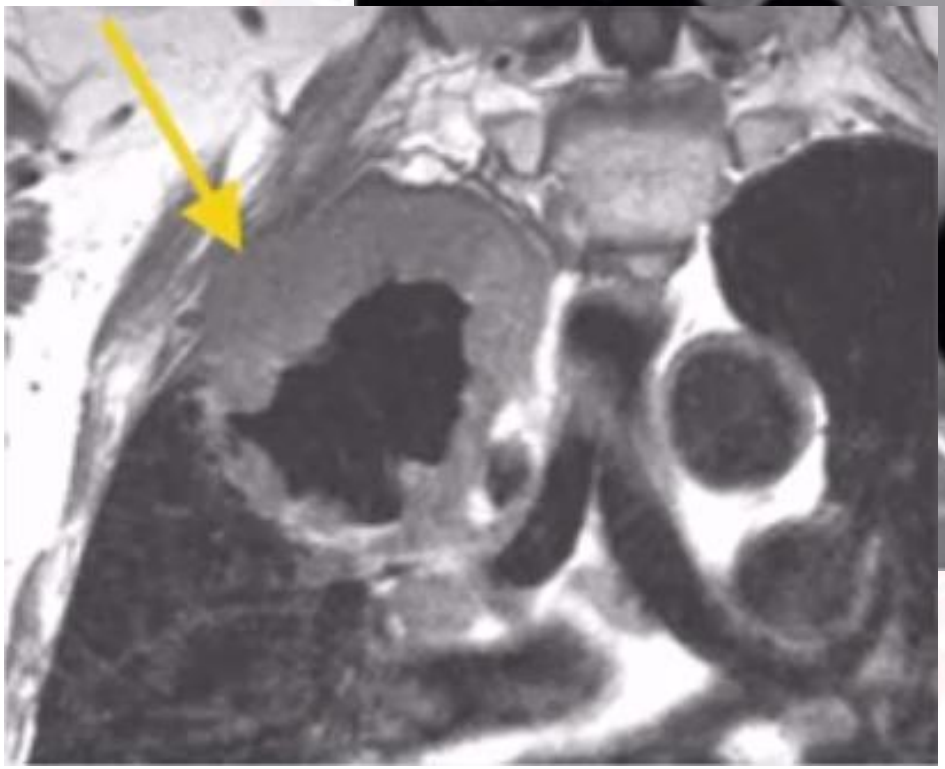
T3 tumors

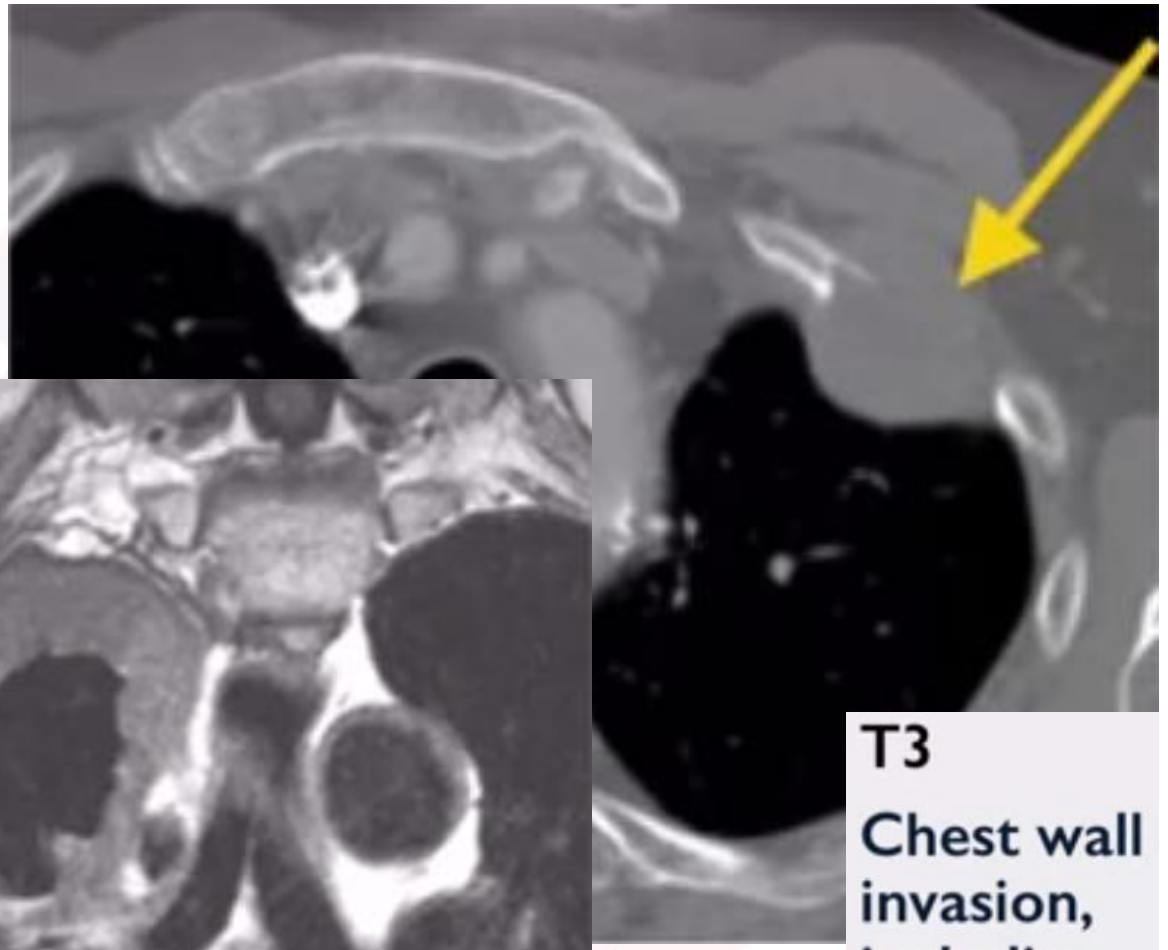


T3

- >5 – 7 cm in greatest dimension

T3 tumors





T3

Chest wall invasion, including superior sulcus

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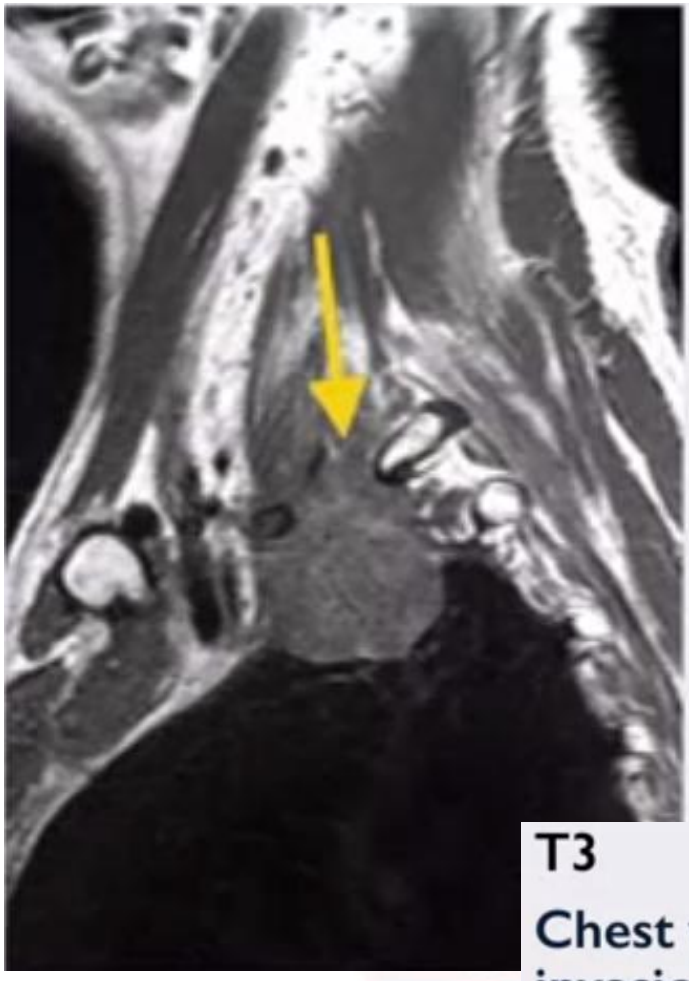
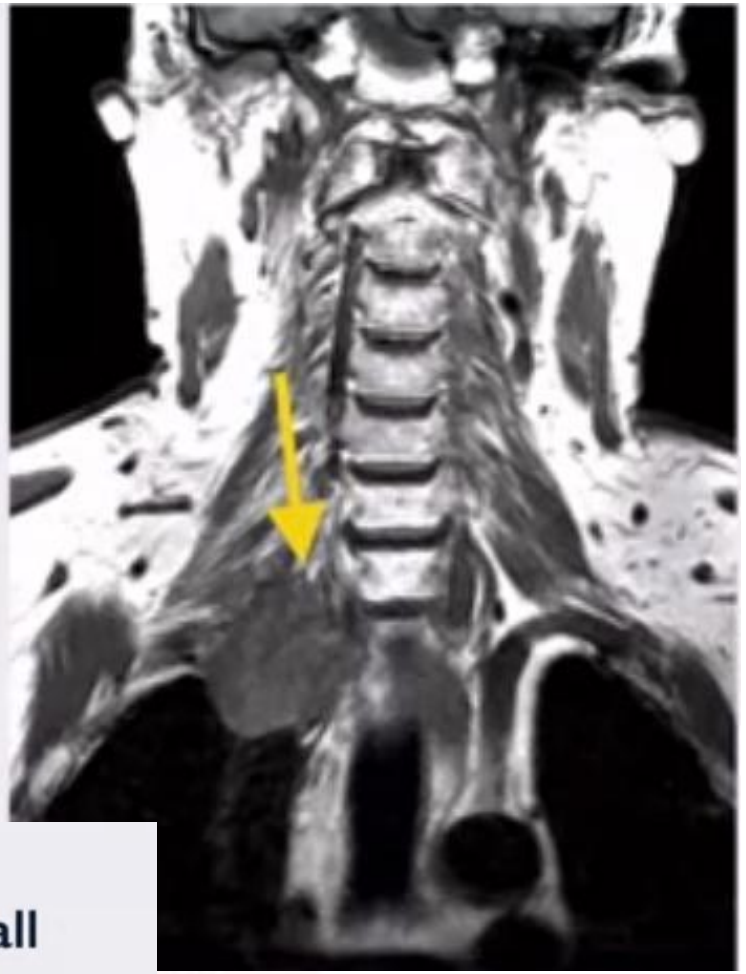
T3 tumors





T3

Chest wall invasion, including superior sulcus

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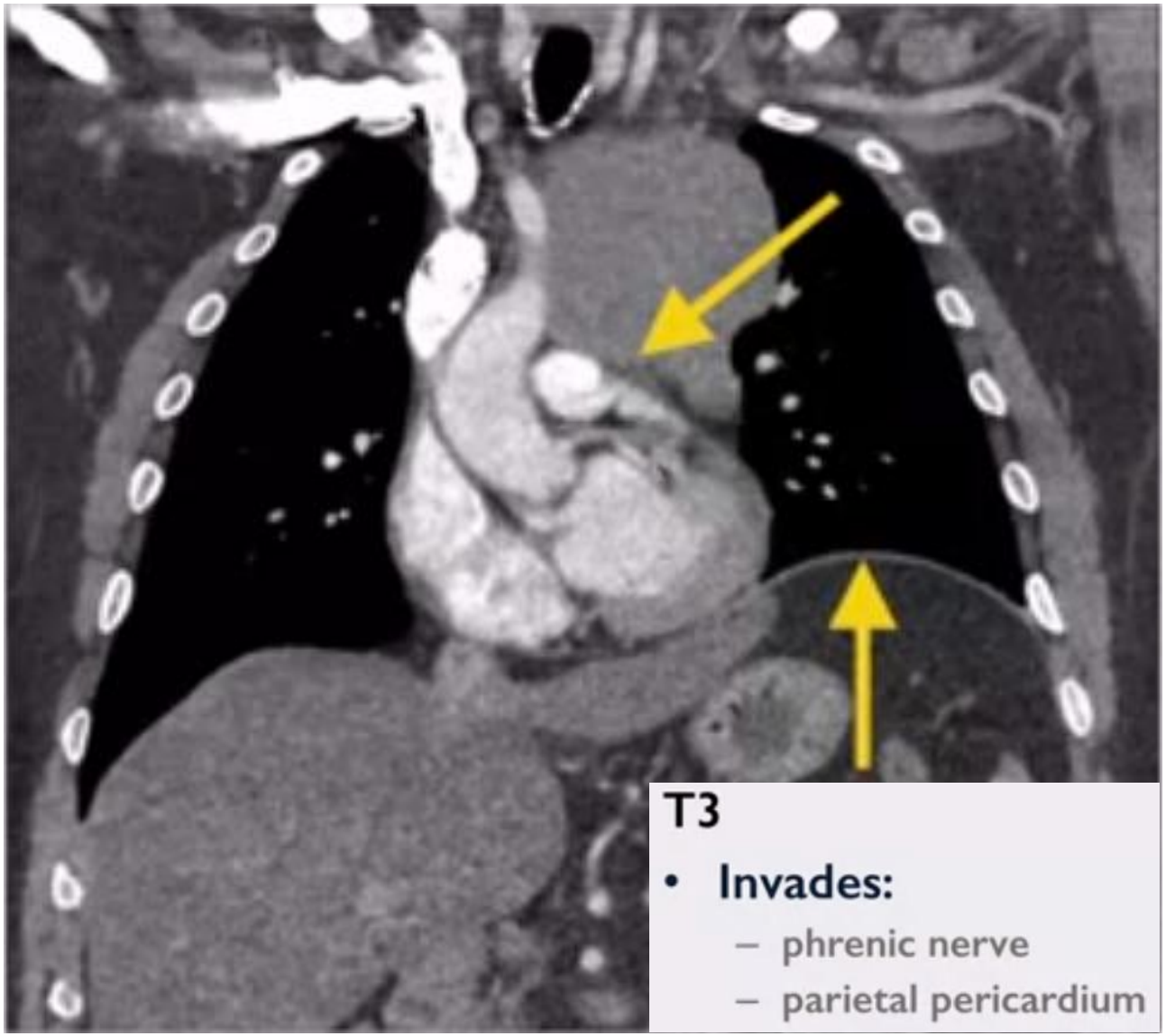
T3 tumors



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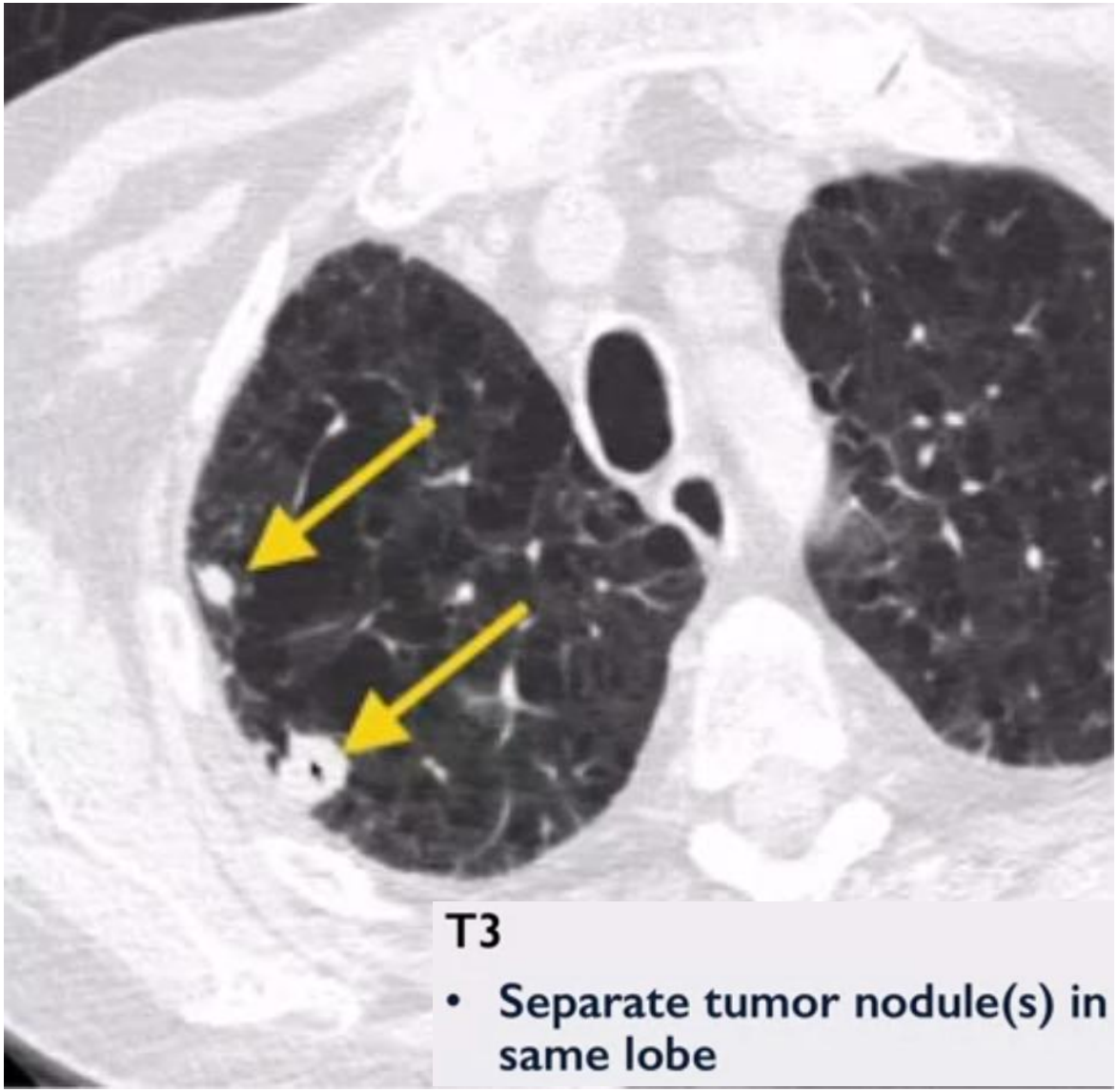
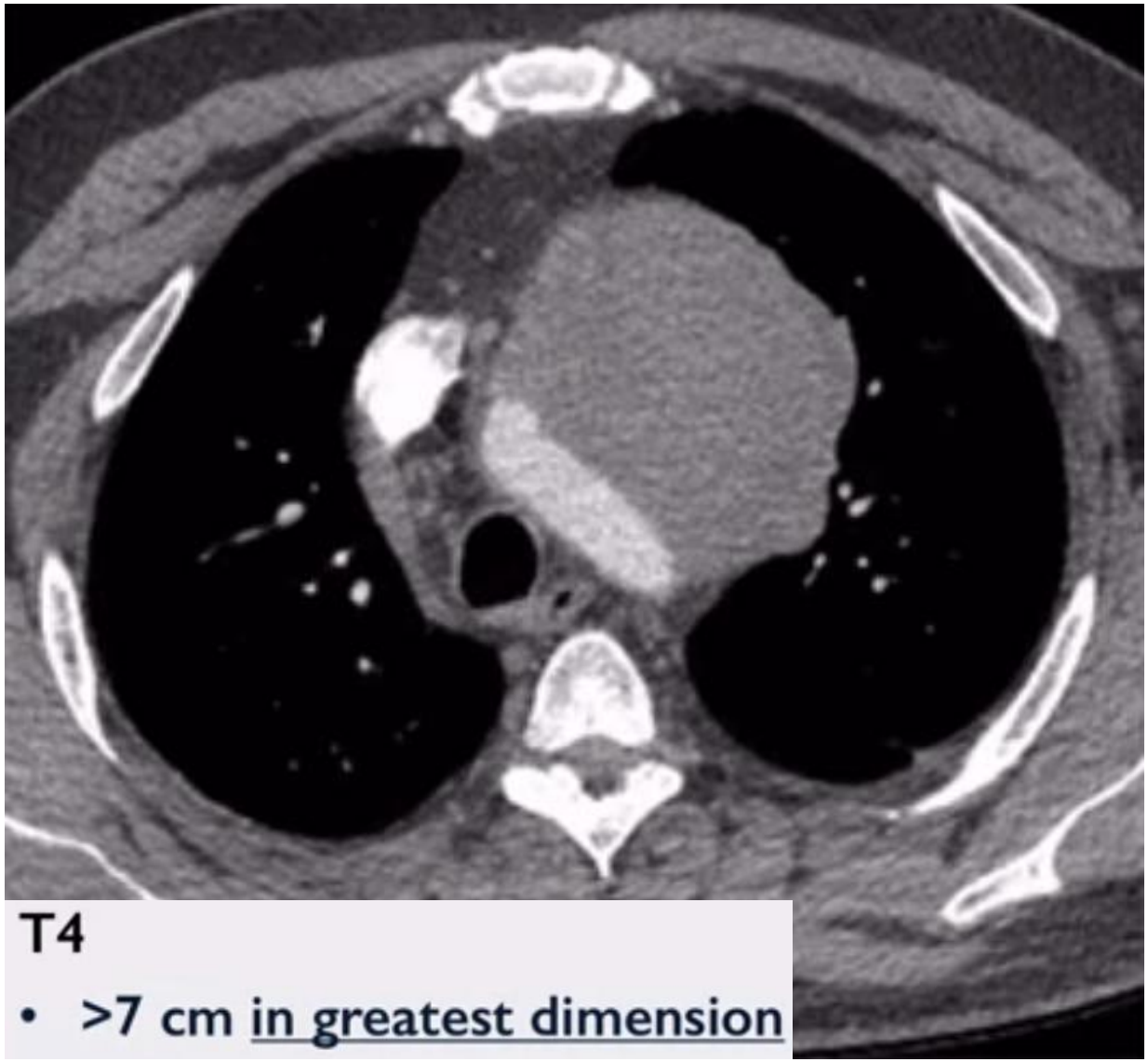
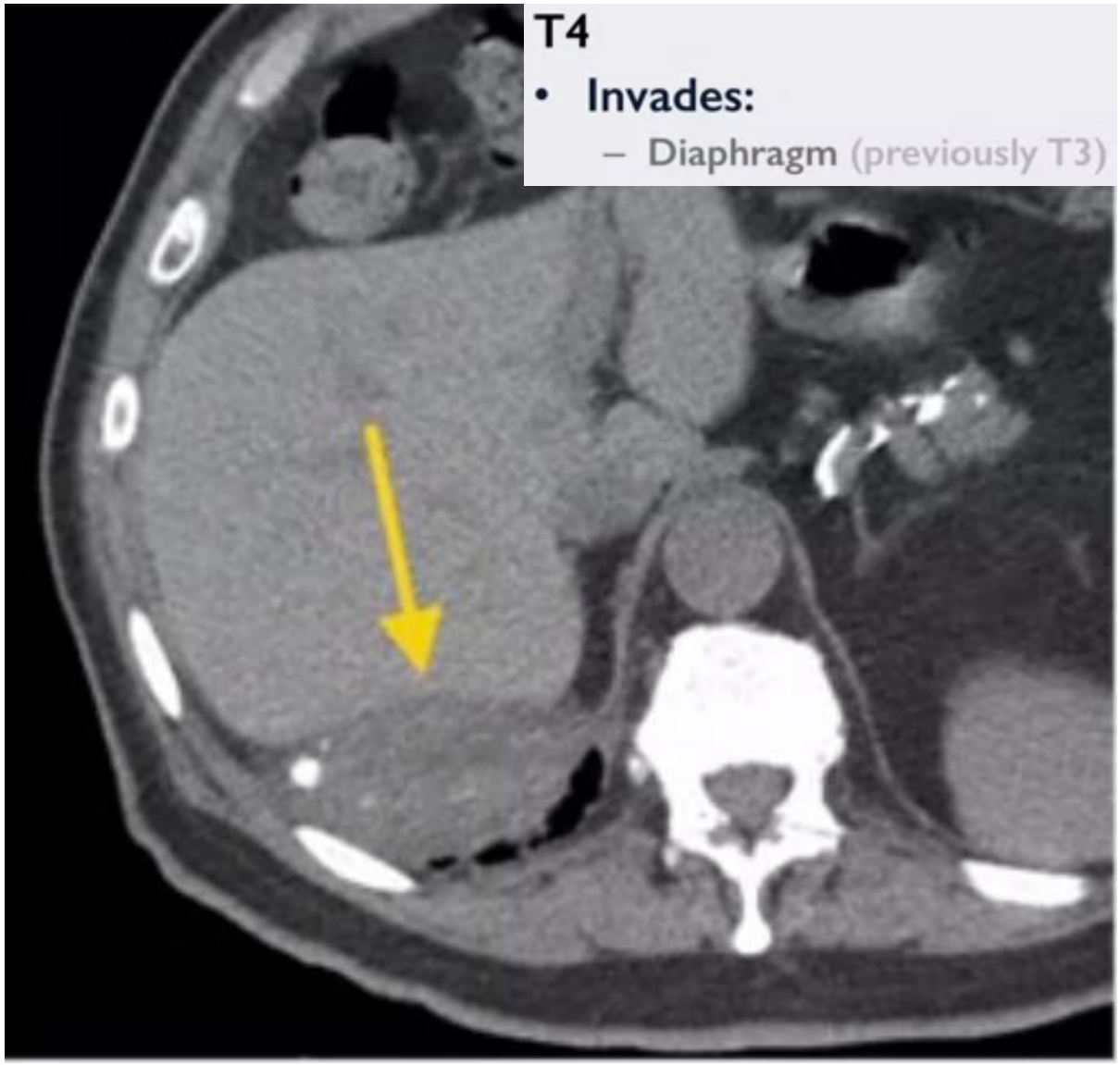
T3 tumors



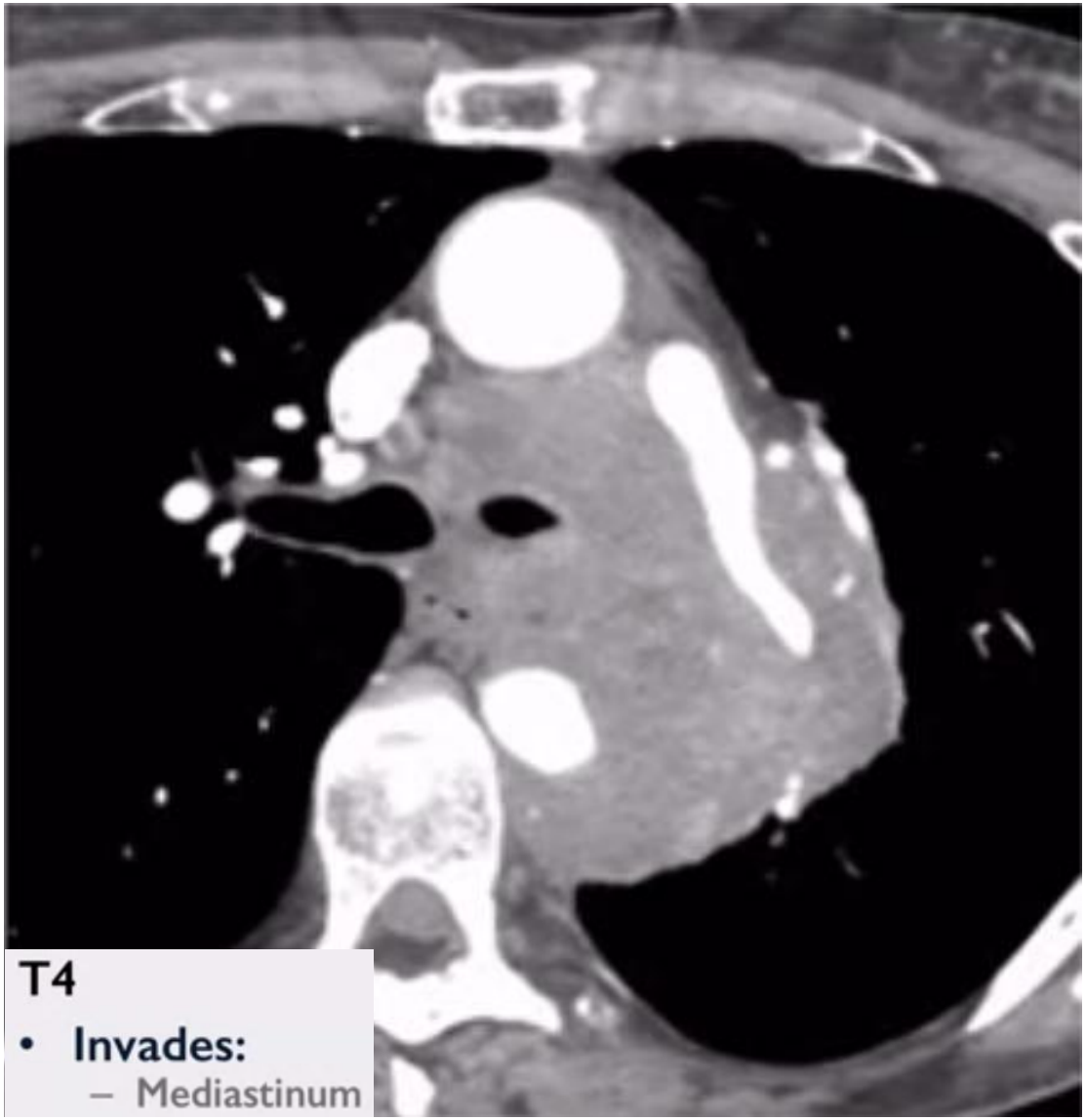
T4 tumors



T4 tumors



T4 tumors



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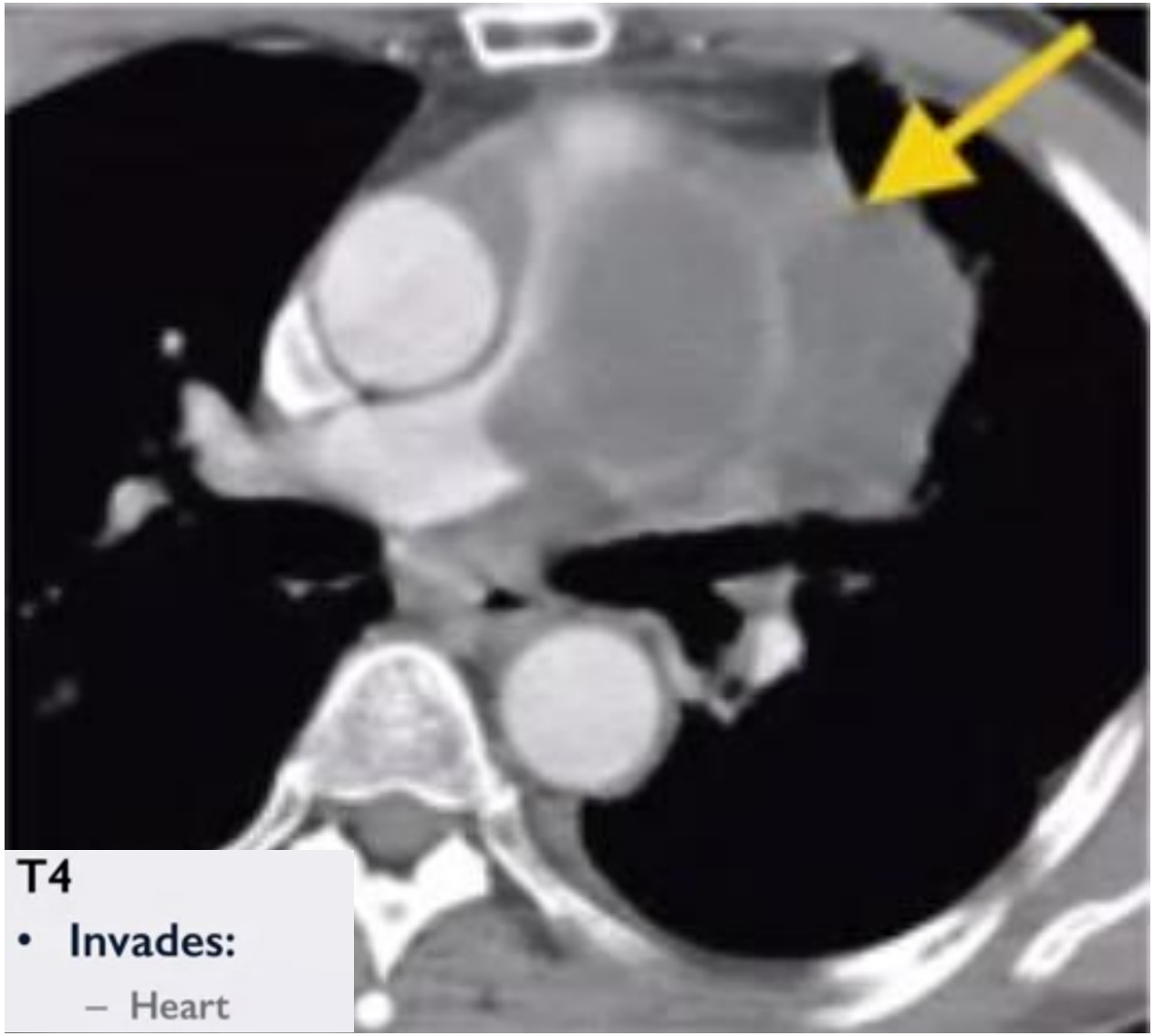
T4 tumors



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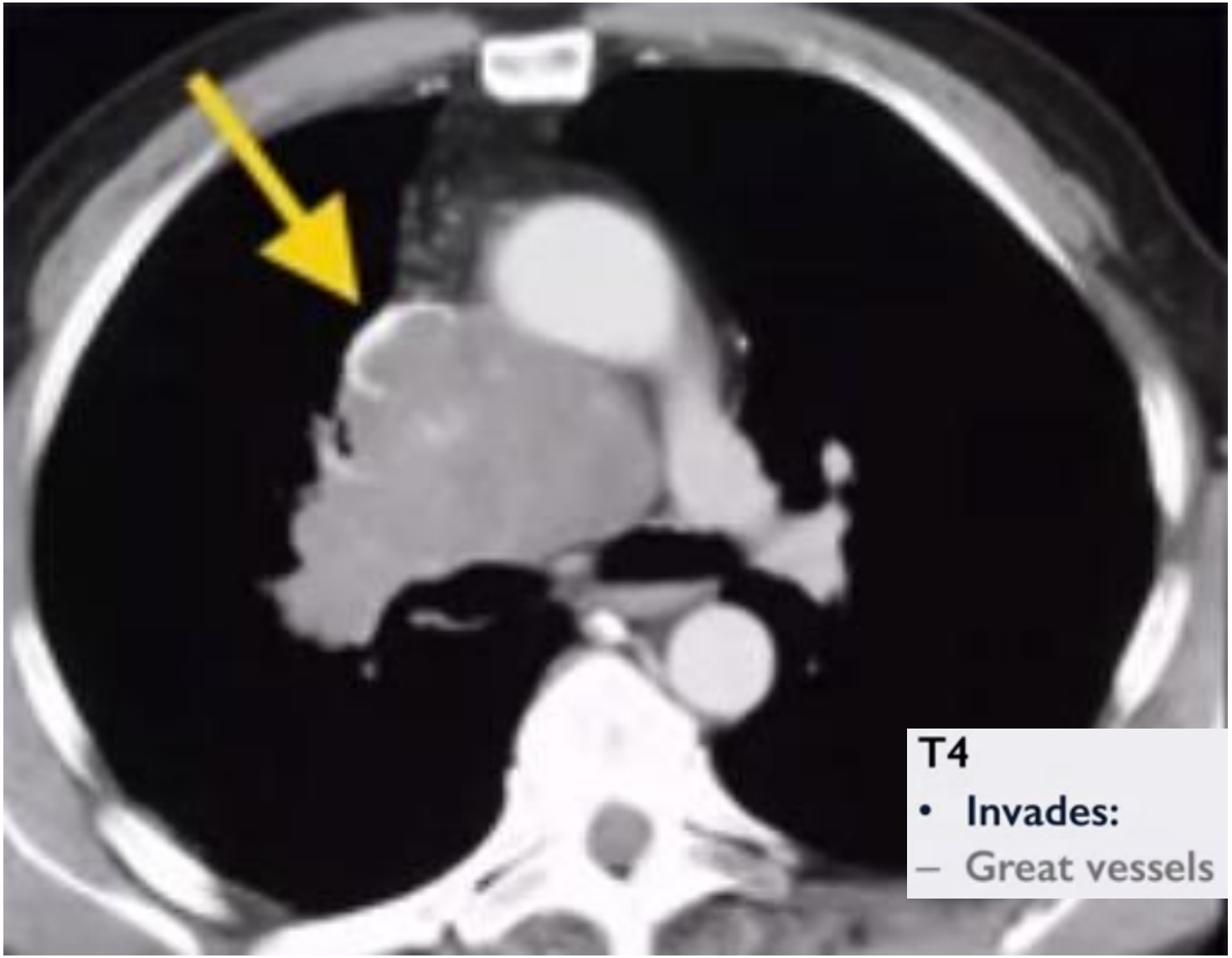
T4 tumors



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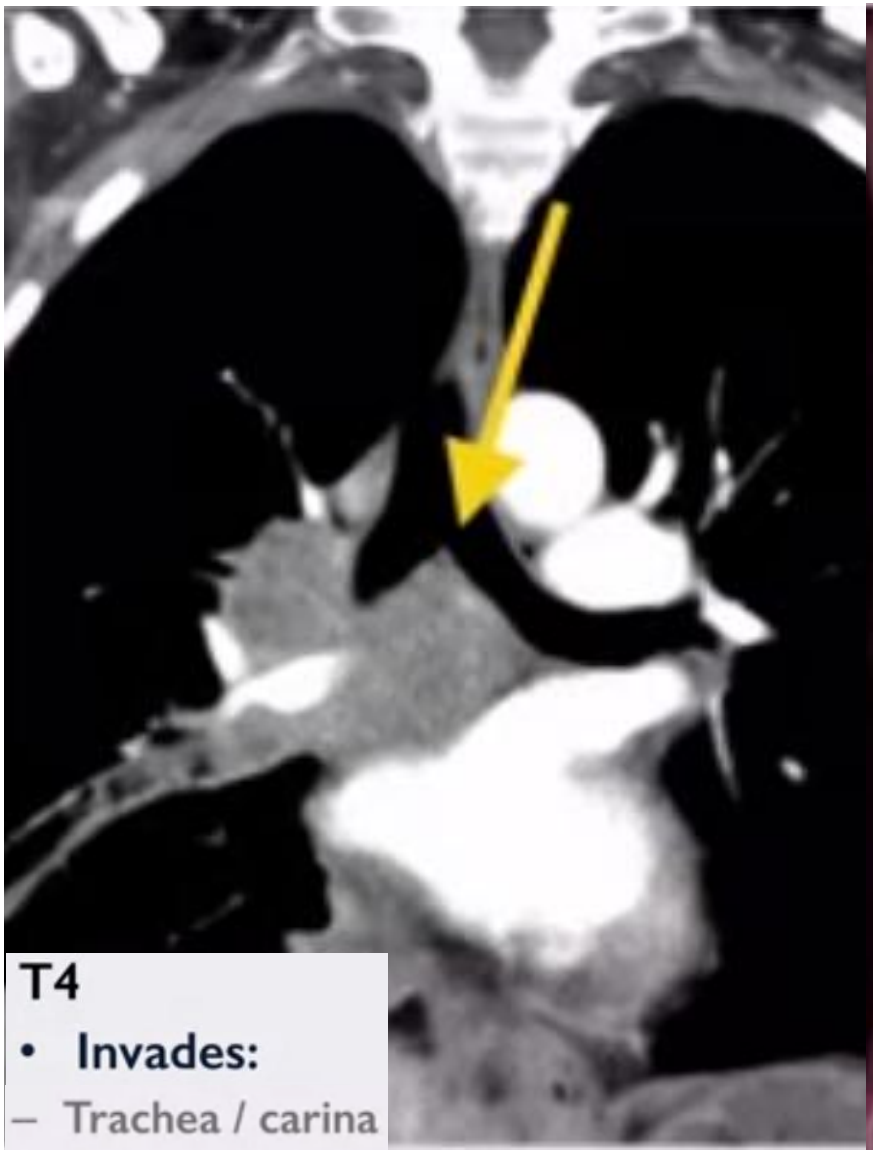
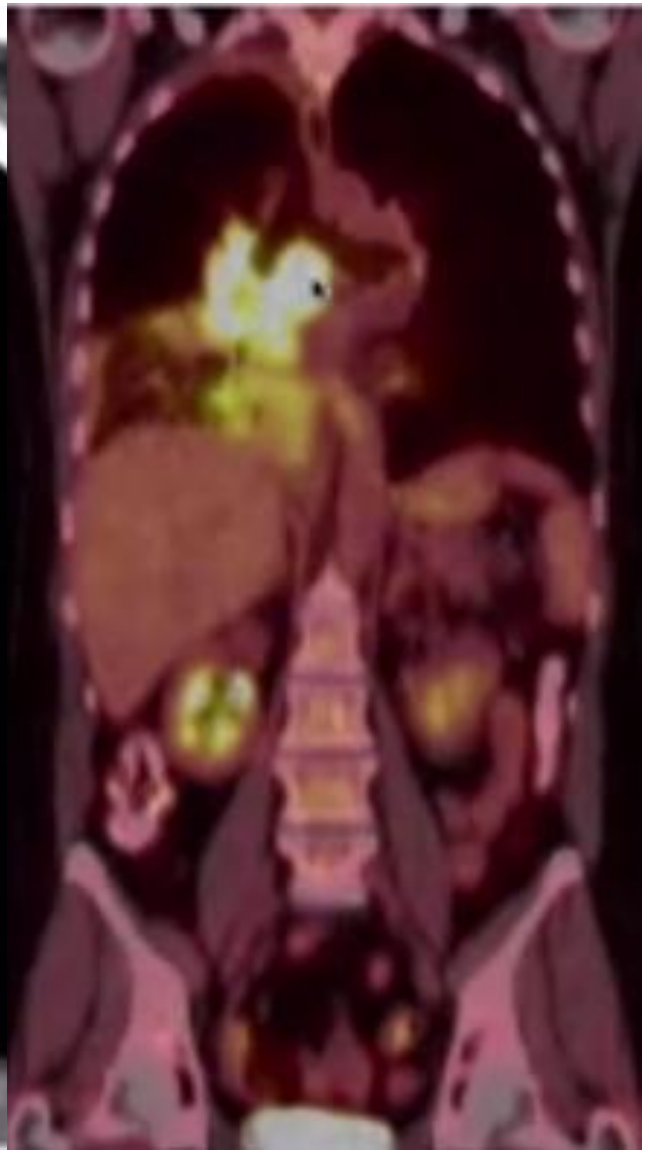
T4 tumors





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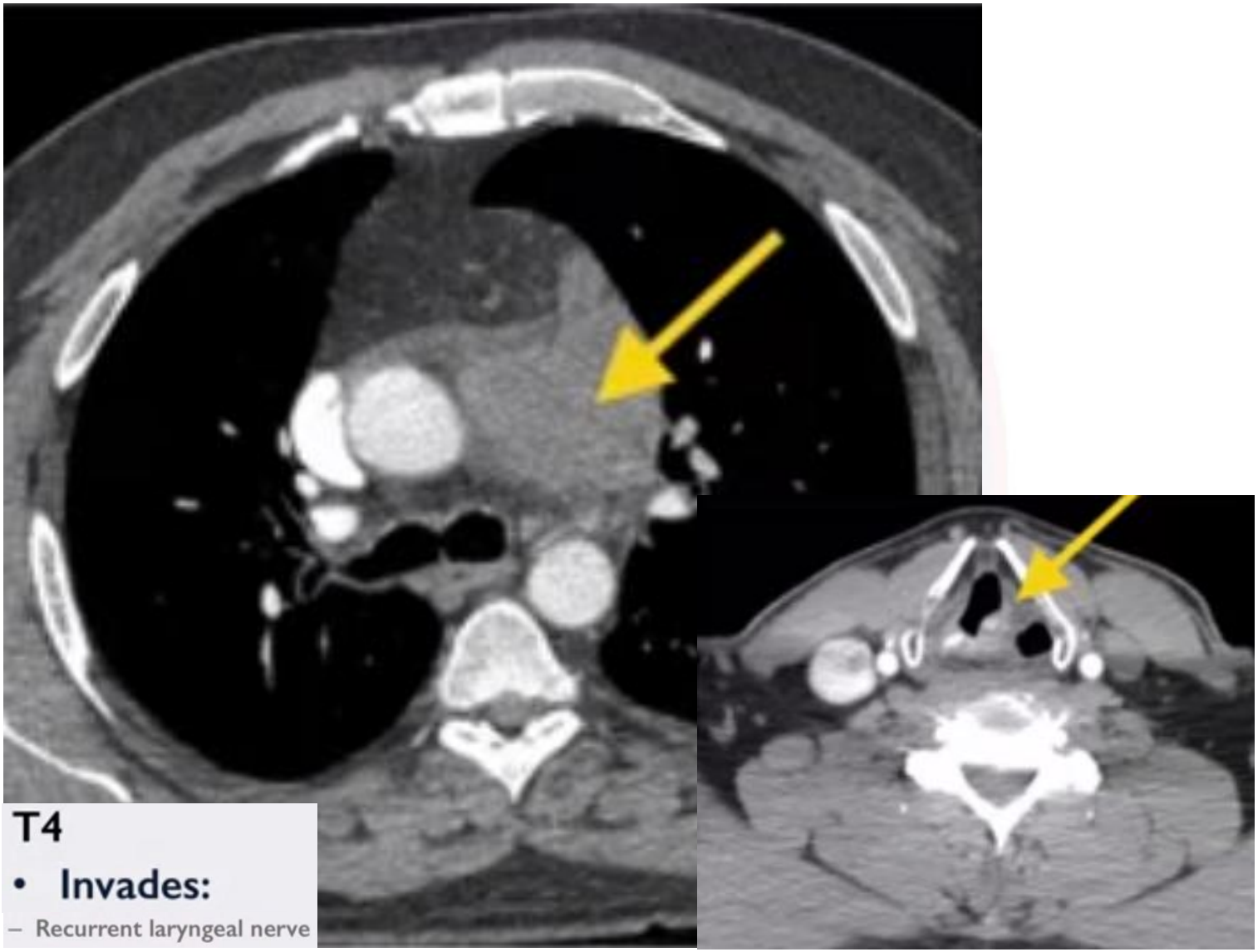
T4 tumors

- Staging
- Assessment
- Guidelines
- Approaches
- Resections
- Chest Wall
- Pancoast
- Diaphragm
- SVC
- Left Atrium
- Aorta
- Spine
- CPB
- Experience



T4

- **Invades:**
  - Recurrent laryngeal nerve

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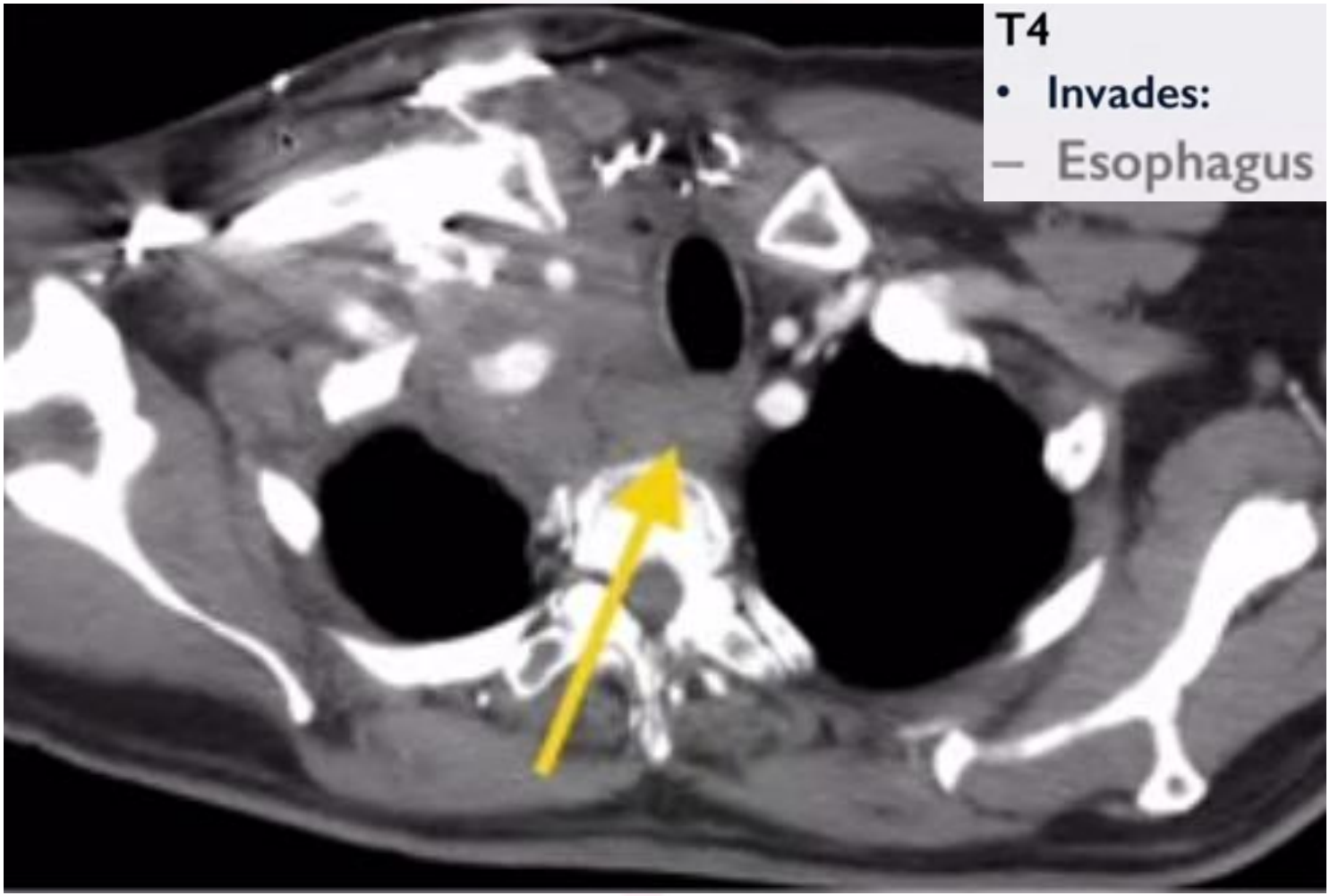
T4 tumors



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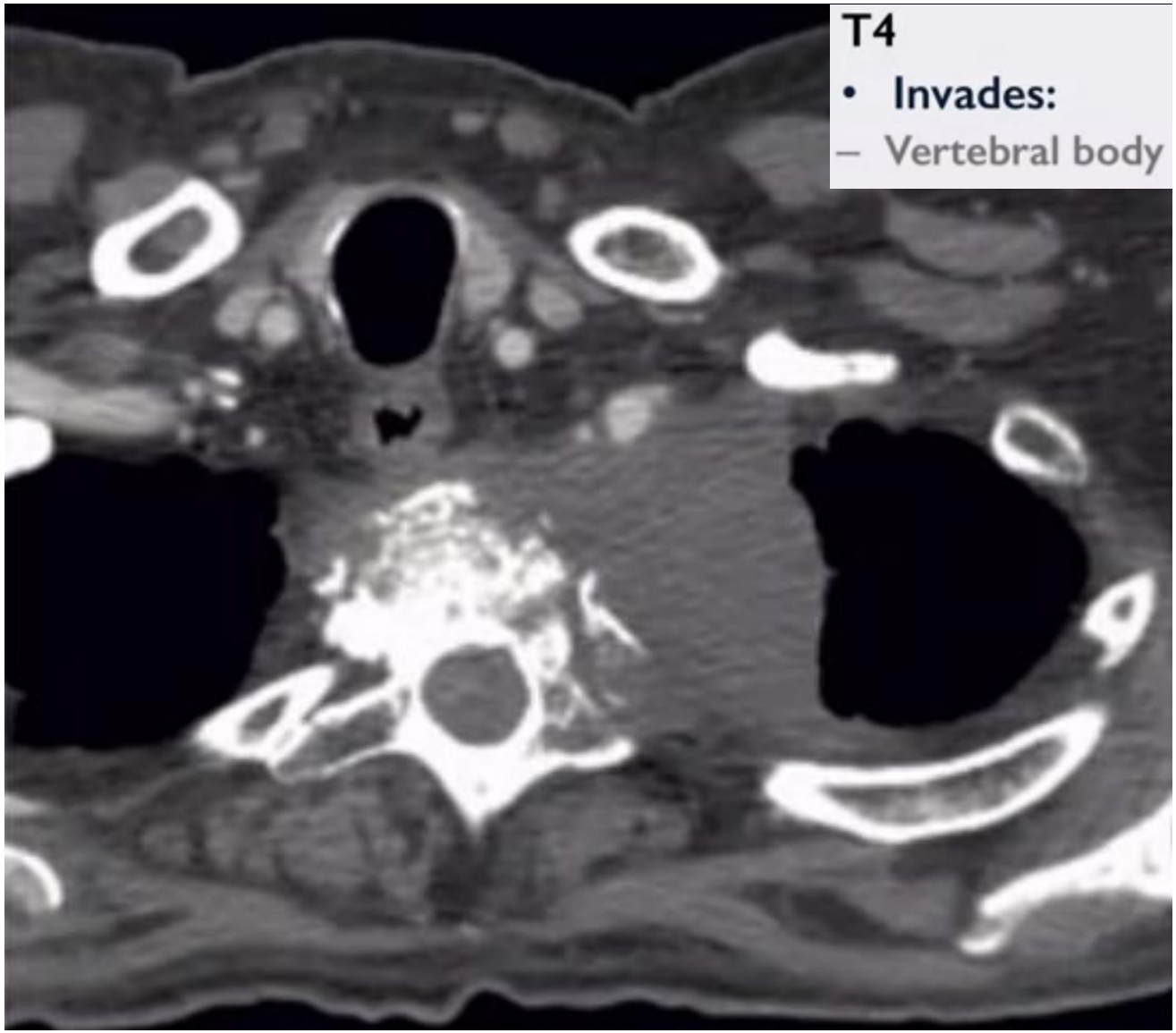
T4 tumors



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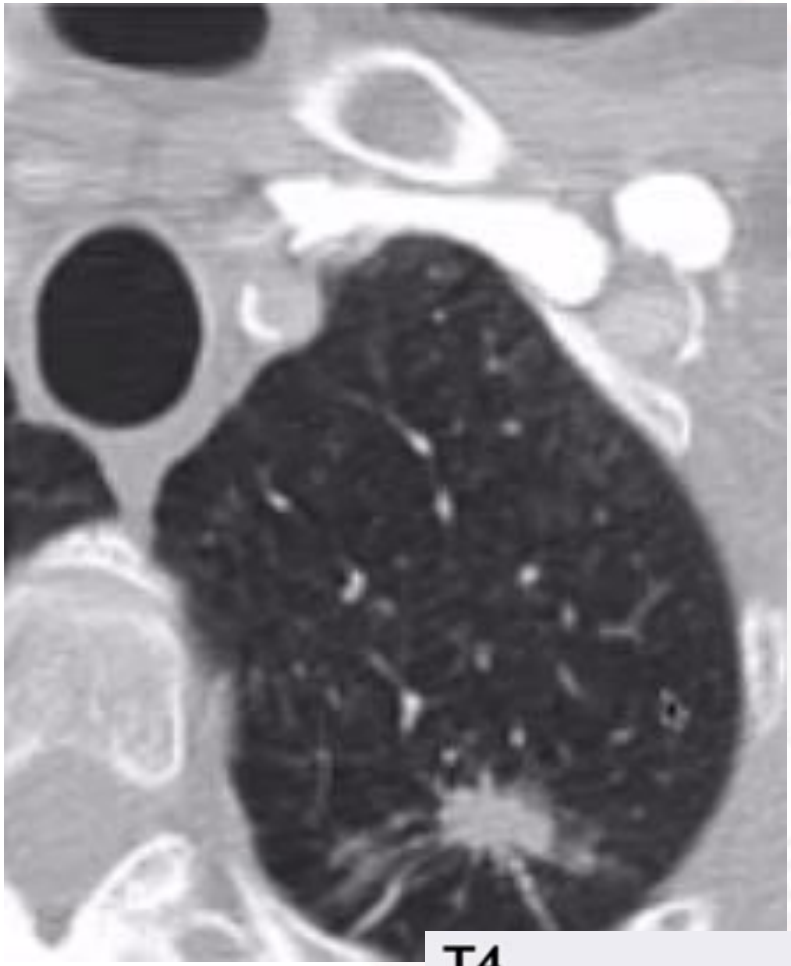
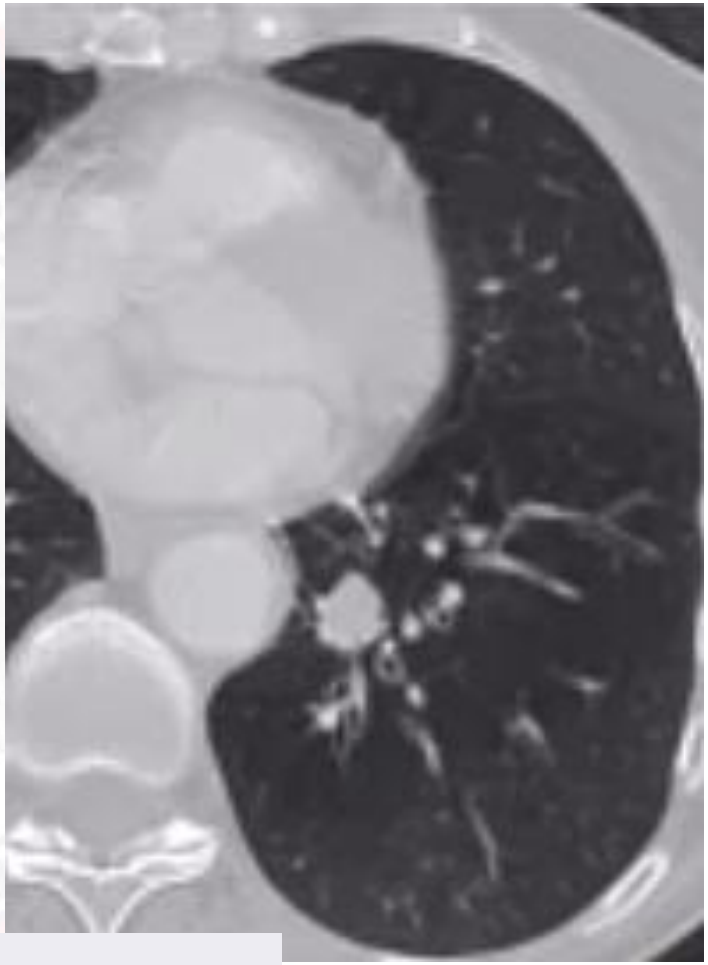
T4 tumors





T4

- Separate tumor nodule in different ipsilateral lobe

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The 8th Edition Lung Cancer Stage Classification
F. Dettterbeck, D.Boffa, A. Kim, L.Tanoue
CHEST 2017; 151(1):193-203

Extended Resection? When?

- Staging
- Assessment
- Guidelines
- Approaches
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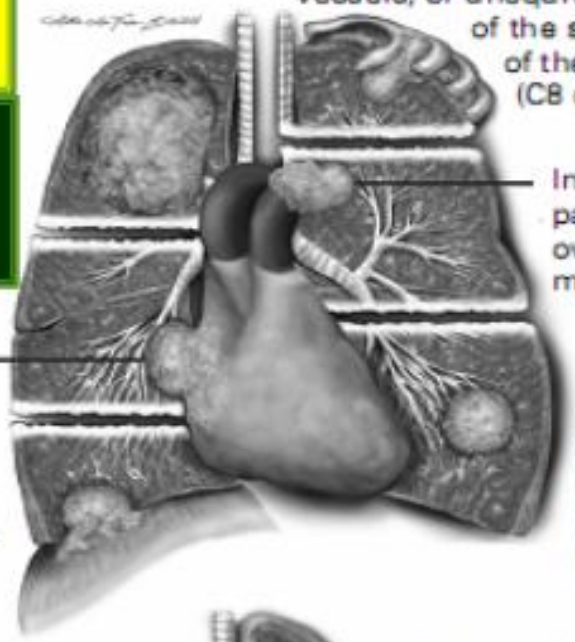
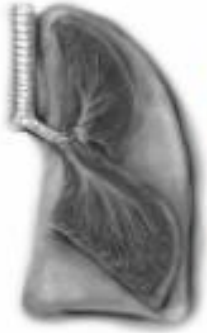
- Chest Wall
- Pancoast
- Diaphragm
- SVC
- Left Atrium
- Aorta
- Spine
- CPB
- Experience

T3

Όγκος > 7cm*





Tumour in the main bronchus less than 2 cms from the carina (without involvement of the carina) and/or associated atelectasis or obstructive pneumonitis of the entire lung

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Extended Resection? When?

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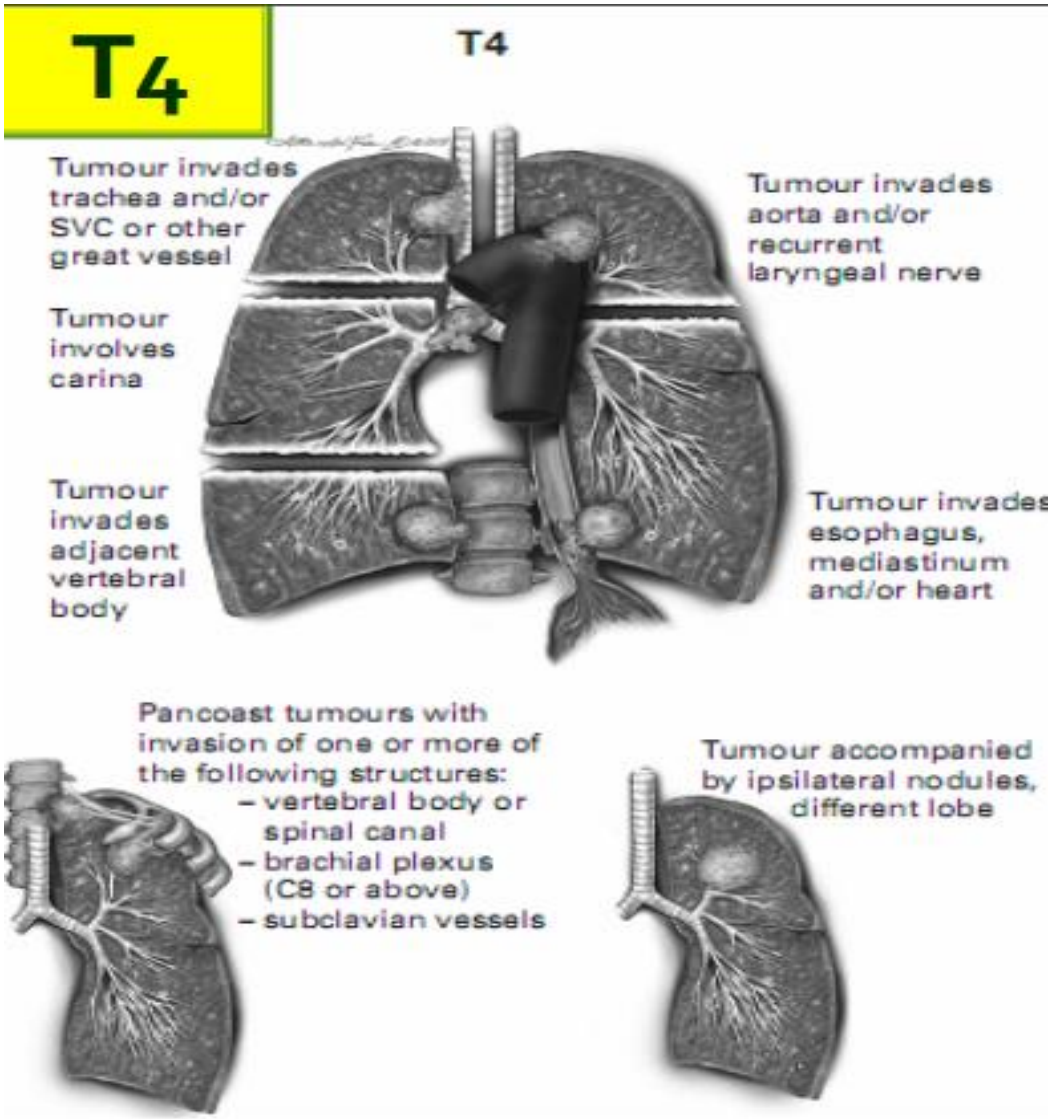

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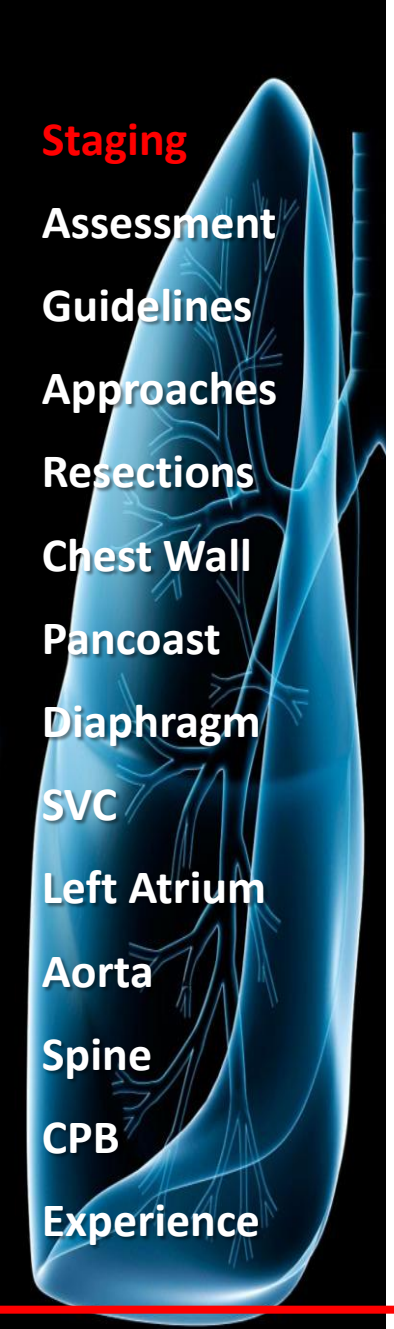

8th Lung Cancer Staging

TABLE 5] Lung Cancer Stage Grouping (Eighth Edition)

T/M	Label	N0	N1	N2	N3
T1	T1a ≤1	IA1	IIB	IIIA	IIIB
	T1b >1-2	IA2	IIB	IIIA	IIIB
	T1c >2-3	IA3	IIB	IIIA	IIIB
T2	T2a Cent, Visc Pl	IB	IIB	IIIA	IIIB
	T2a >3-4	IB	IIB	IIIA	IIIB
	T2b >4-5	IIA	IIB	IIIA	IIIB
T3	T3 >5-7	IIB	IIIA	IIIB	IIIC
	T3 Inv	IIB	IIIA	IIIB	IIIC
	T3 Satell	IIB	IIIA	IIIB	IIIC
T4	T4 >7	IIIA	IIIA	IIIB	IIIC
	T4 Inv	IIIA	IIIA	IIIB	IIIC
	T4 Ipsi Nod	IIIA	IIIA	IIIB	IIIC
M1	M1a Contr Nod	IVA	IVA	IVA	IVA
	M1a Pl Dissem	IVA	IVA	IVA	IVA
	M1b Single	IVA	IVA	IVA	IVA
	M1c Multi	IVB	IVB	IVB	IVB

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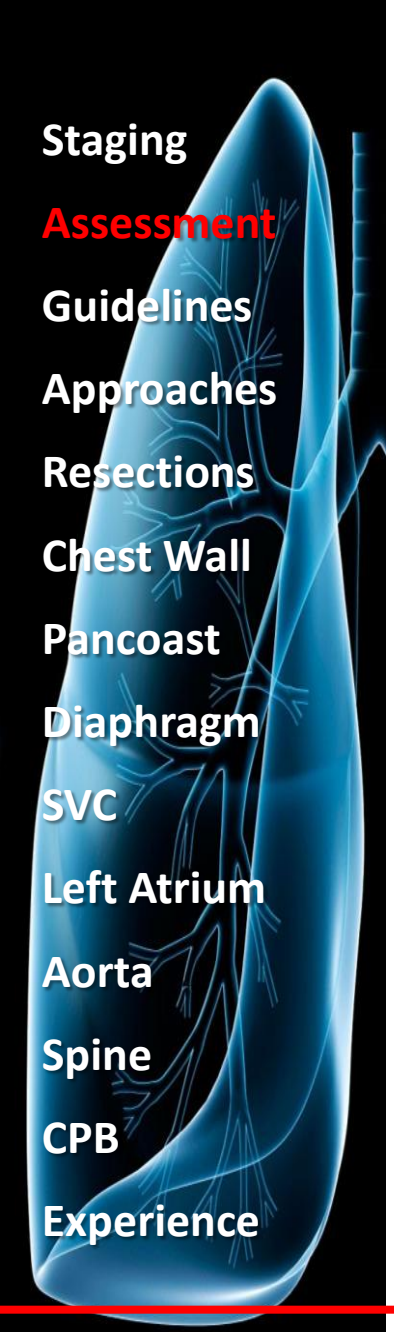

- Staging
- Assessment
- Guidelines
- Approaches
- Resections
- Chest Wall
- Pancoast
- Diaphragm
- SVC
- Left Atrium
- Aorta
- Spine
- CPB
- Experience

Main Goal of Surgery

Achievement of R0 resection

Indicates
a microscopically margin-negative resection, in which no gross or microscopic tumor remains in the primary tumor bed.

The Criteria for Operability and Resectability in Lung Cancer
Eugene E. Clifton, MD
JAMA. 1966;195(12):1031-1032

Preoperative Assessment

- Staging
- Assessment
- Guidelines
- Approaches
- Resections
- Chest Wall
- Pancoast
- Diaphragm
- SVC
- Left Atrium
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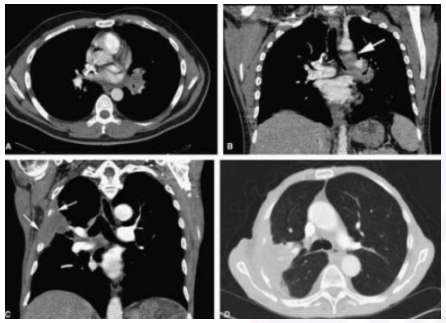
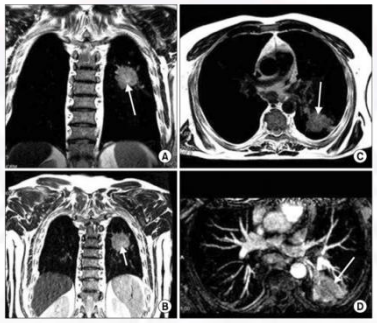
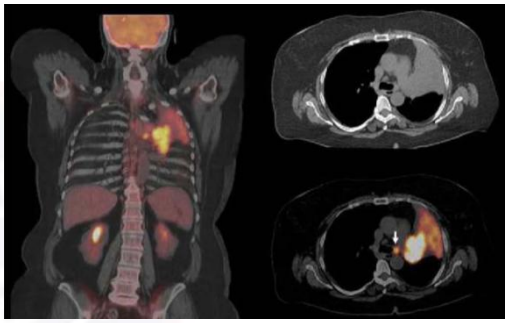


CT

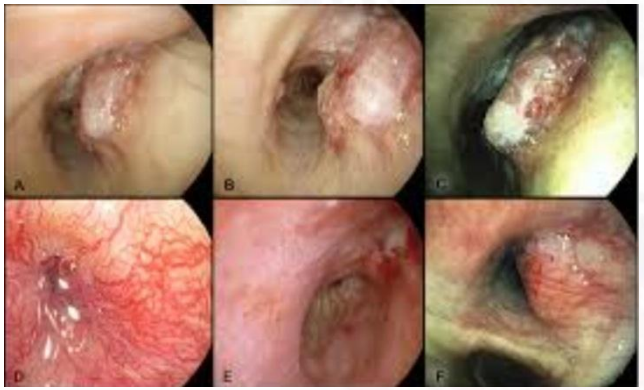


MRI

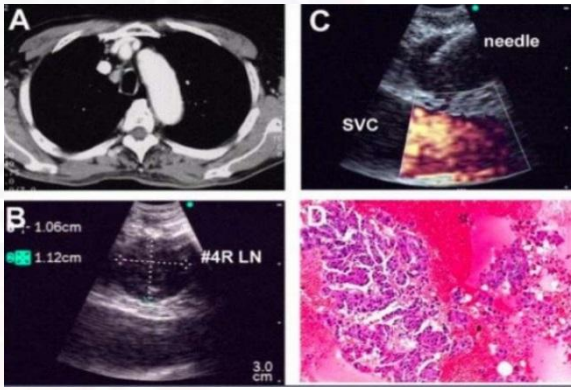


PET-CT

Resectability



Bronchoscopy



EBUS

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Preoperative Assessment

- Staging
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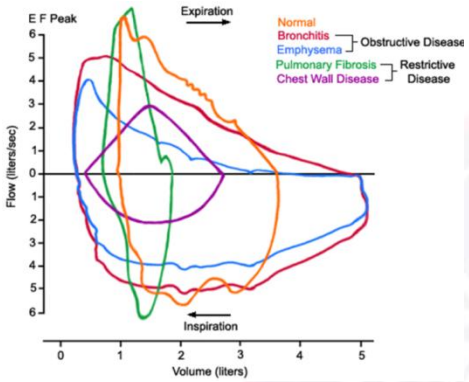
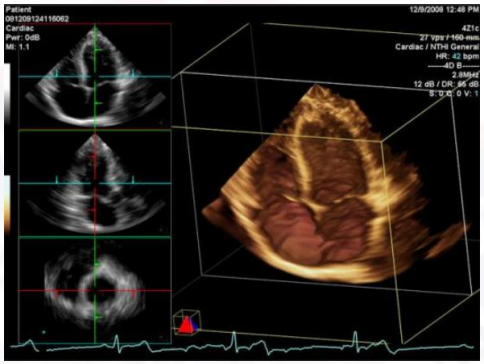
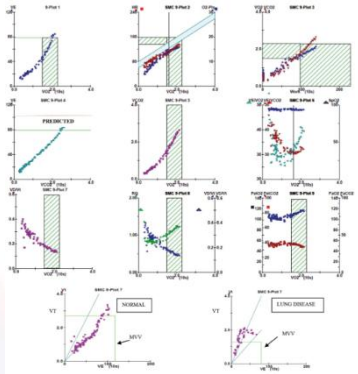


PFT



Cardiac Echo



CPET

Operability

Comorbidities

Personal Opinion

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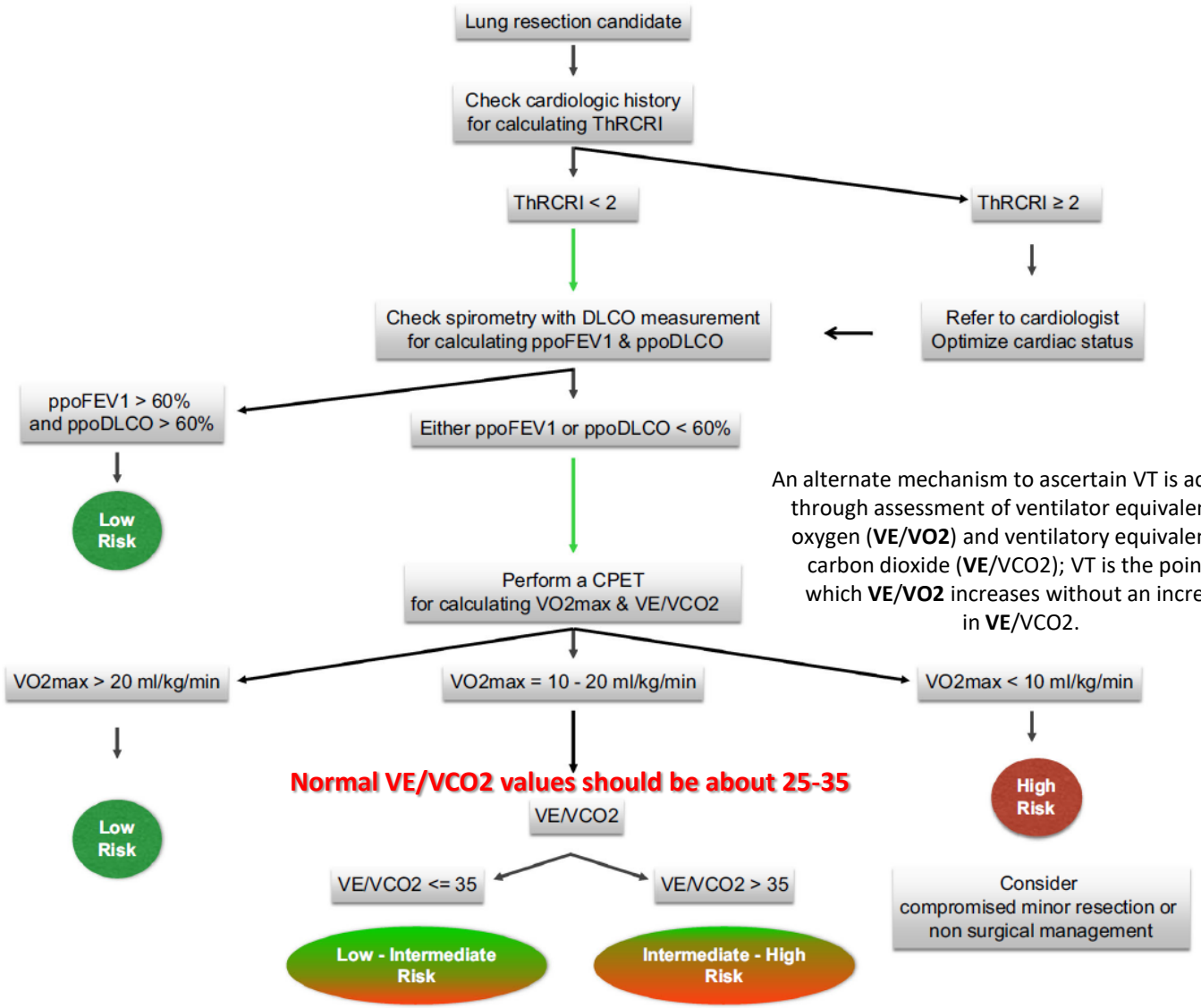
Preoperative Assessment



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Risk Stratification in Lung Resection
Michele Salati, Alessandro Brunelli
Curr Surg Rep (2016) 4:37

Scores

Thoracoscore (The Thoracic Surgery Scoring System)

Variables (help)	Values (all values are mandatory)	Beta
Age (years)		0
Sex		0
ASA Classification		0
Performance Status Classification		0
Dyspnea score		0
Priority of surgery		0
Procedure class		0
Diagnosis group		0
Comorbidity Score		0

Clear

Thoracoscore: 0

Logit = -7.3737 + Sum (beta)
Predicted death Rate = $e^{(Logit)} / (1 + e^{(Logit)})$

Reference

- Falcoz P.E. et al. The Thoracic Surgery Scoring System (Thoracoscore): Risk model for in-hospital death in 15,183 patients requiring thoracic surgery
J Thorac Cardiovasc Surg 2007; 133: 325-32

Lung Resection Score

Variables (help)	Values
Age (years)	
$ppoFEV_1$ (%)	
Cardiac Comorbidity	0

Predicted Mortality: 0

Logit = -6.97+0.095Xage-0.042ppoFEV
Predicted Mortality = $1/ (1 + e^{-Logit}) e$

Compute

Predicted Morbidity: 0

Logit = -2.4 +0.03Xage-0.02ppoFEV + 0.6Xcardiac comorbidity
Predicted Morbidity = $1/ (1 + e^{-Logit}) e$

Clear

Reference

Brunelli A. et al. Risk-adjusted morbidity and mortality models to compare the performance of two units after major lung resections. *J Thorac Cardiovasc Surg* 2007;133:88-96

Table 1 Eurolung 1—distribution of complications according to the Eurolung 1 aggregate morbidity score (1)

Eurolung 1 score	Morbidity rate (%)
0–1	5.2
2–4	8.2
5–7	14.3
8–11	21.6
12–16	32.4
17–19	43.1

Eurolung 1 scoring—chronic kidney disease: 1 point; coronary artery disease: 2 points; cerebrovascular disease: 2 points; age over 65: 3 points; male sex: 3 points; thoracotomy: 3 points; extended resection: 3 points; $ppoFEV_1$ less than 70%: 3 points.

ThRCRI Risk Factor	Weighted Score	%	n
Renal comorbidity[a]	1	1.7	76
Ischemic heart disease	1.5	8.8	403
Cerebrovascular disease	1.5	7.0	323
Pneumonectomy	1.5	6.4	298

View Table in HTML

ThRCRI = Thoracic Revised Cardiac Risk Index.

[a] Preoperative serum creatinine >2 mg/dL.

Table 3

Distribution of Patients Within ThRCRI Risk Classes and Rate of Major Cardiac Complications (N = 4,625)

ThRCRI Score	ThRCRI Risk Class	%	n	Cardiac Complication Rate (n)[a]
0	A	78	3,637	1.4% (49)
1.0–1.5	B	19	882	2.7% (24)
2.0–2.5	C	0.5	22	9.1% (2)
>2.5	D	1.8	84	3.6% (3)

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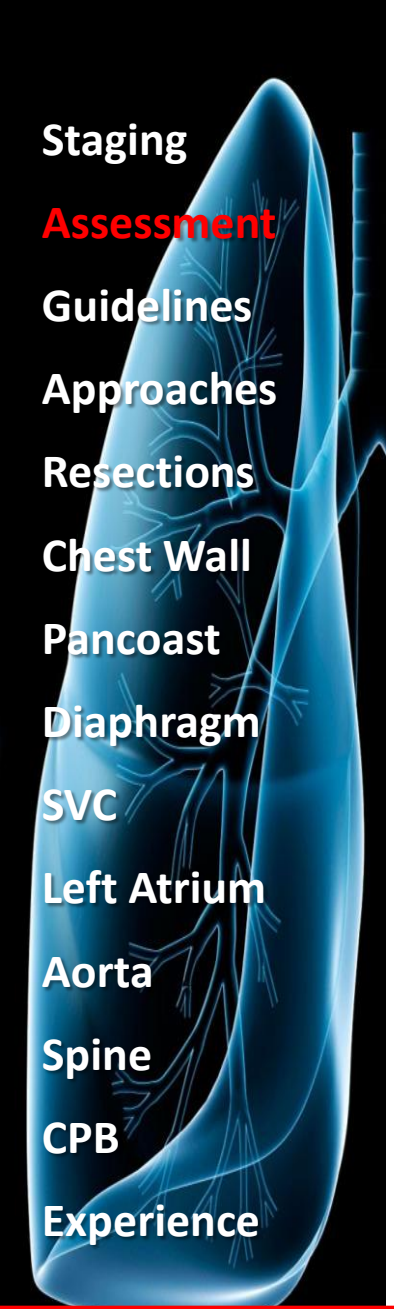

Perioperative Mortality

… must be

<4%

for Lobectomy

<8%

for pneumonectomy

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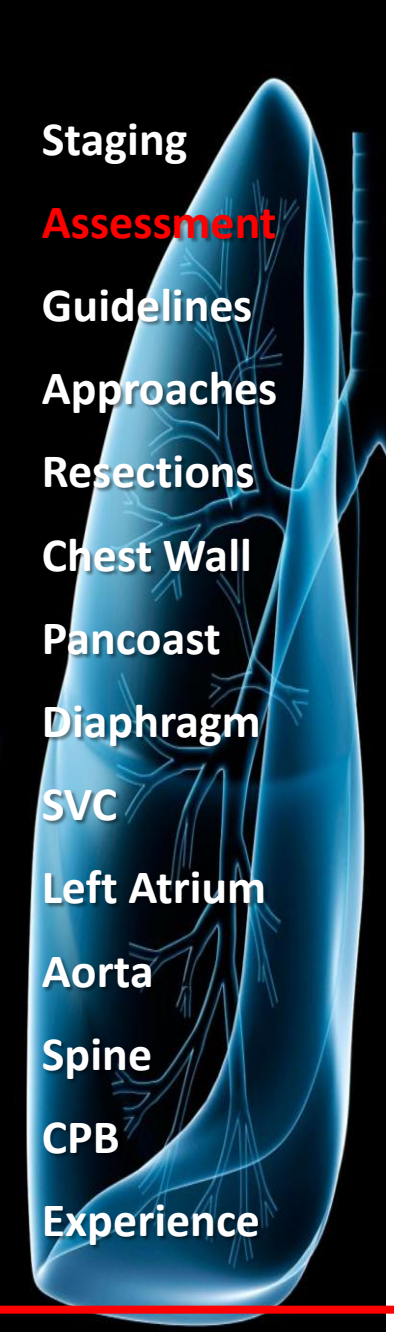
NICE National Institute for Health and Care Excellence

Lung cancer: diagnosis and management
Clinical guideline [CG121]
April 2011



- Staging
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- Pancoast
- Diaphragm
- SVC
- Left Atrium
- Aorta
- Spine
- CPB
- Experience

Main Goal of Surgery

Table 1. Levels of evidence and grades of recommendation (adapted from the Infectious Diseases Society of America-United States Public Health Service Grading System[a])

Levels of evidence	
I	Evidence from at least one large randomised, controlled trial of good methodological quality (low potential for bias) or meta-analyses of well-conducted randomised trials without heterogeneity
II	Small randomised trials or large randomised trials with a suspicion of bias (lower methodological quality) or meta-analyses of such trials or of trials with demonstrated heterogeneity
III	Prospective cohort studies
IV	Retrospective cohort studies or case–control studies
V	Studies without control group, case reports, experts opinions
Grades of recommendation	
A	Strong evidence for efficacy with a substantial clinical benefit, strongly recommended
B	Strong or moderate evidence for efficacy but with a limited clinical benefit, generally recommended
C	Insufficient evidence for efficacy or benefit does not outweigh the risk or the disadvantages (adverse events, costs, …), optional
D	Moderate evidence against efficacy or for adverse outcome, generally not recommended
E	Strong evidence against efficacy or for adverse outcome, never recommended

[a]By permission of the Infectious Diseases Society of America [1].

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The Criteria for Operability and Resectability in Lung Cancer
Eugene E. Clifton, MD
JAMA. 1966;195(12):1031-1032

Guidelines

1.2.1 T3 disease

22. Offer patients with T3N0–1M0 disease radical treatment. **[D]**

1.2.2 T4 disease

23. Consider selected patients with T4N0–1M0 disease for radical multimodality treatment. **[D]**

26. Consider surgery as part of multimodality management in patients with T1–3N2 (non-fixed, non-bulky, single zone) M0 disease. **[B]**

Guidelines on the radical management of patients with lung cancer
British Thoracic Society (BTS)
Thorax 2010;**65**(Suppl III):iii1—iii27. doi:10.1136/thx.2010.145938

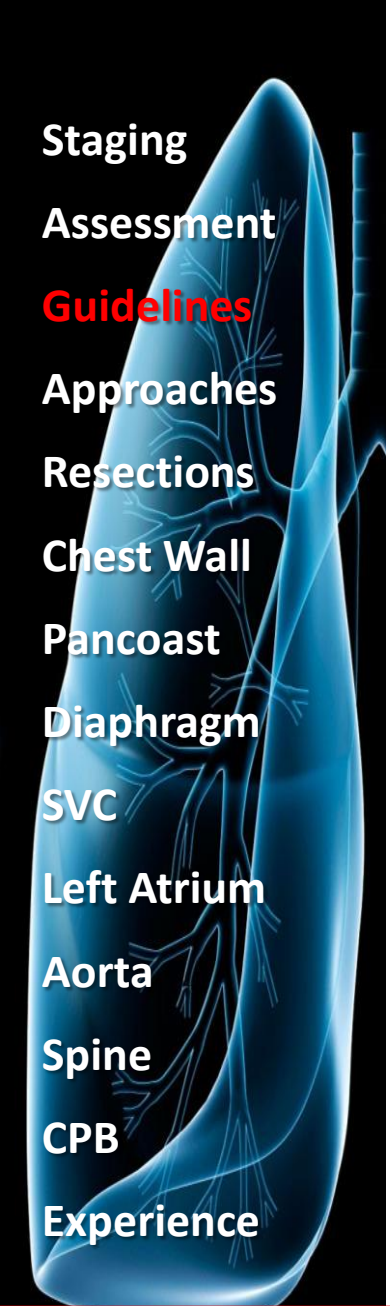
Guidelines

1.4.21 Offer more extensive surgery (bronchoangioplastic surgery, bilobectomy, pneumonectomy) only when needed to obtain clear margins. **[new 2011]**

1.4.22 Perform hilar and mediastinal lymph node sampling or en bloc resection for all patients undergoing surgery with curative intent. **[new 2011]**

1.4.23 For patients with T3 NSCLC with chest wall involvement who are undergoing surgery, complete resection of the tumour should be the aim by either extrapleural or en bloc chest wall resection. **[2005]**

1.4.39 Treat Pancoast tumours in the same way as other types of NSCLC. Offer multimodality therapy according to resectability, stage of the tumour and performance status of the patient. **[new 2011]**



Resectable Locally Advanced NSCLC

Resectable in this situation usually refers to the following situations:

- **single station N2 disease** where other nodal stations have been biopsied and proved to be benign. Postoperative ChT should then be advised.

- **T4N0** tumors where nodal disease had been excluded by invasive methods when a **R0 resection is considered to be feasible.**

- **after induction therapy,** when there has been **nodal downstaging** and a pneumonectomy can be avoided.

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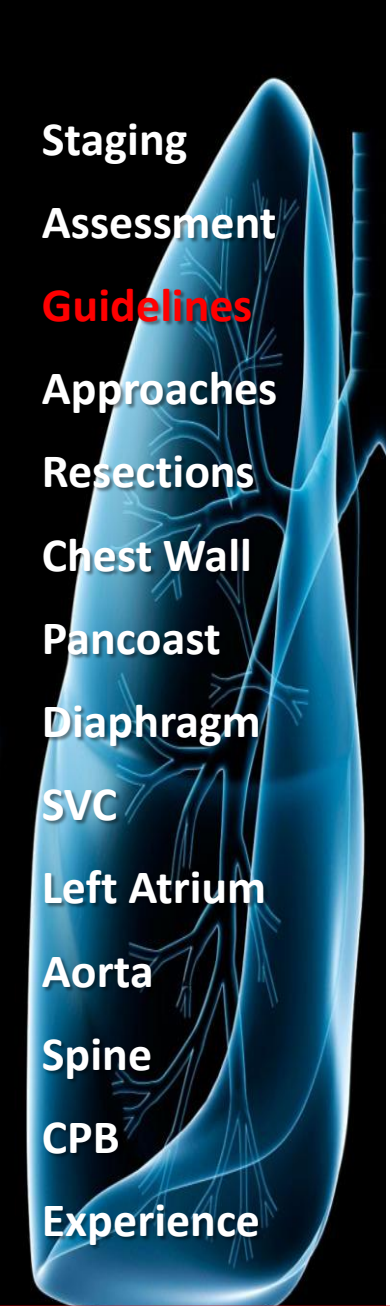
Early and locally advanced non-small-cell lung cancer (NSCLC):
ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up
ESMO Guidelines Committee - Annals of Oncology 28 (Supplement 4): iv1–iv21, 2017



- Staging
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Resectable Locally Advanced NSCLC

In potentially resectable superior sulcus tumors, concurrent CRT induction followed by definitive surgery is the treatment of choice [III, A].

The same strategy may be applied for potentially resectable T3 or T4 central tumors in highly selected cases and experienced centers [III, B].

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In both situations, surgery should be carried out within 4 weeks after the end of RT [III, B].

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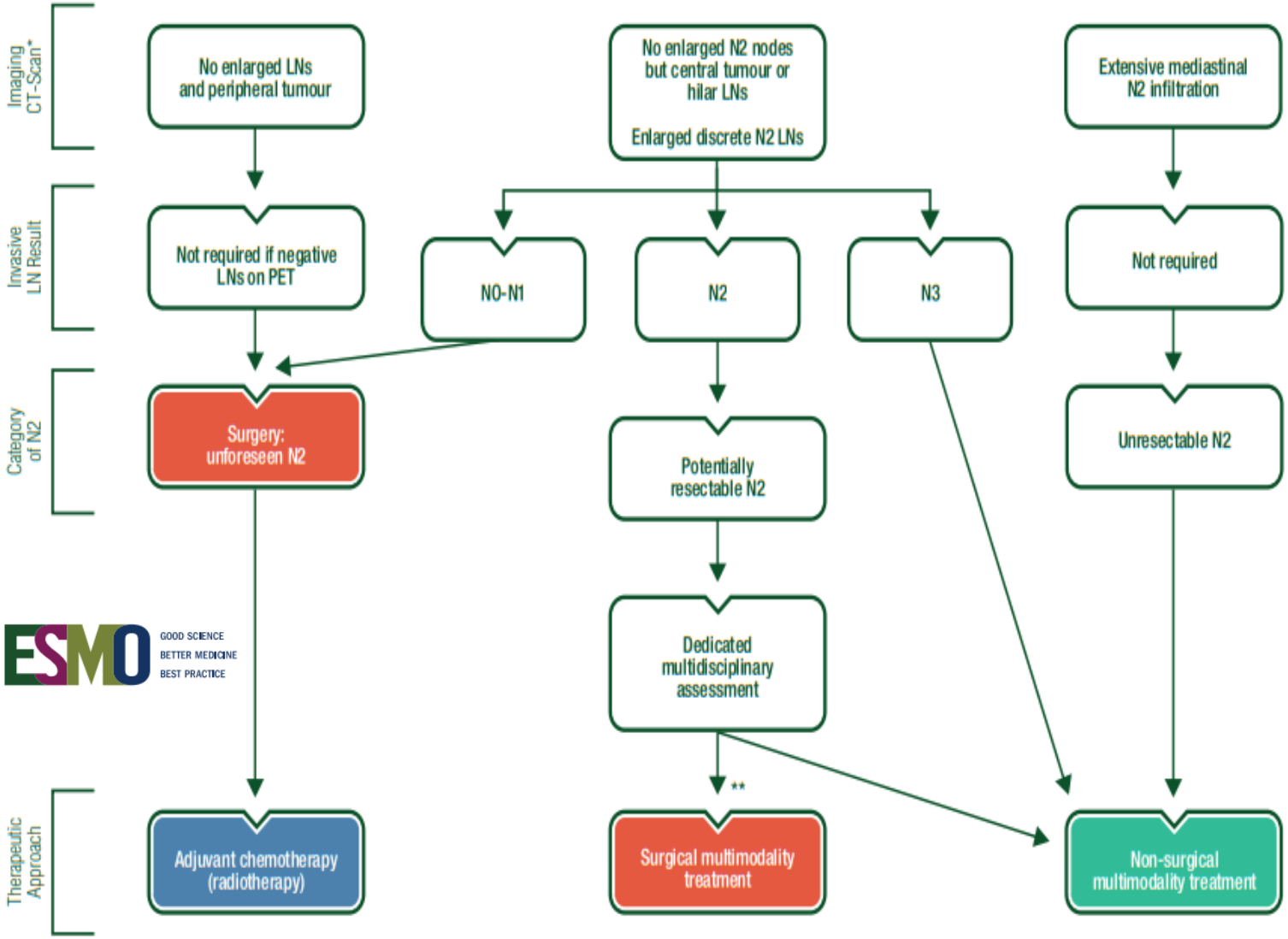
Resectable Locally Advanced NSCLC



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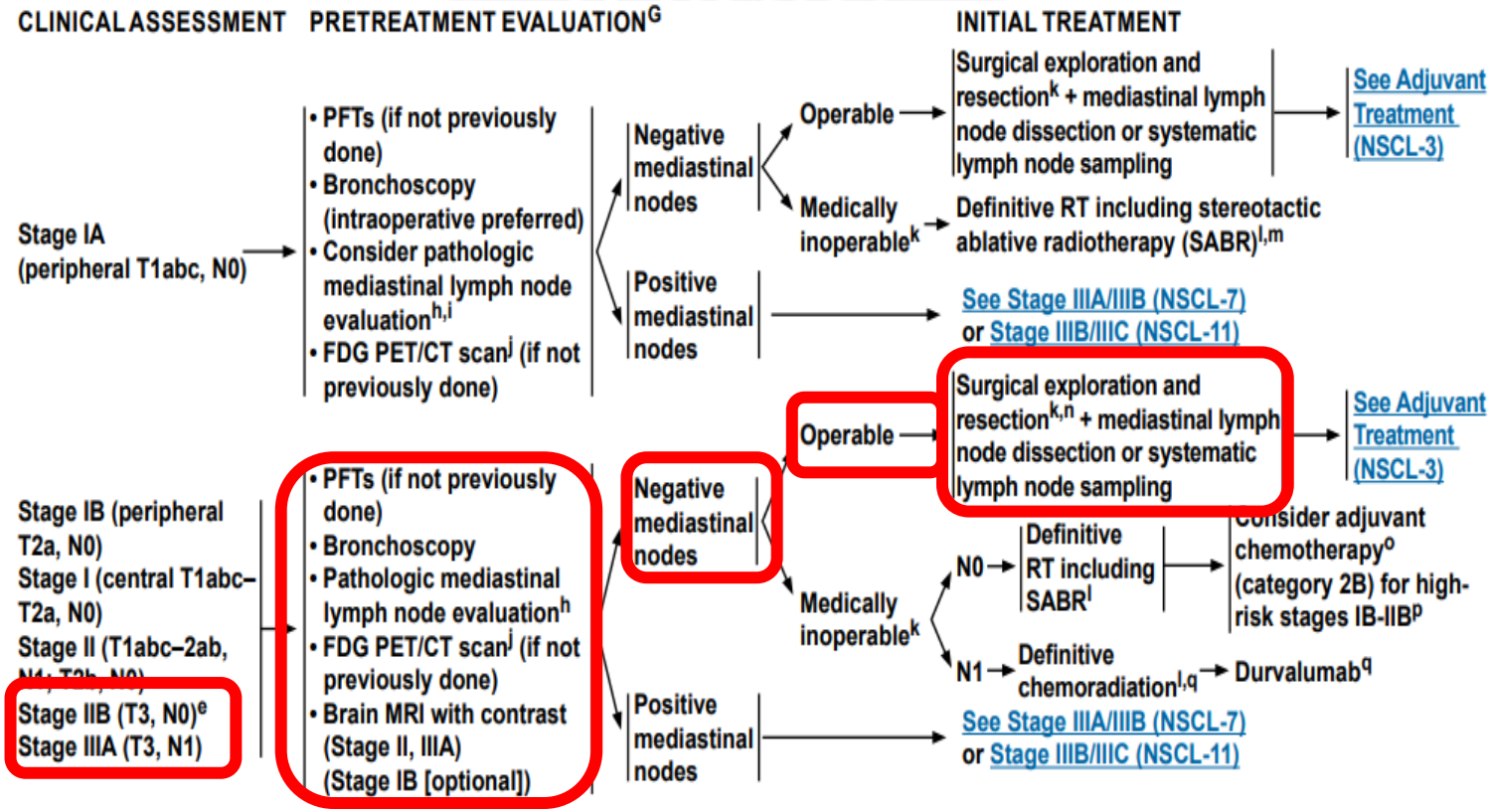
ESMO Guidelines Committee - Annals of Oncology 28 (Supplement 4): iv1–iv21, 2017

Guidelines



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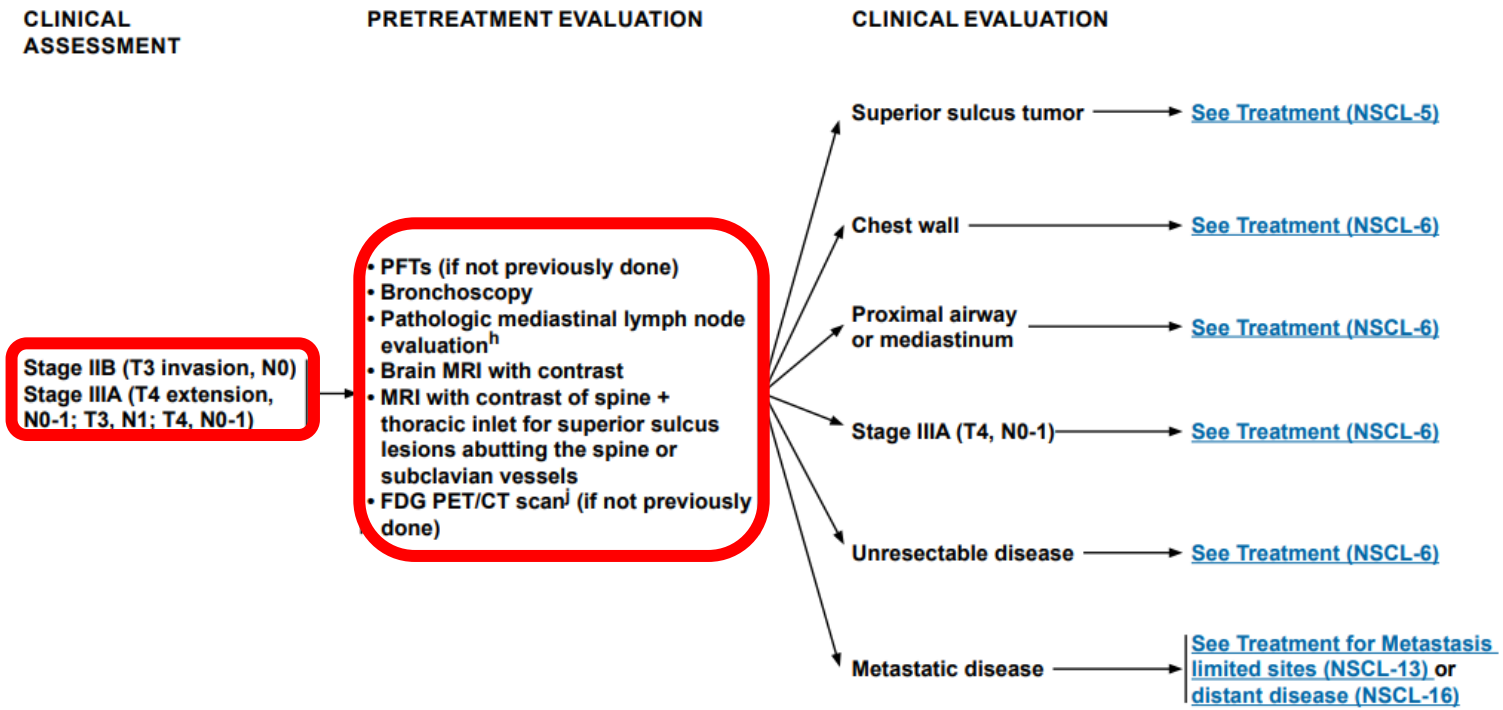
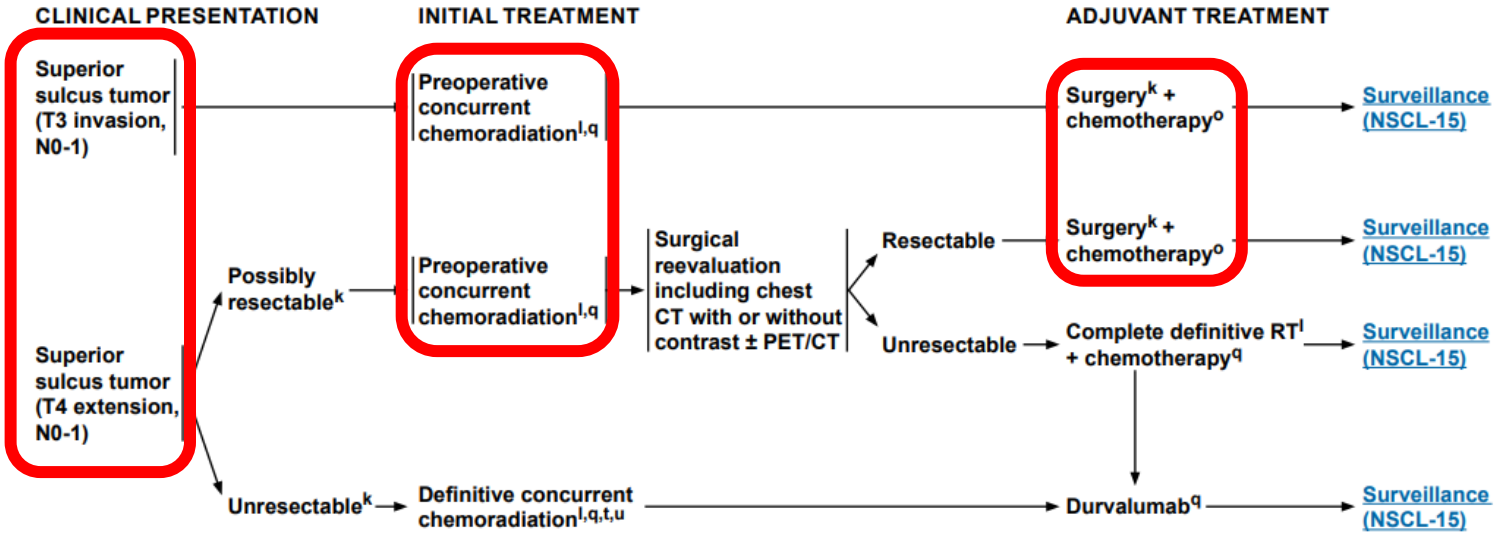
NCCN National Comprehensive Cancer Network®

NCCN Clinical Practice Guidelines for NSCLC
Version 6.2018

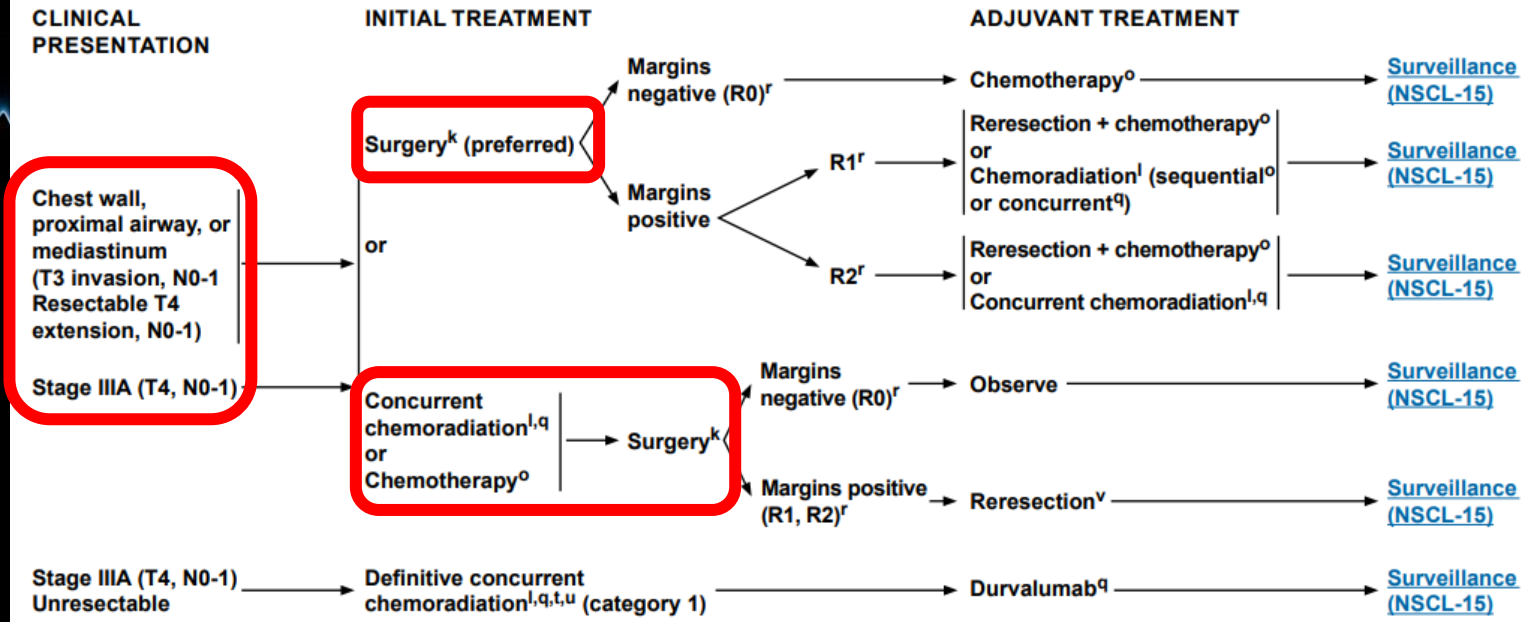
Guidelines


CLINICAL ASSESSMENT
PRETREATMENT EVALUATION
CLINICAL EVALUATION
Stage IIB (T3 invasion, N0)
Stage IIIA (T4 extension, N0-1; T3, N1; T4, N0-1)
• PFTs (if not previously done)
• Bronchoscopy
• Pathologic mediastinal lymph node evaluation[h]
• Brain MRI with contrast
• MRI with contrast of spine + thoracic inlet for superior sulcus lesions abutting the spine or subclavian vessels
• FDG PET/CT scan[j] (if not previously done)
Superior sulcus tumor → See Treatment (NSCL-5)
Chest wall → See Treatment (NSCL-6)
Proximal airway or mediastinum → See Treatment (NSCL-6)
Stage IIIA (T4, N0-1) → See Treatment (NSCL-6)
Unresectable disease → See Treatment (NSCL-6)
Metastatic disease → See Treatment for Metastasis limited sites (NSCL-13) or distant disease (NSCL-16)

Guidelines


CLINICAL PRESENTATION
INITIAL TREATMENT
ADJUVANT TREATMENT
Superior sulcus tumor (T3 invasion, N0-1)
Superior sulcus tumor (T4 extension, N0-1)
Possibly resectable[k]
Unresectable[k]
Preoperative concurrent chemoradiation[l,q]
Preoperative concurrent chemoradiation[l,q]
Definitive concurrent chemoradiation[l,q,t,u]
Surgical reevaluation including chest CT with or without contrast ± PET/CT
Resectable
Unresectable
Surgery[k] + chemotherapy[o]
Surgery[k] + chemotherapy[o]
Complete definitive RT[l] + chemotherapy[q]
Durvalumab[q]
Surveillance (NSCL-15)
Surveillance (NSCL-15)
Surveillance (NSCL-15)
Surveillance (NSCL-15)

Guidelines



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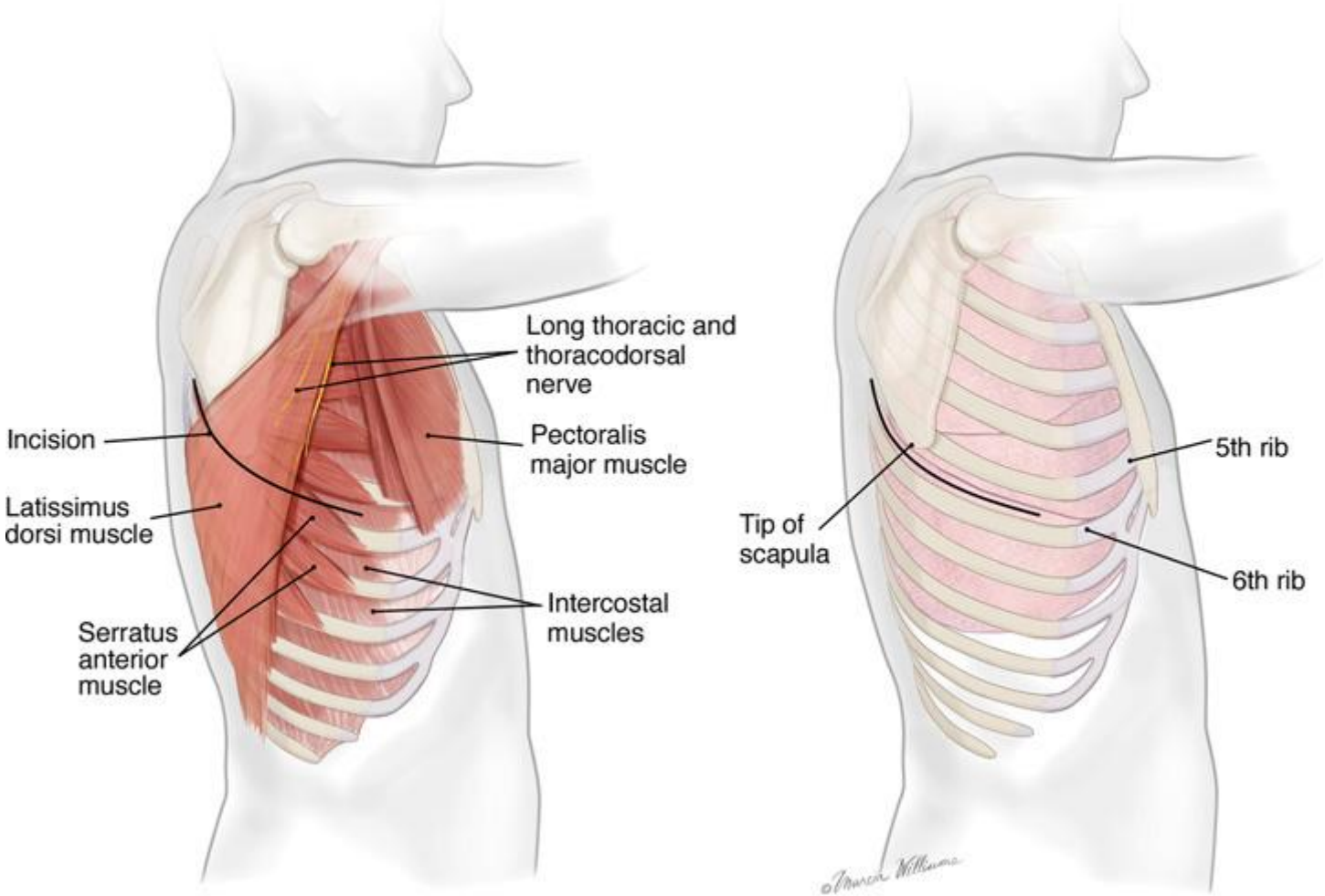
Guidelines

Lung-sparing anatomic resection (sleeve lobectomy) is preferred over pneumonectomy if anatomically appropriate and margin negative resection is achieved.

T3 (invasion) and T4 extension tumors require en-bloc resection of the involved structure with negative margins.

If a surgeon or center is uncertain about potential complete resection, consider an additional surgical opinion from a high volume specialized center.

Usual Surgical Approaches



Posterolateral Thoracotomy

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Thoracic Surgery
2018

Source: Sugarbaker DJ, Bueno R, Krasna MJ, Mentzer SJ, Zellos L: *Adult Chest Surgery*: http://www.accesssurgery.com

Usual Surgical Approaches

- Staging
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- SVC
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- Aorta
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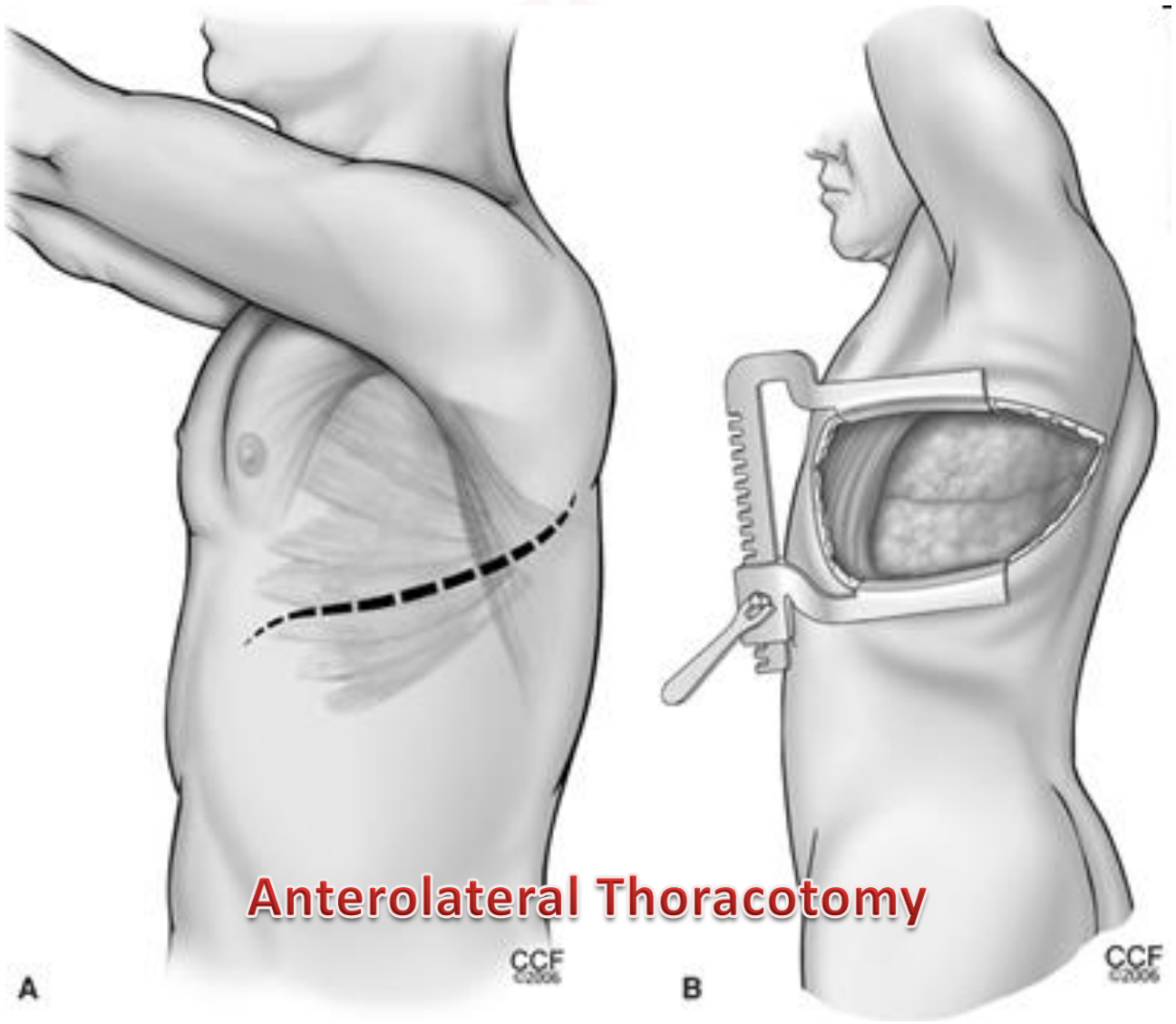
- Experience



Anterolateral Thoracotomy

The Criteria for Operability and Resectability in Lung Cancer
Eugene E. Clifton, MD
JAMA. 1966;195(12):1031-1032

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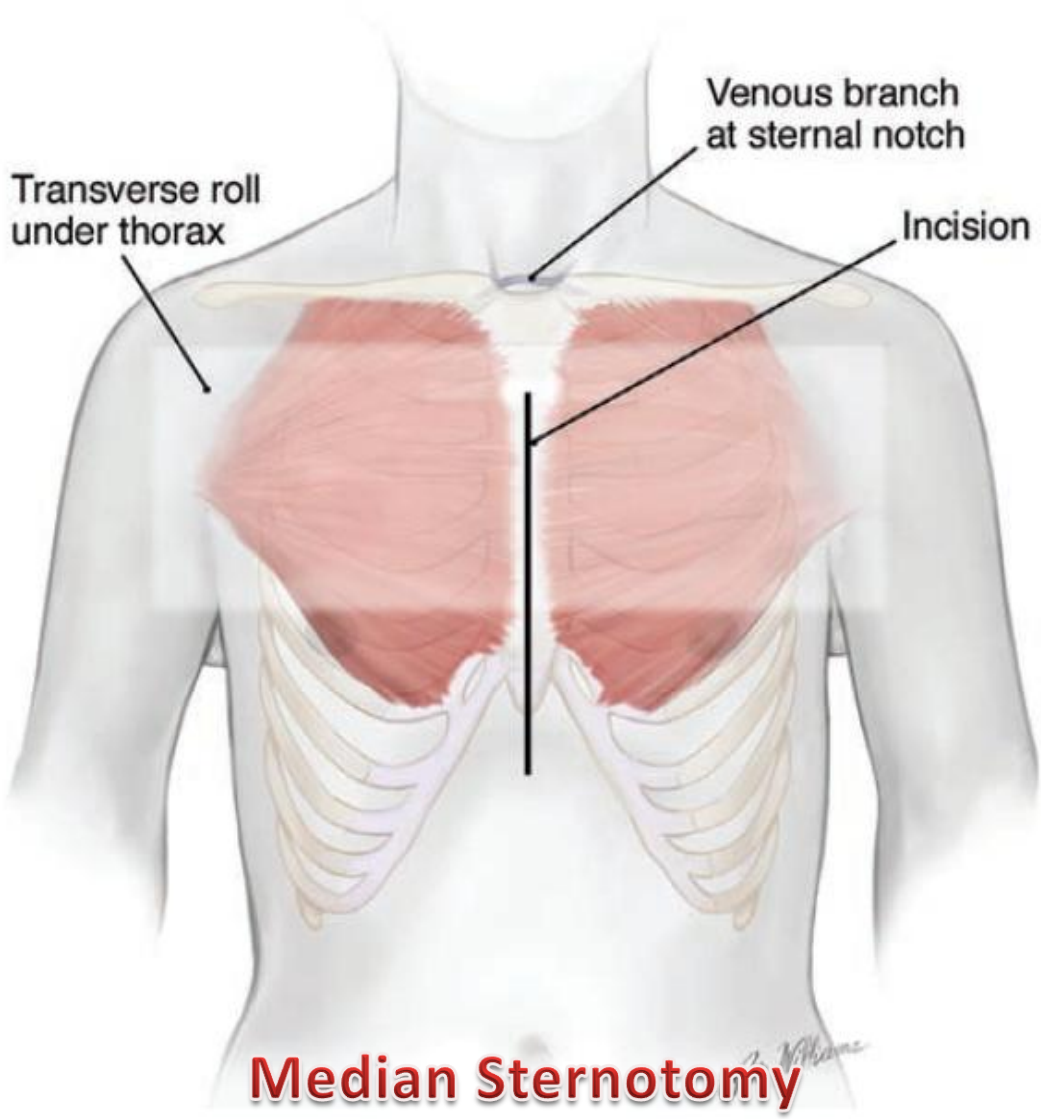
Usual Surgical Approaches



Source: Sugarbaker DJ, Bueno R, Krasna MJ, Mentzer SJ, Zellos L: *Adult Chest Surgery*: http://www.accesssurgery.com

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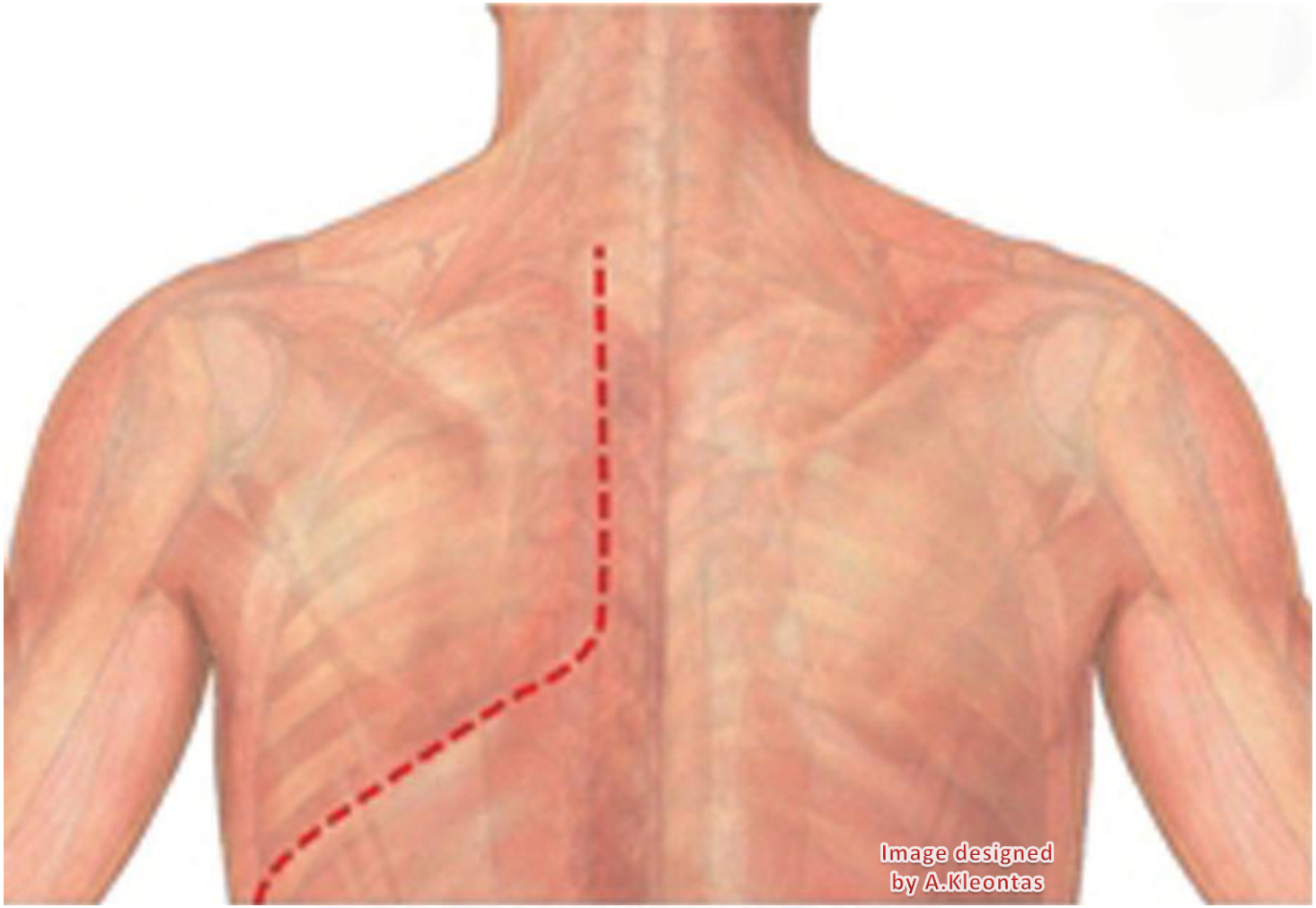
Unusual Surgical Approaches



Shaw Paulson

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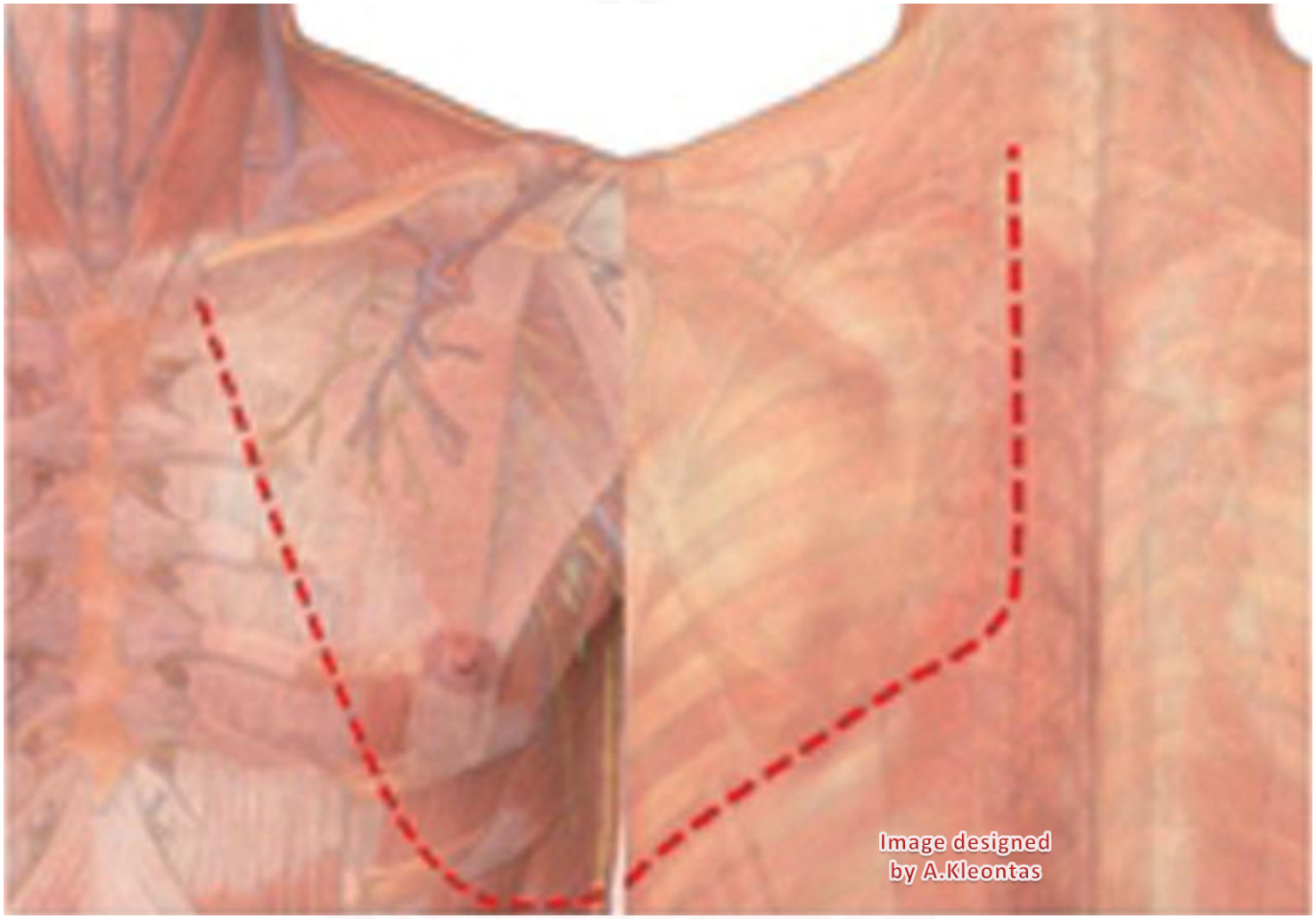
Superior sulcus (Pancoast) tumors:
current evidence on diagnosis and radical treatment
C. Foroulis et al - *Thorac Dis 2013 Apr 09*

Unusual Surgical Approaches



Tatsamura

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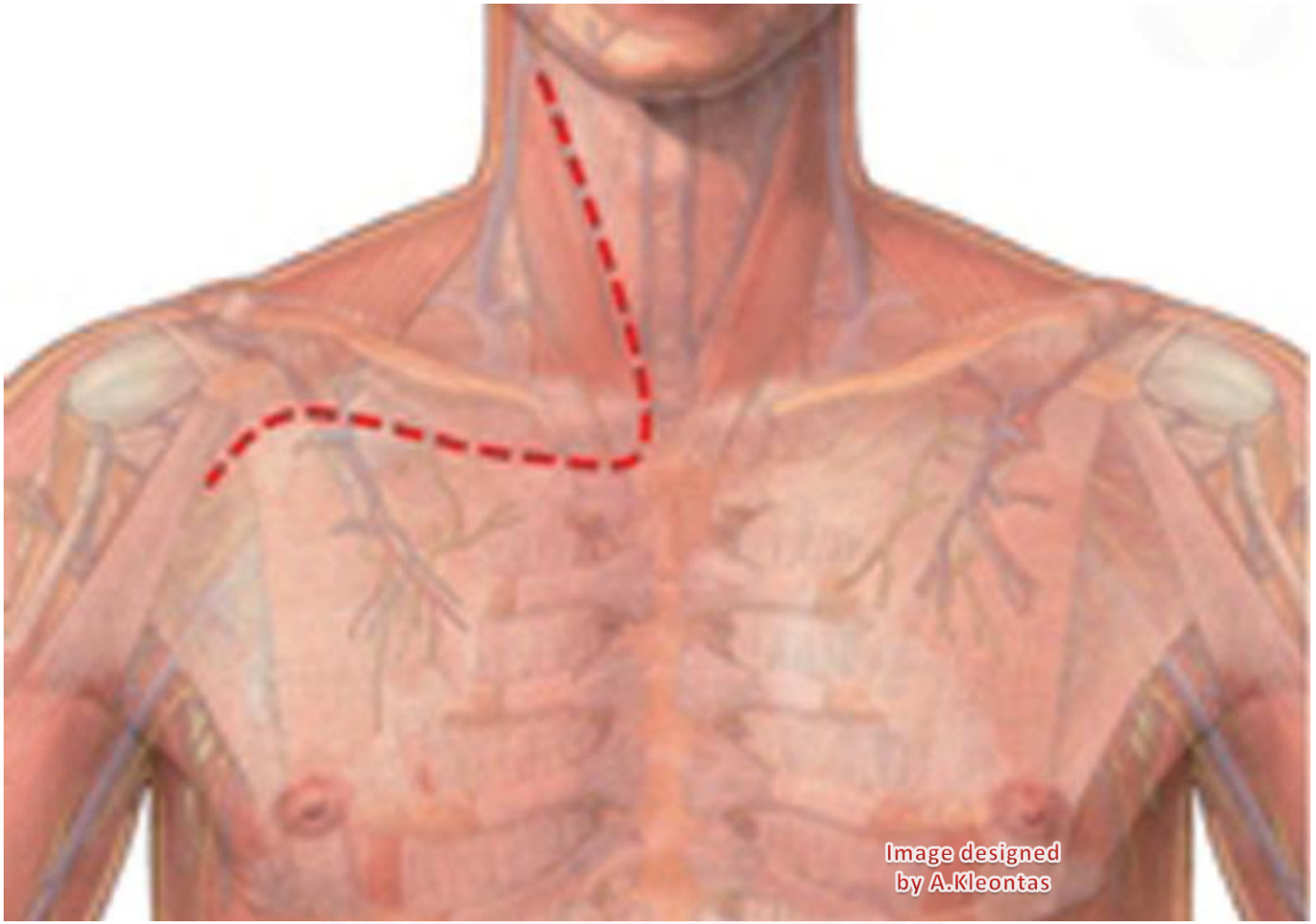
Unusual Surgical Approaches



Dartevelle

Staging
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Resections
Chest Wall
Pancoast
Diaphragm
SVC
Left Atrium
Aorta
Spine
CPB
Experience

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Unusual Surgical Approaches

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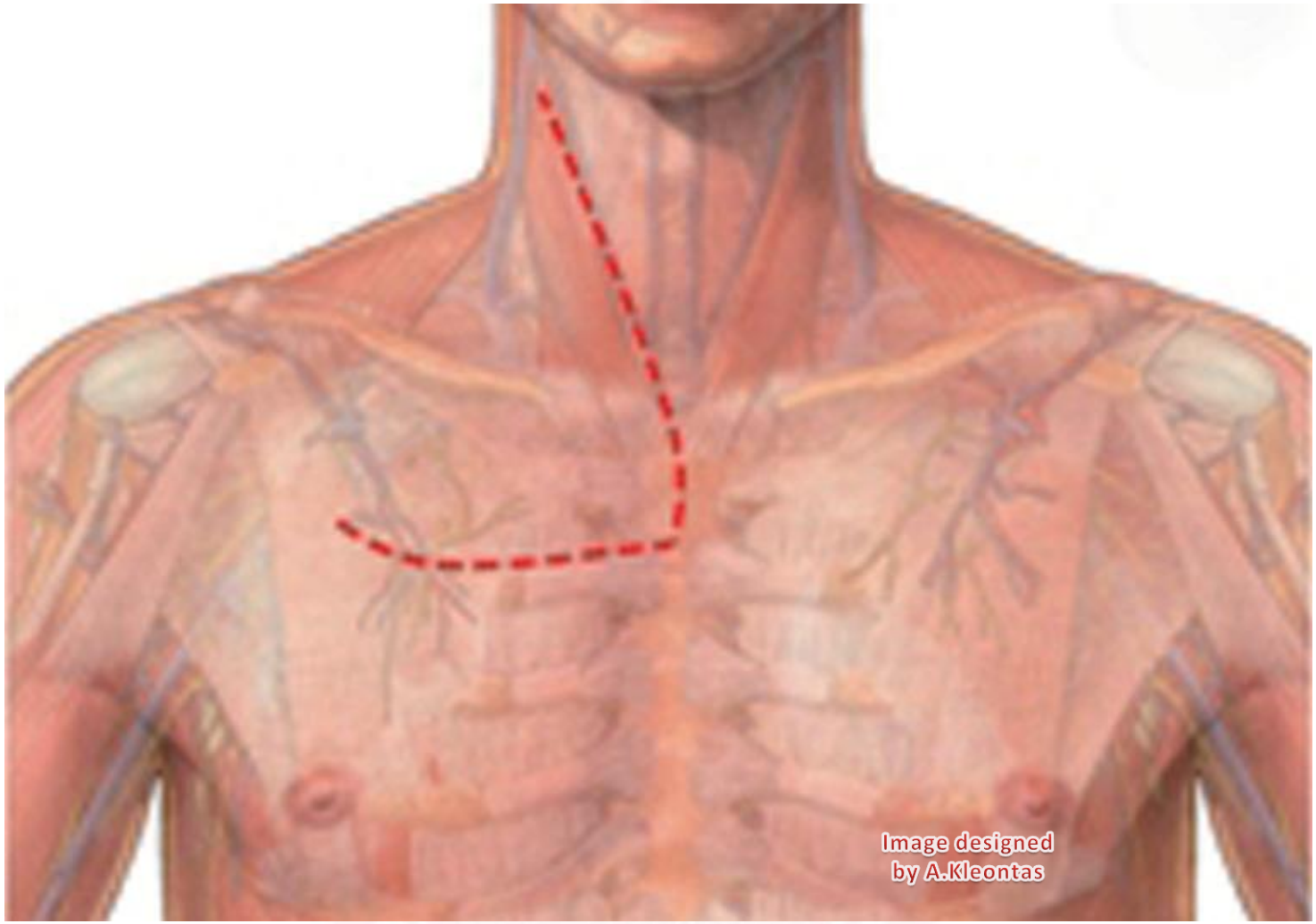

Grunenwald

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C. Foroulis et al - *Thorac Dis 2013 Apr 09*

Unusual Surgical Approaches

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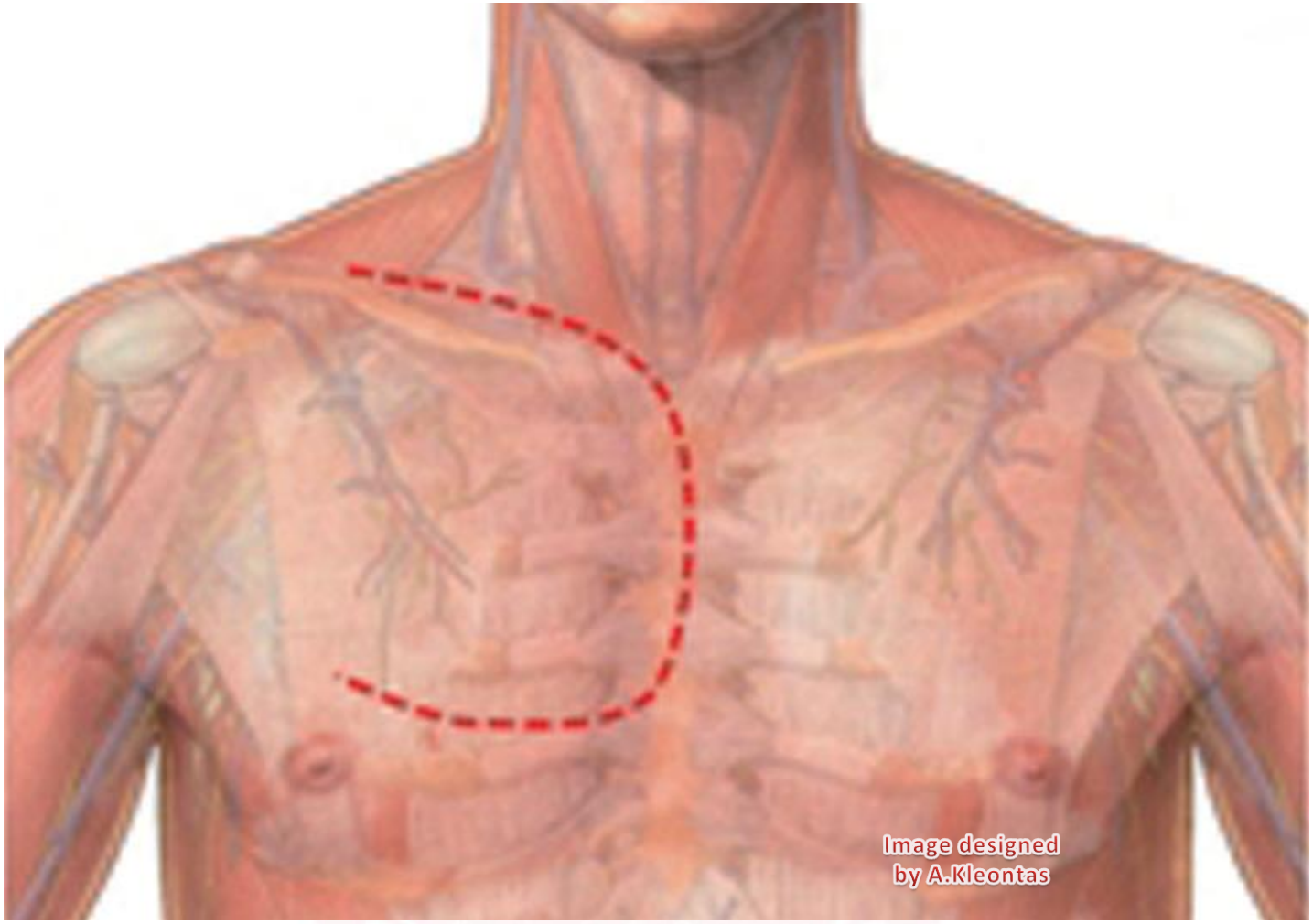

Masaoka

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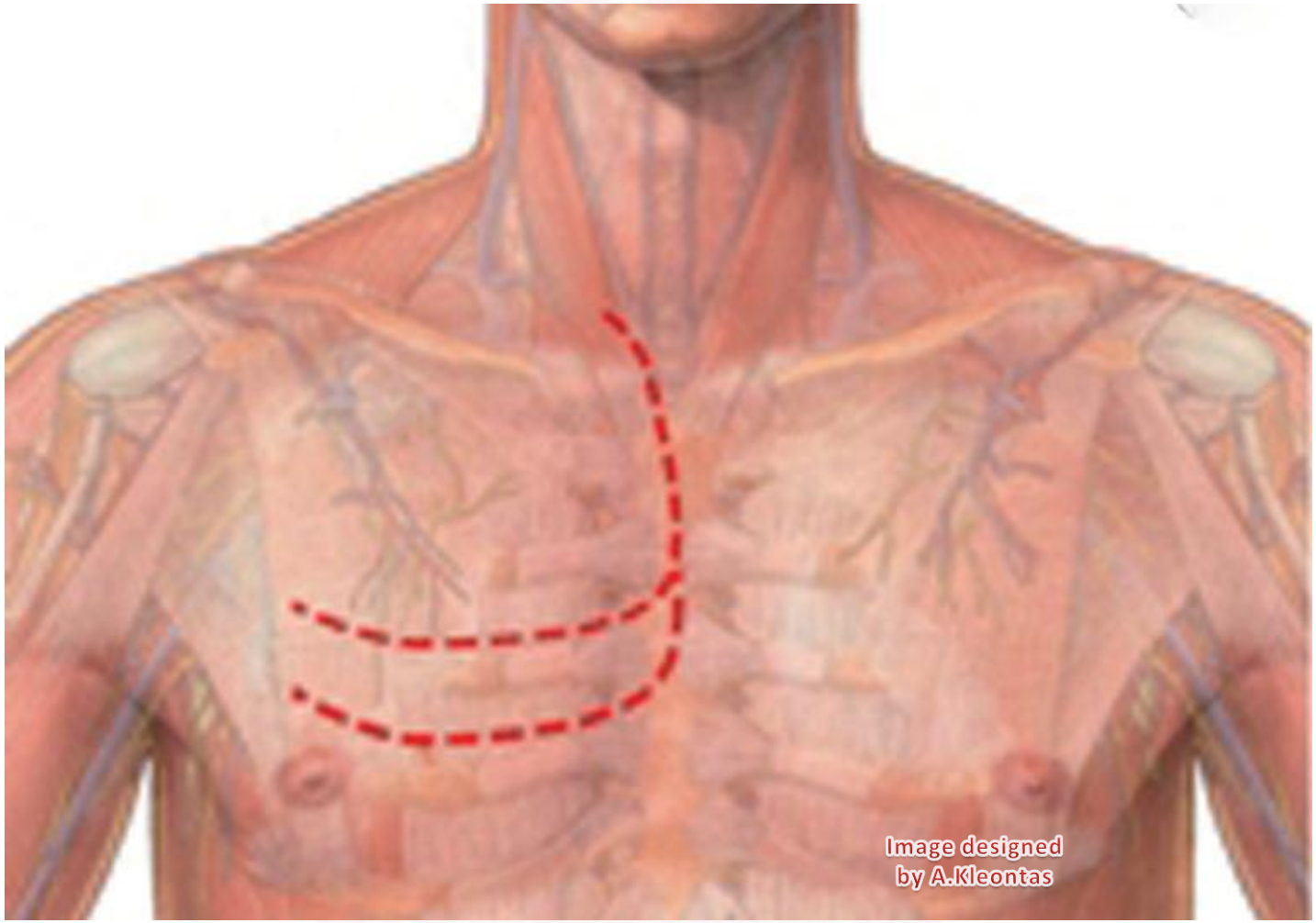

Hemi-Clamshell

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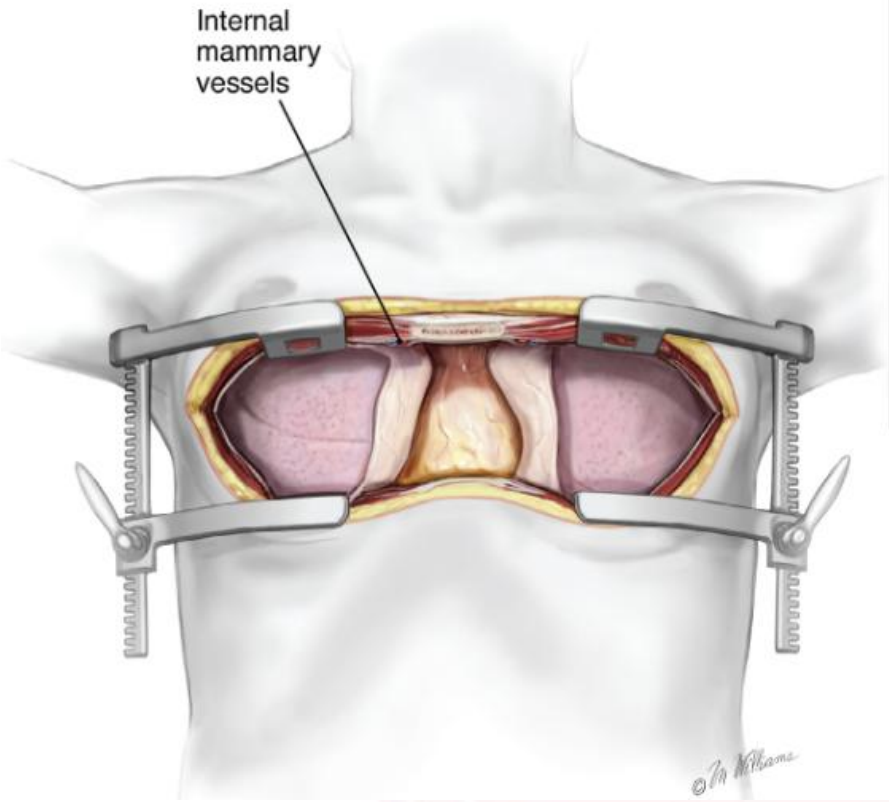

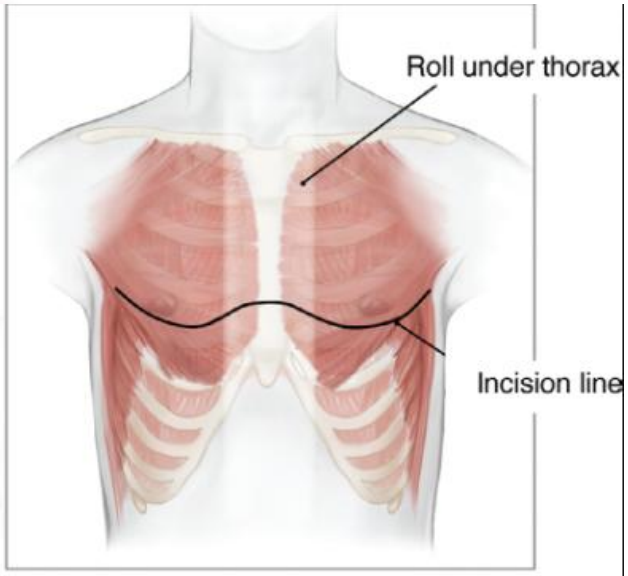

Clamshell

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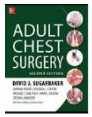

Adult Chest Surgery, 2e
David J. Sugarbaker et al
2015 by McGraw-Hill

Sleeve RUL Lobectomy

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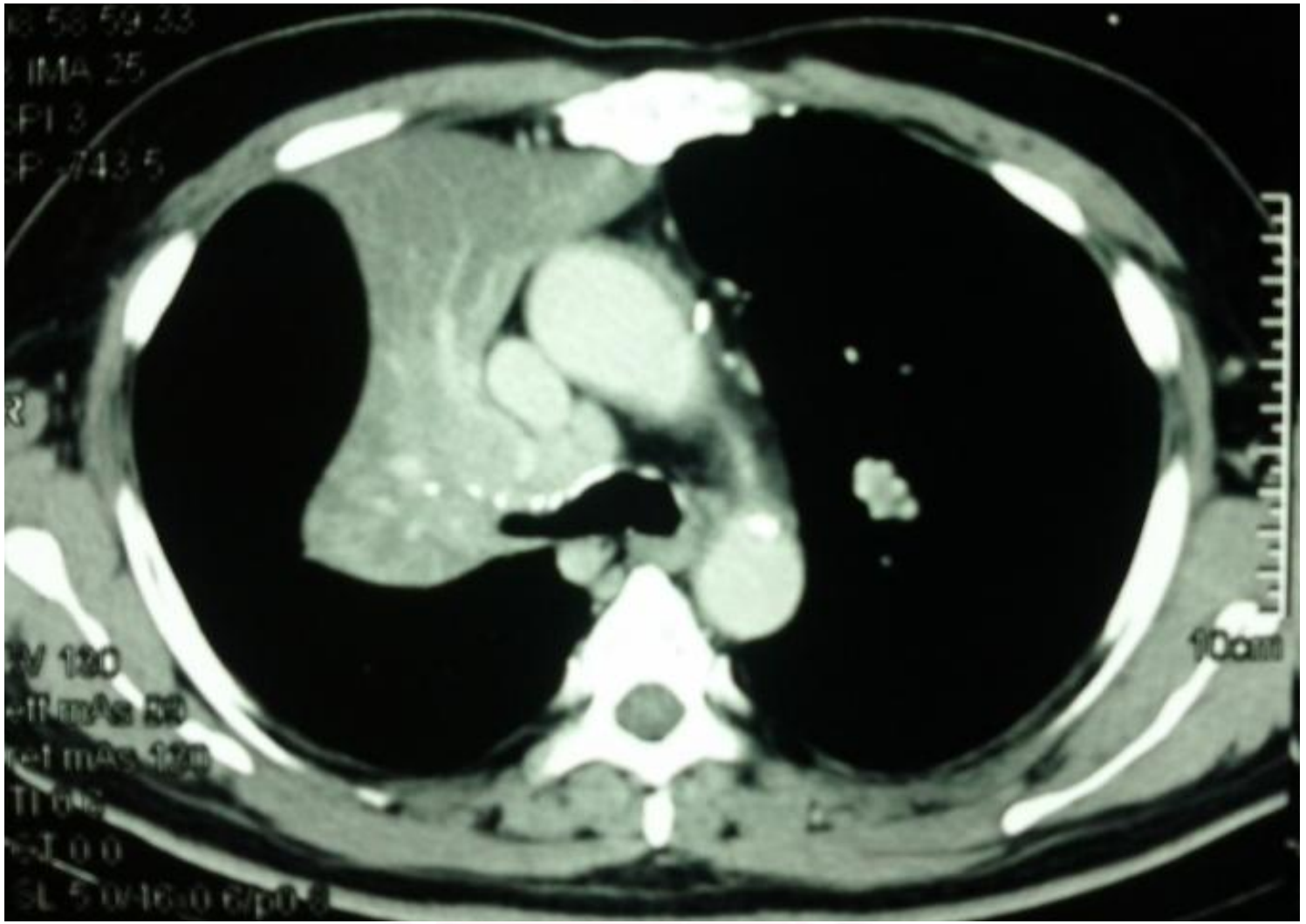

Case

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Sleeve RUL Lobectomy

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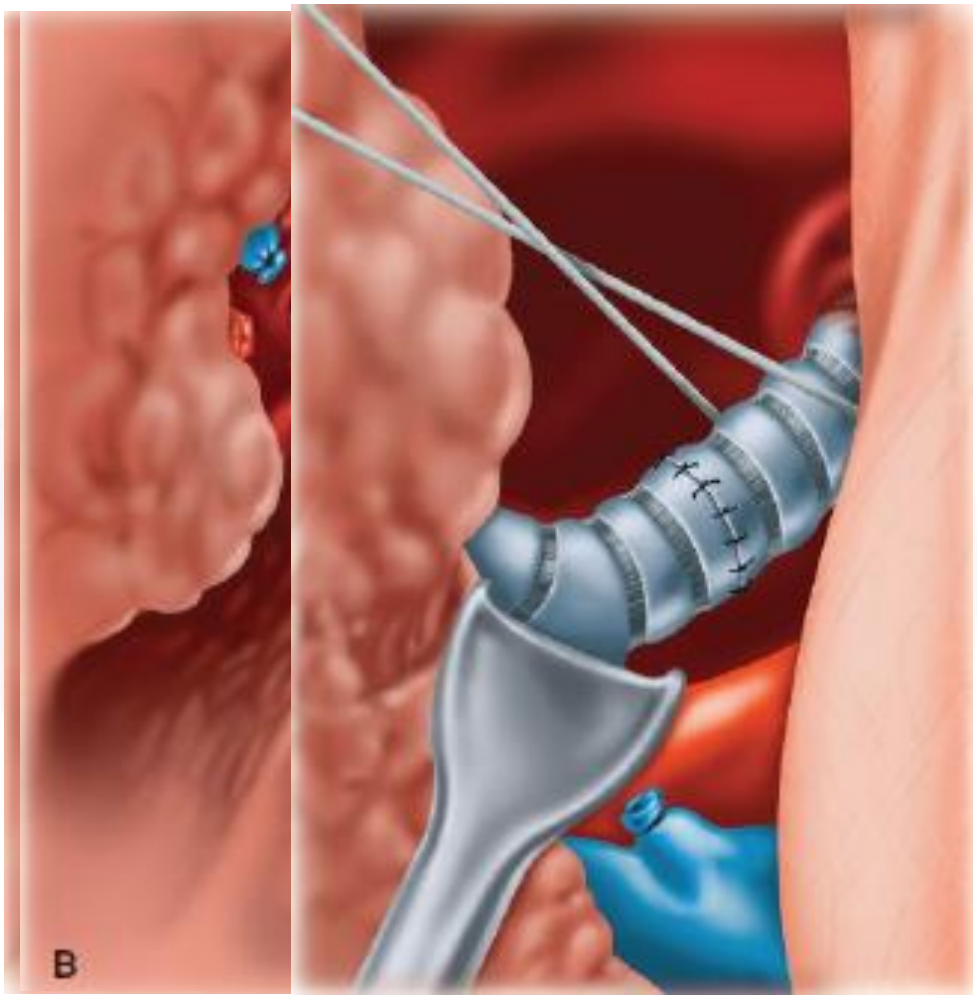

FIGURE 30.1 Illustration of sleeve right upper lobectomy which is the most commonly performed bronchial sleeve resection. A: The right main bronchus is taped. The venous and arterial branch for the right upper lobe are ligated. B: The lobe with a circumferential part of its origin and right main bronchus are removed. C: The bronchus intermedius is reimplanted at the right main bronchus.

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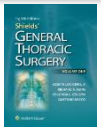
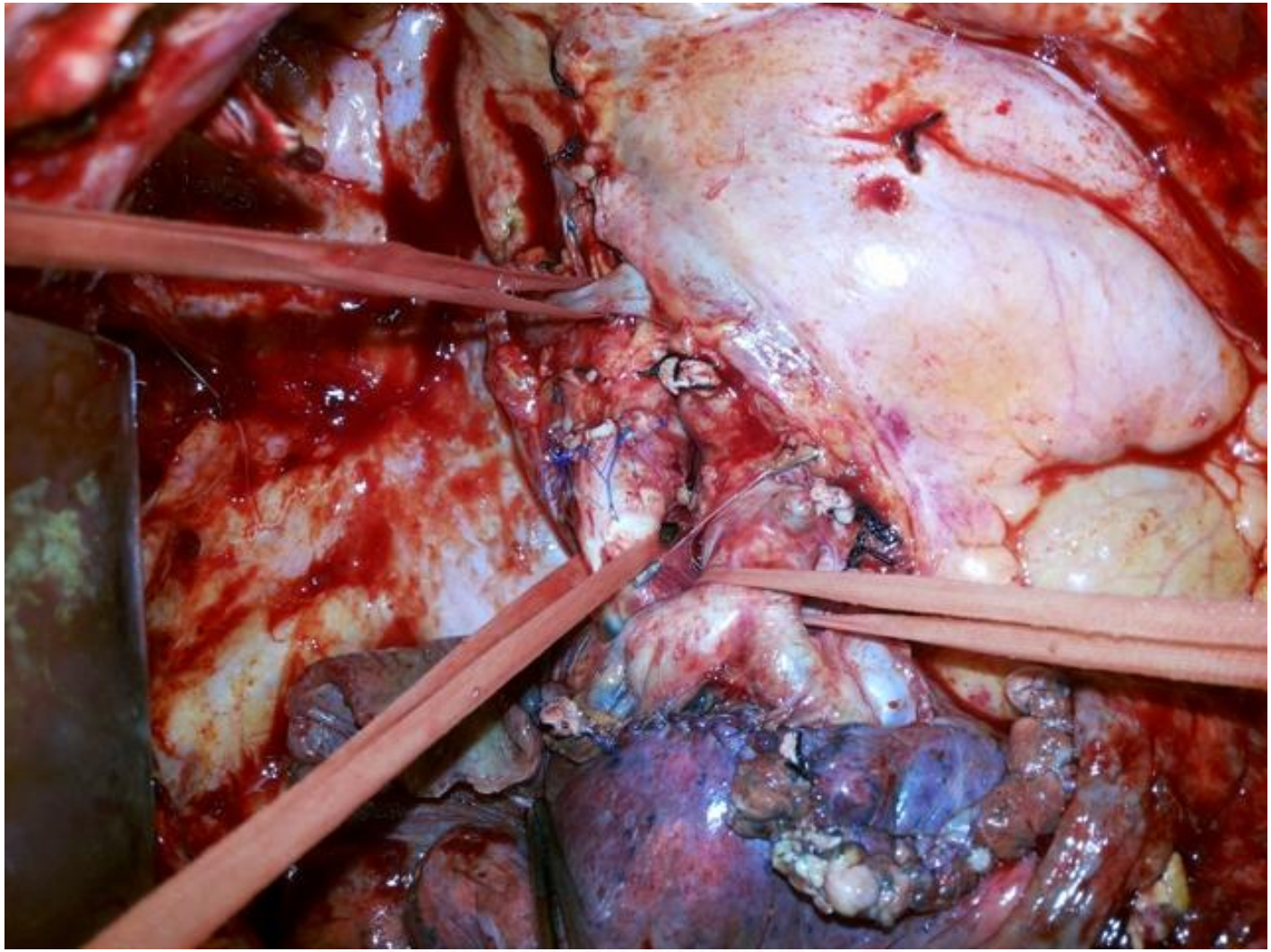


Shields' General Thoracic Surgery
J. Locicero, R. Feins, Y. Colson, G. Rocco
2019 8th edition Wolters Kluwer

Sleeve RUL Lobectomy



Case

- Staging
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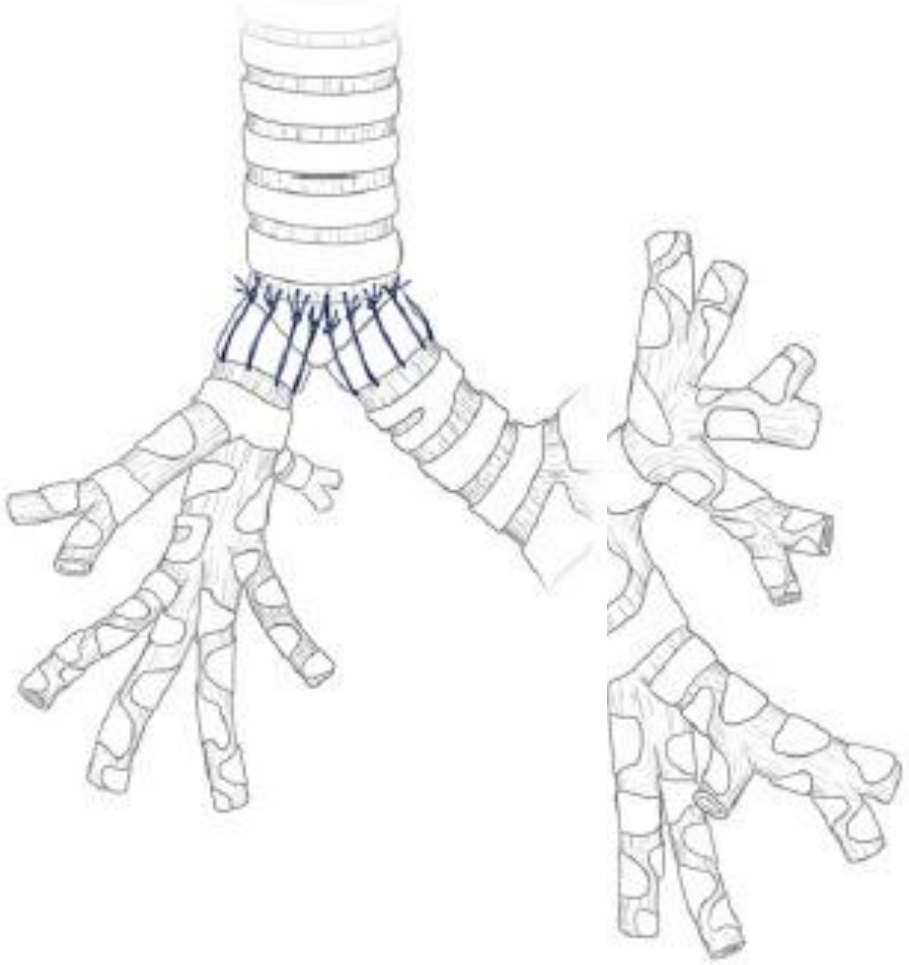
Sleeve RUL Lobectomy
Carina Resection



- Staging
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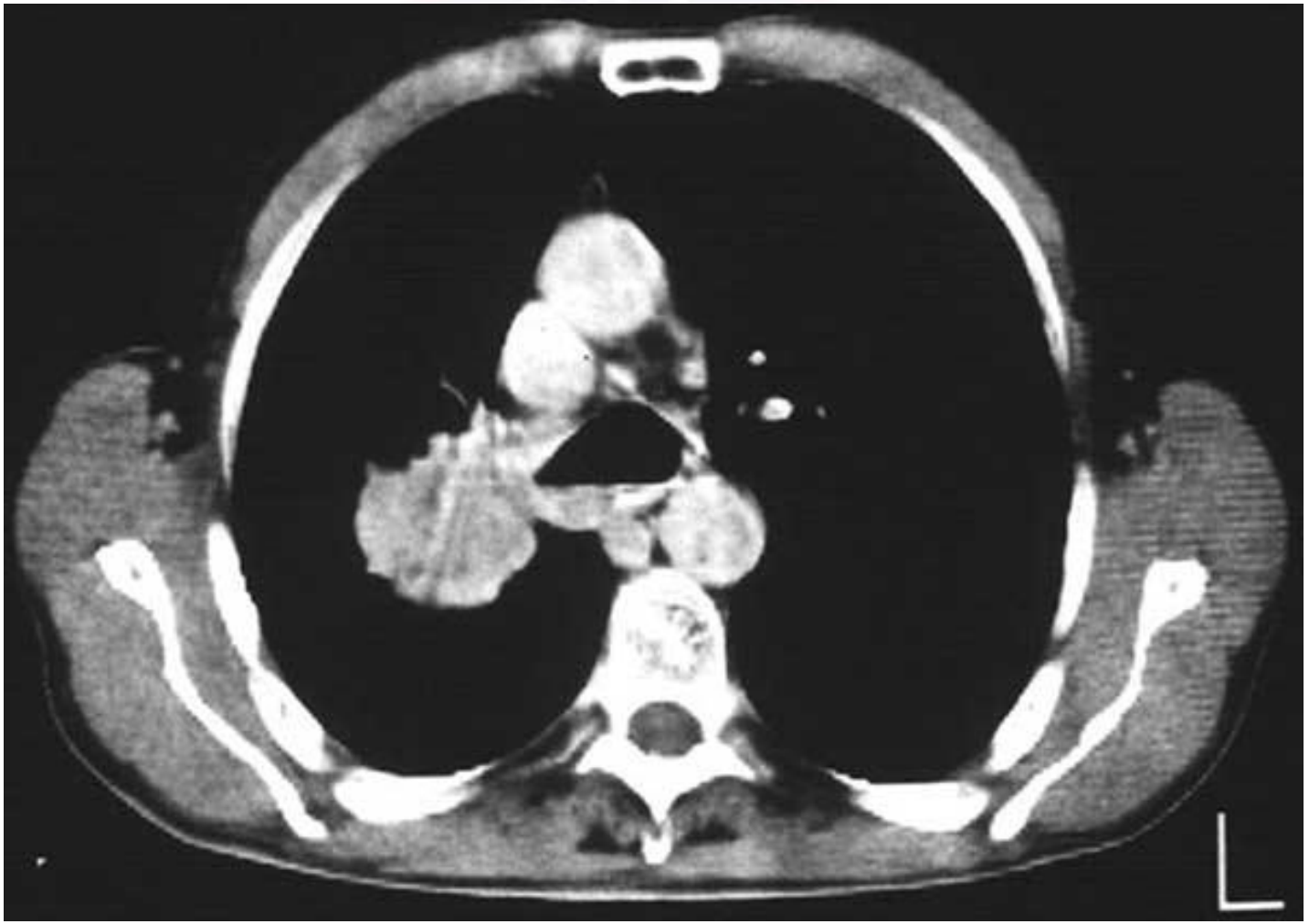
Chest Surgery
H. Dienemann, H. Hoffmann, F. Detterbeck
2015 Springer

Sleeve RUL Lobectomy
Carina Resection



- Staging
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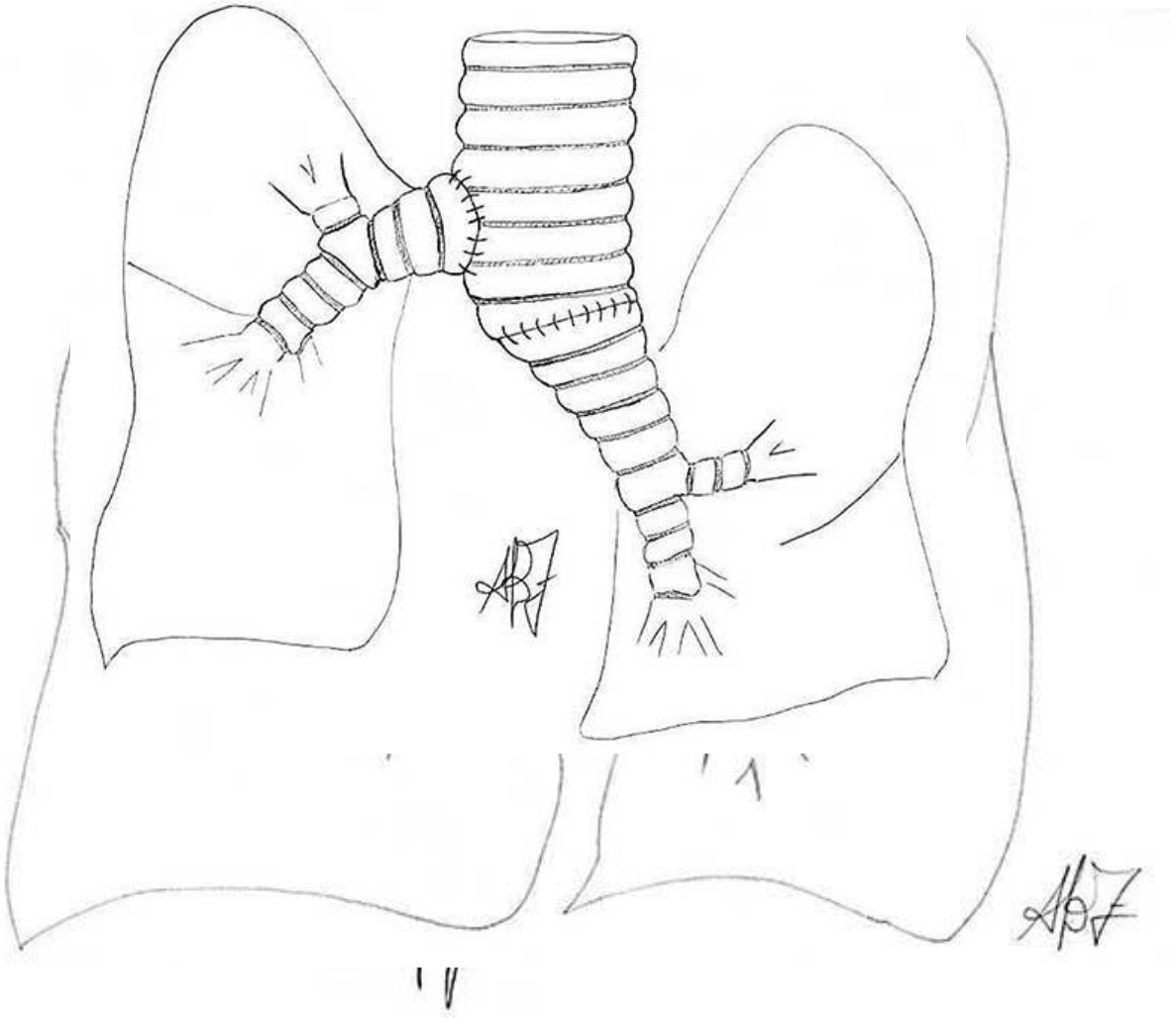
2018

http://www.ctsnet.org/sites/default/files/graphics/experts/Thoracic/reaF2012/fig1A.jpg

Sleeve RUL Lobectomy
Carina Resection



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http://www.ctsnet.org/sites/default/files/graphics/experts/Thoracic/miller/miller-figure-07_400px.jpg

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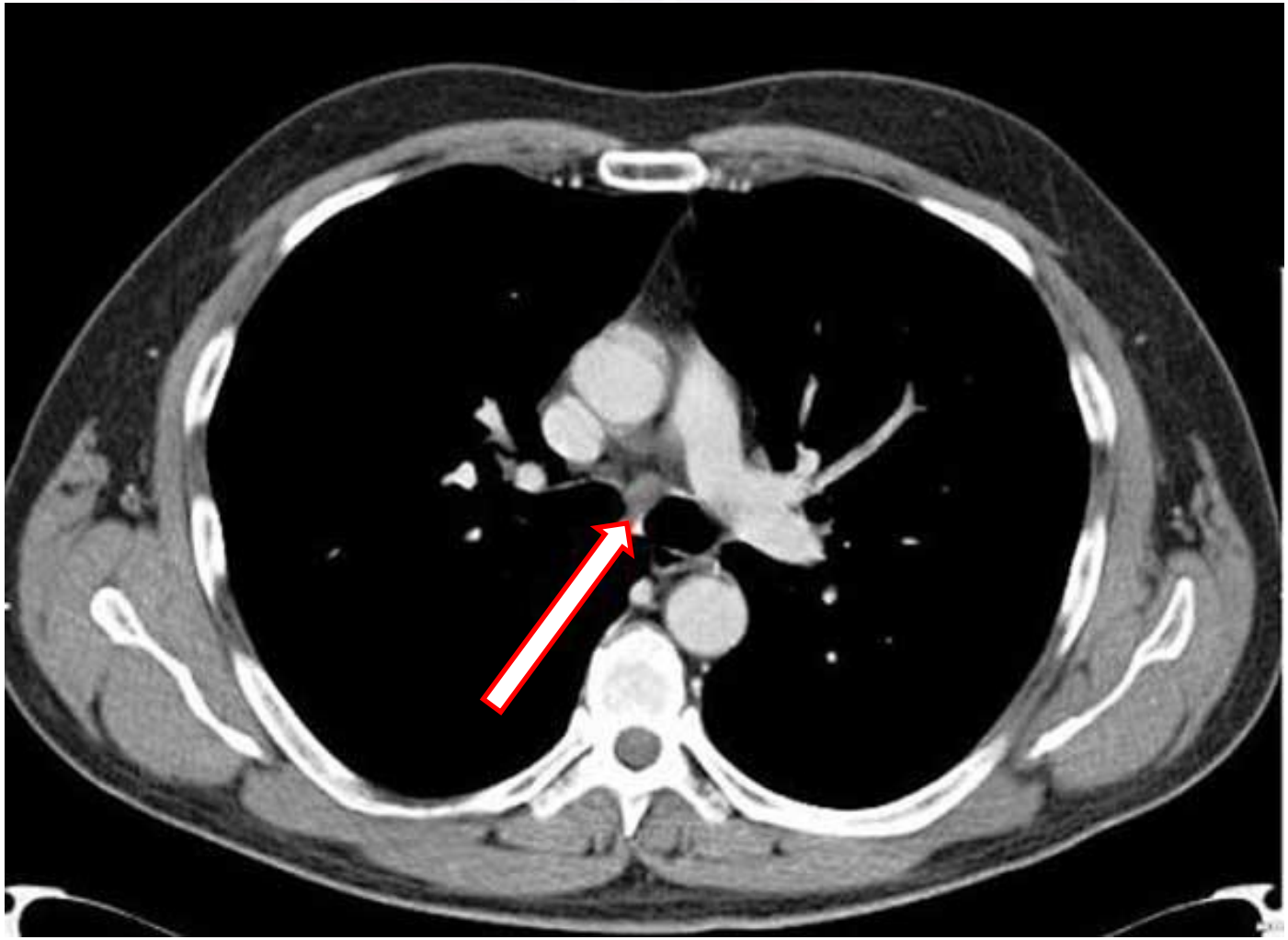
Tracheoplasty
Carina Resection



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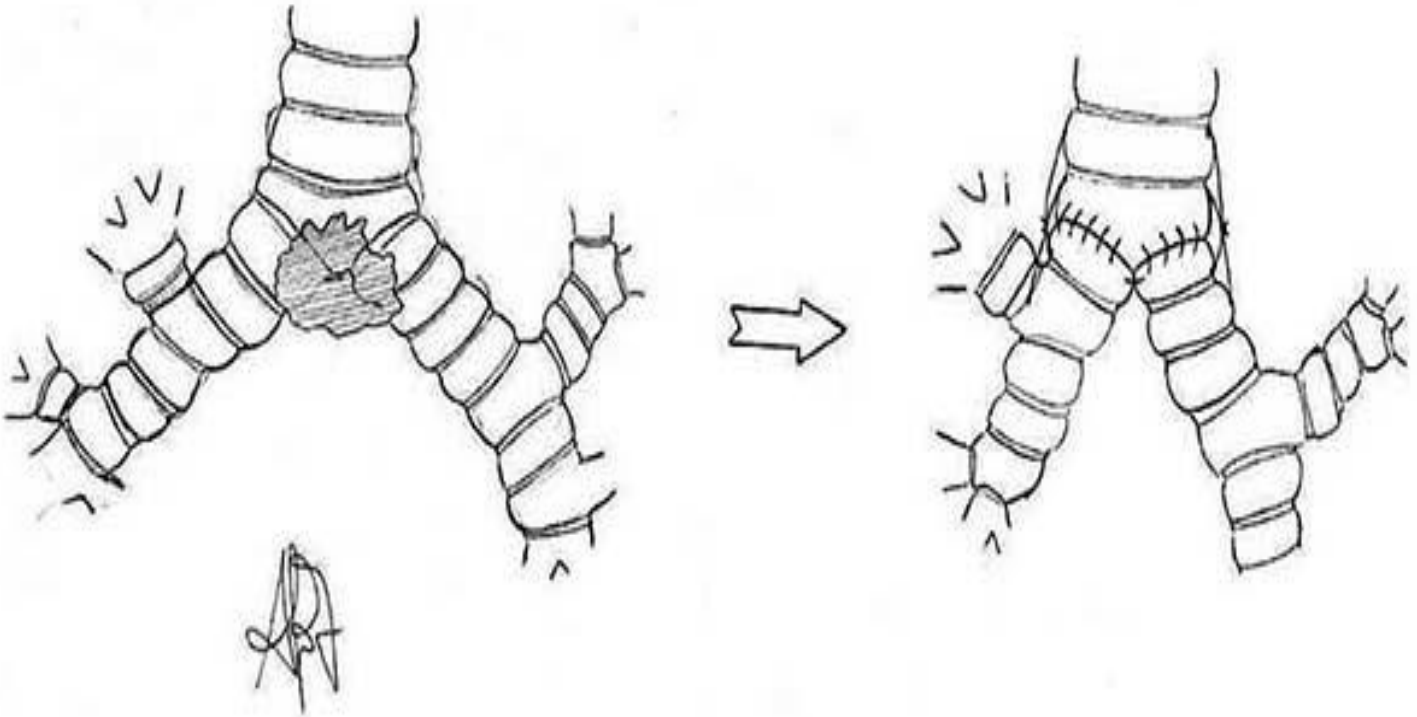
http://www.ctsnet.org/sites/default/files/graphics/experts/Thoracic/reaF2012/fig1C.jpg

Tracheoplasty
Carina Resection



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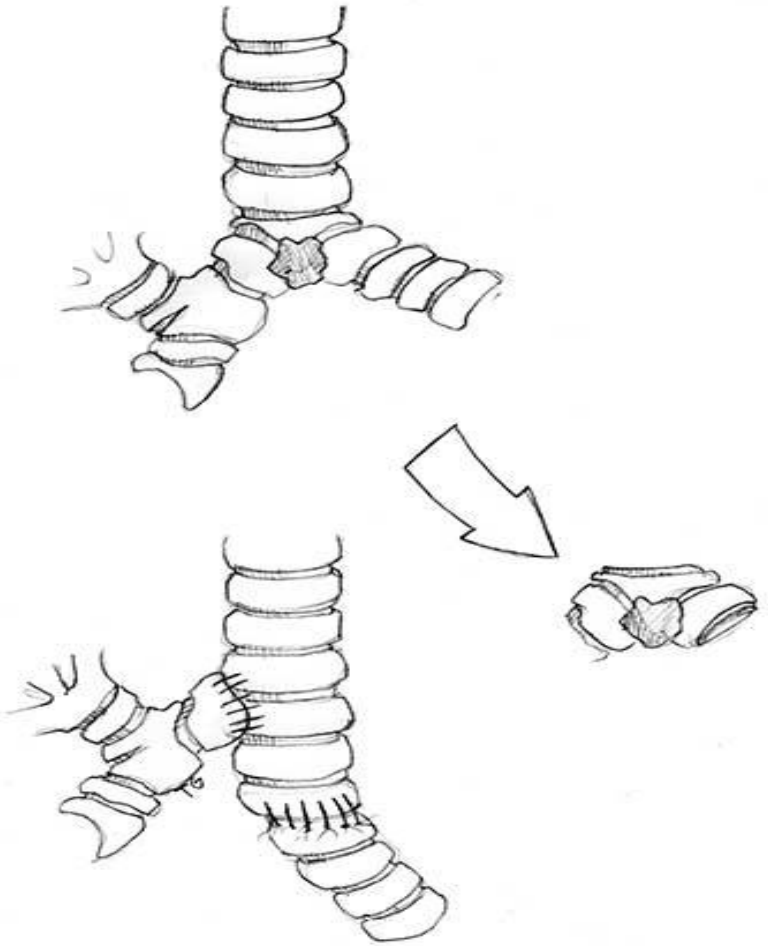
Tracheoplasty
Carina Resection



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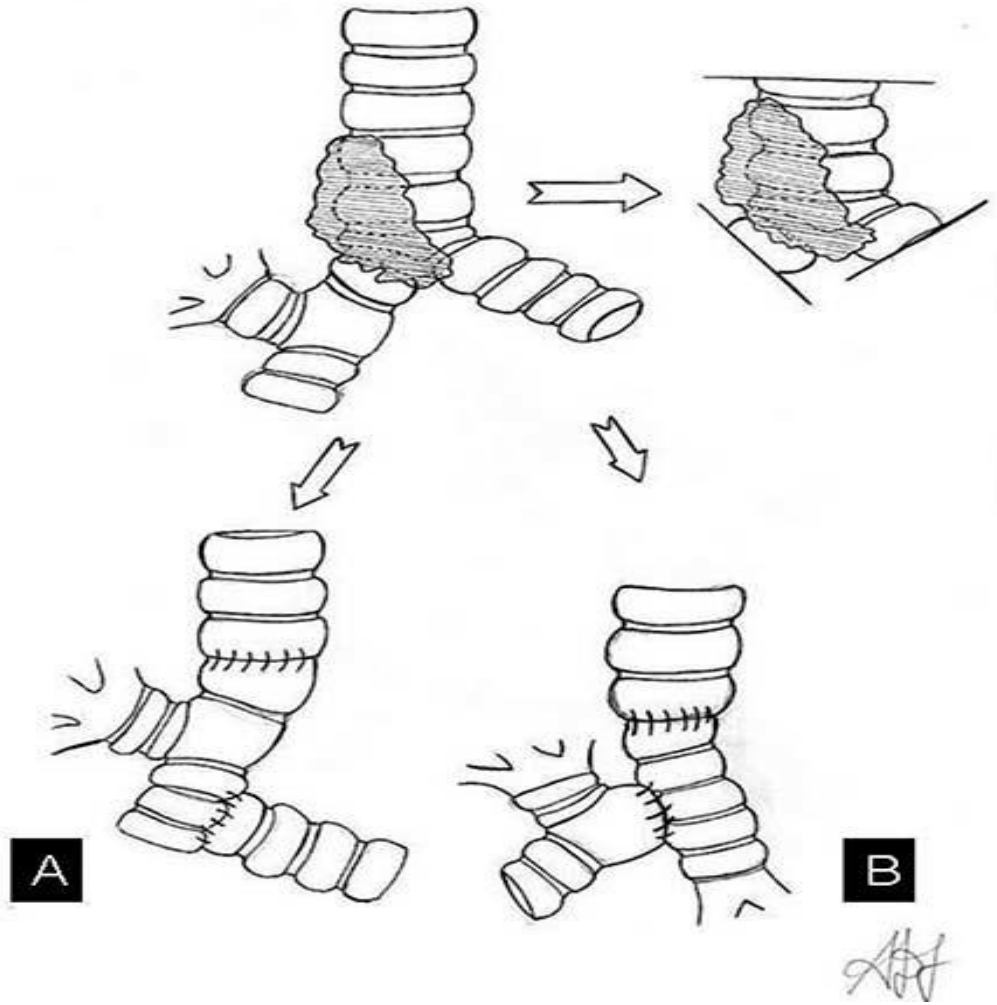
Tracheoplasty
Carina Resection



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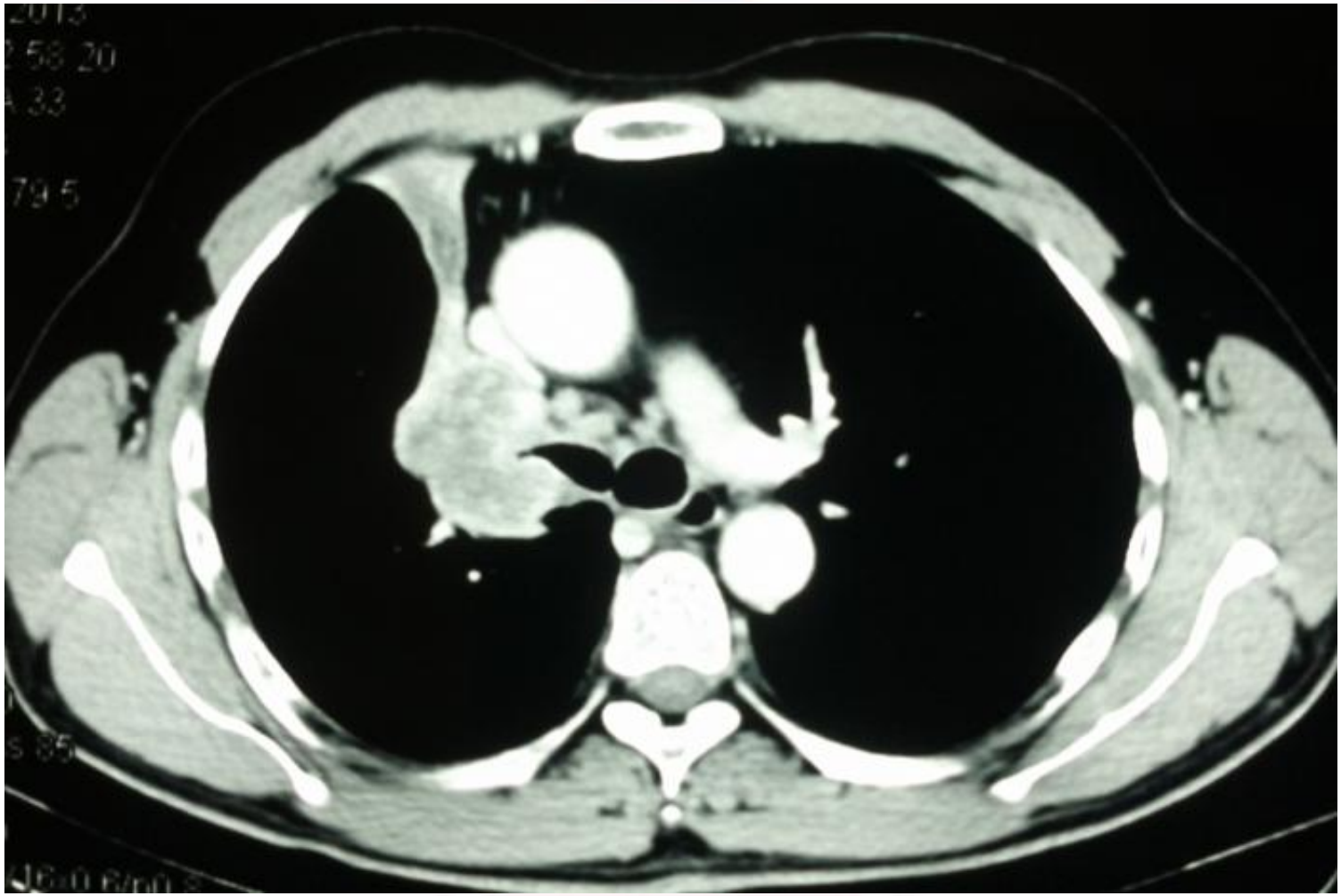
Right Sleeve Pneumonectomy



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Right Sleeve Pneumonectomy

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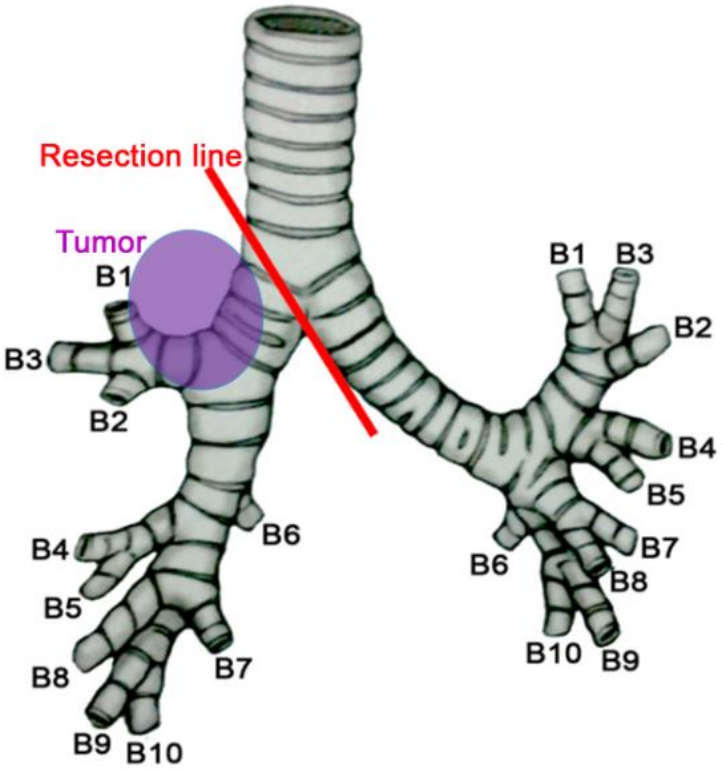

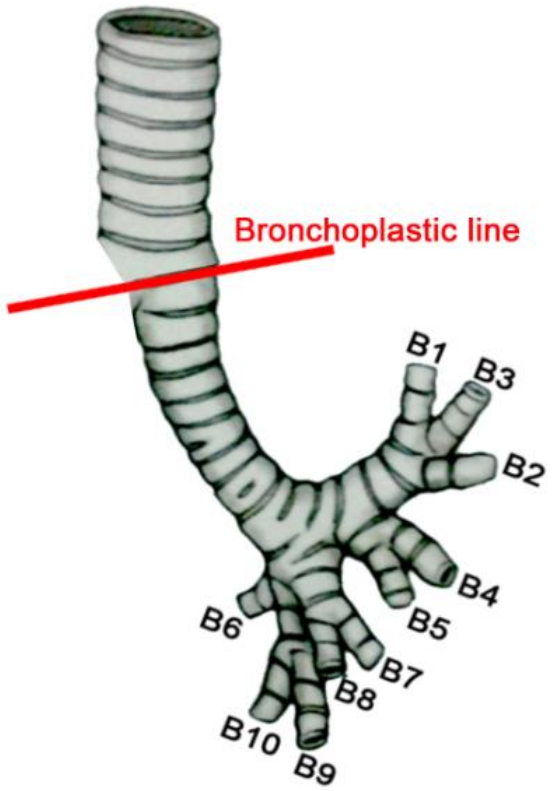

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Right Sleeve Pneumonectomy

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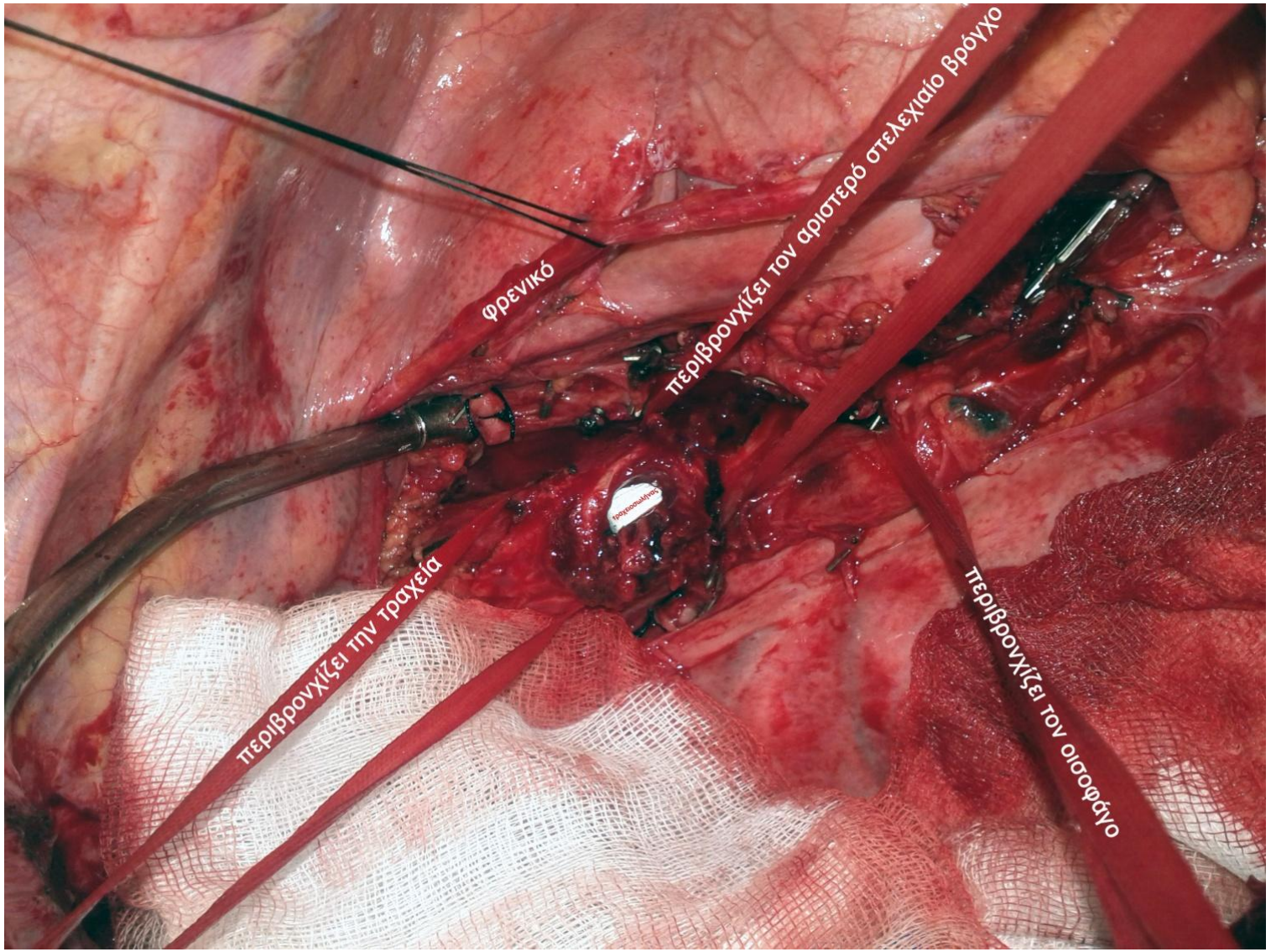

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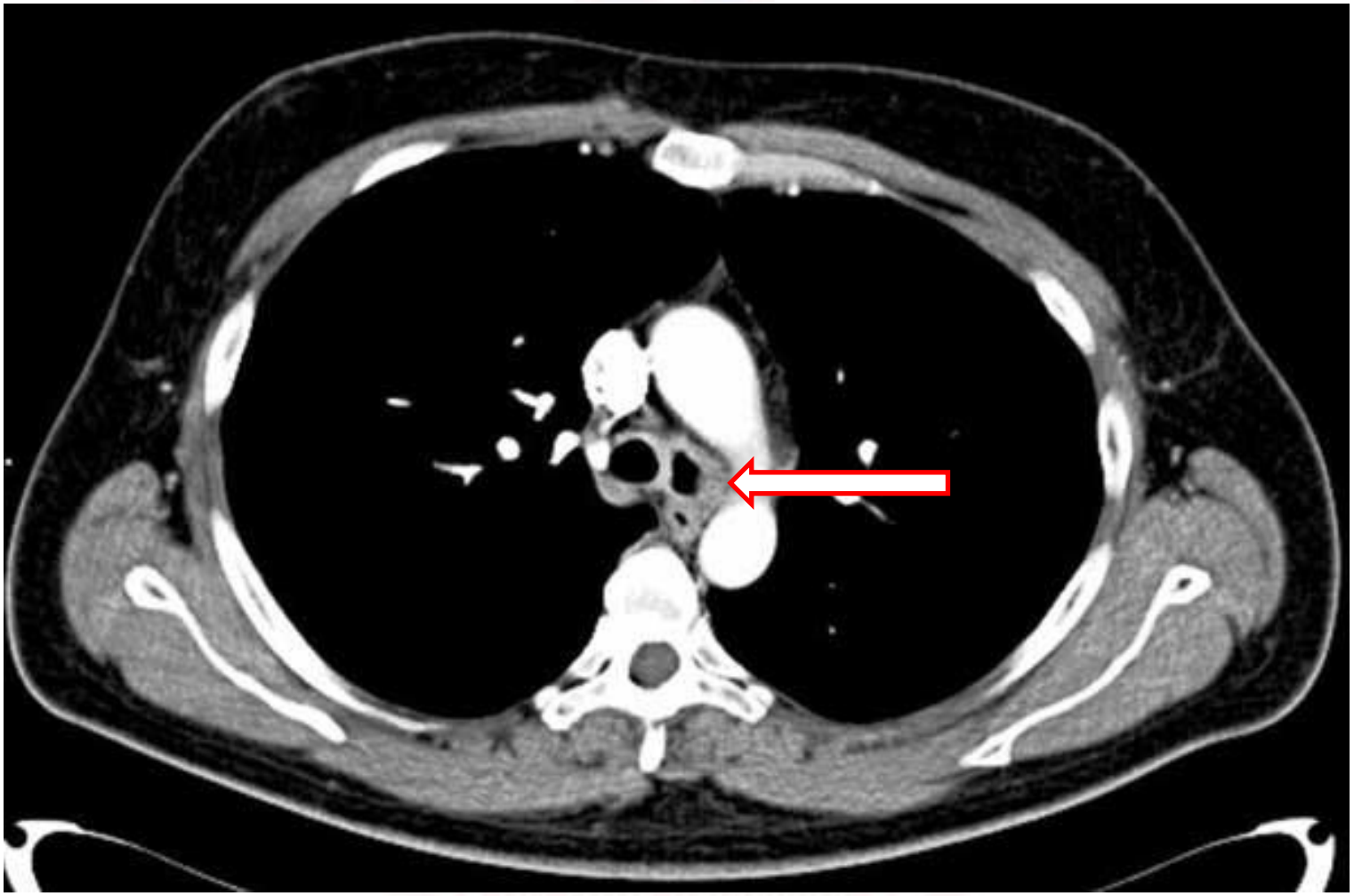
Left Sleeve Pneumonectomy



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Left Sleeve Pneumonectomy

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- Chest Wall
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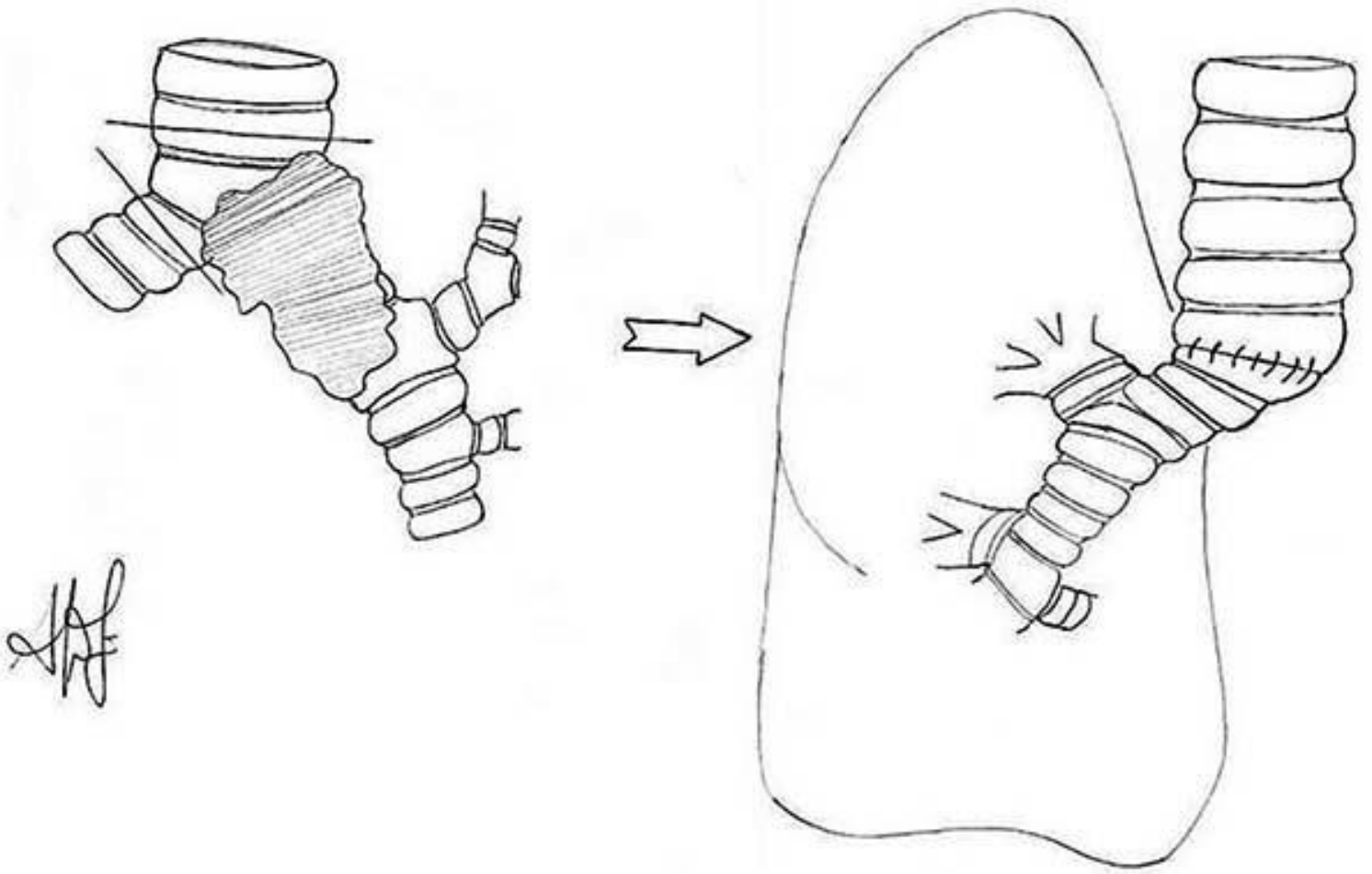

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Double sleeve LUL Lobectomy

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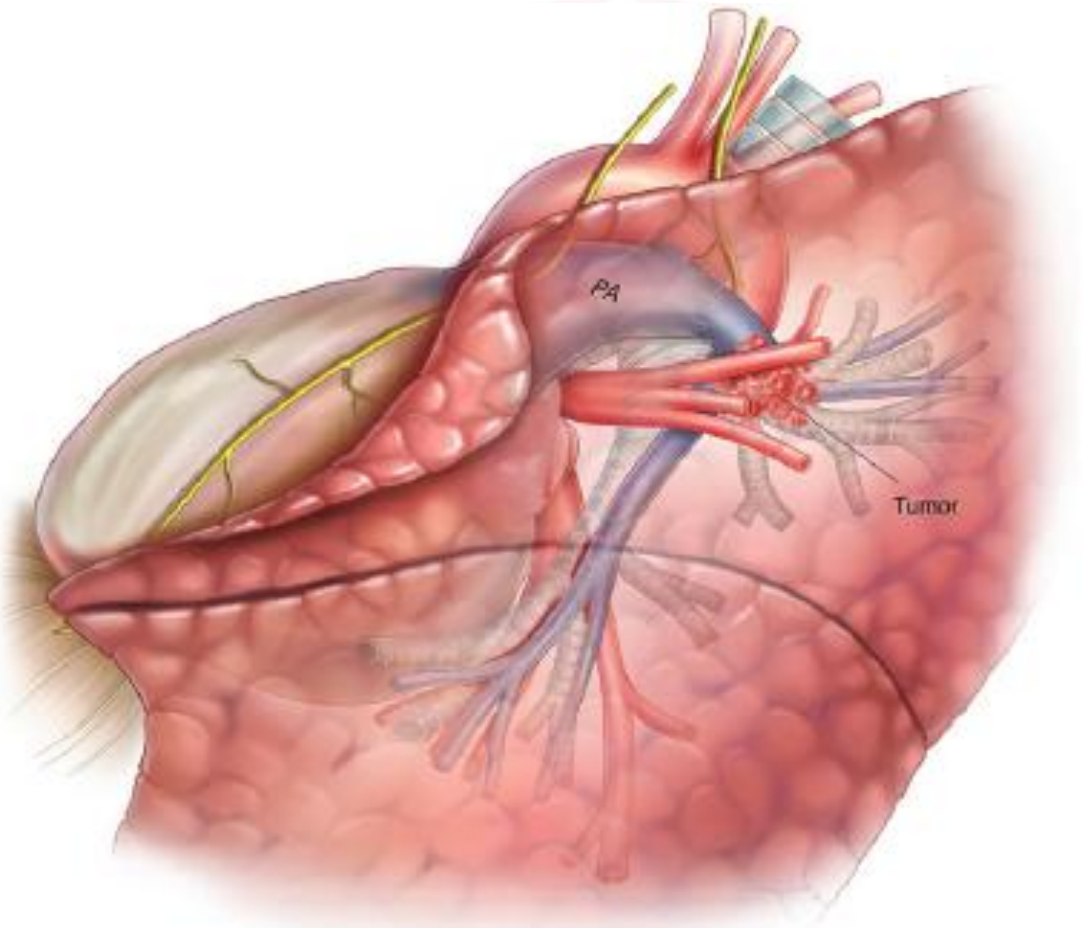

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2015 Springer

PA patch reconstruction

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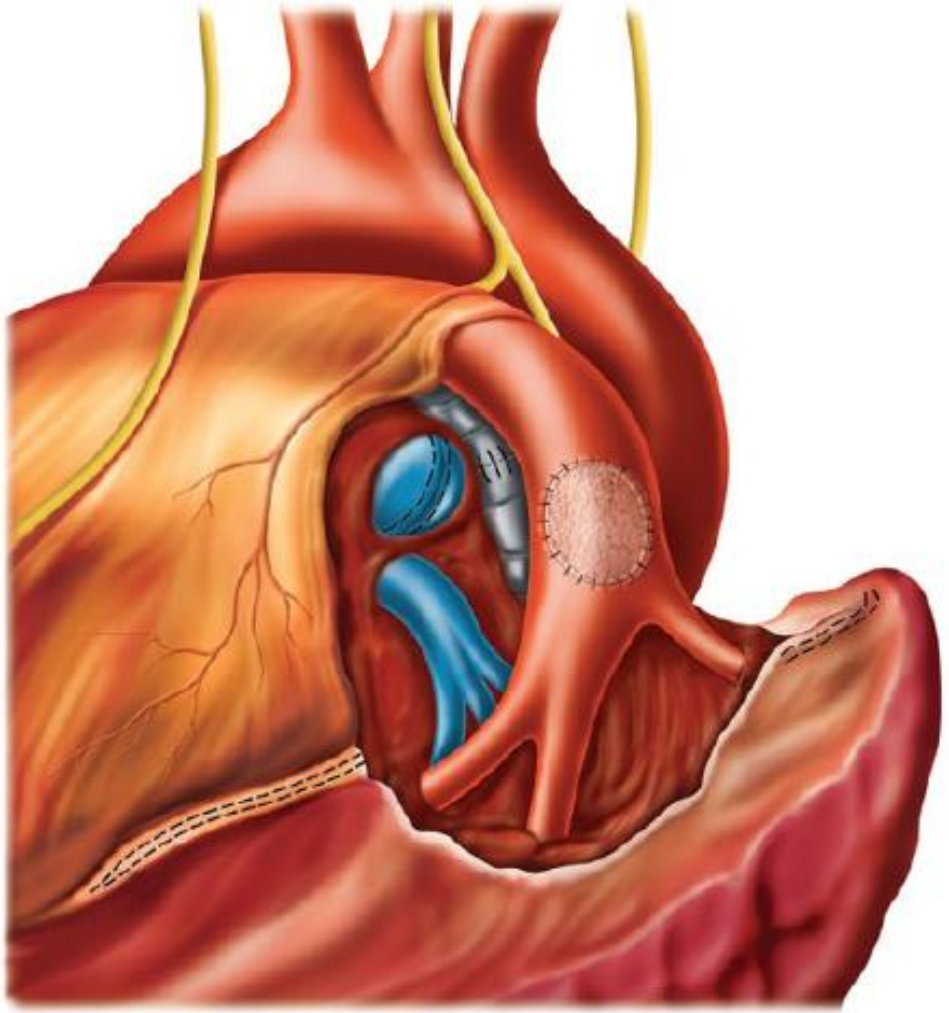

URE 30.20 The patch reconstruction is completed. he anastomosis is
he med with 5.0 or 6.0 Prolene.

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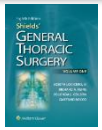

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PA anastomosis

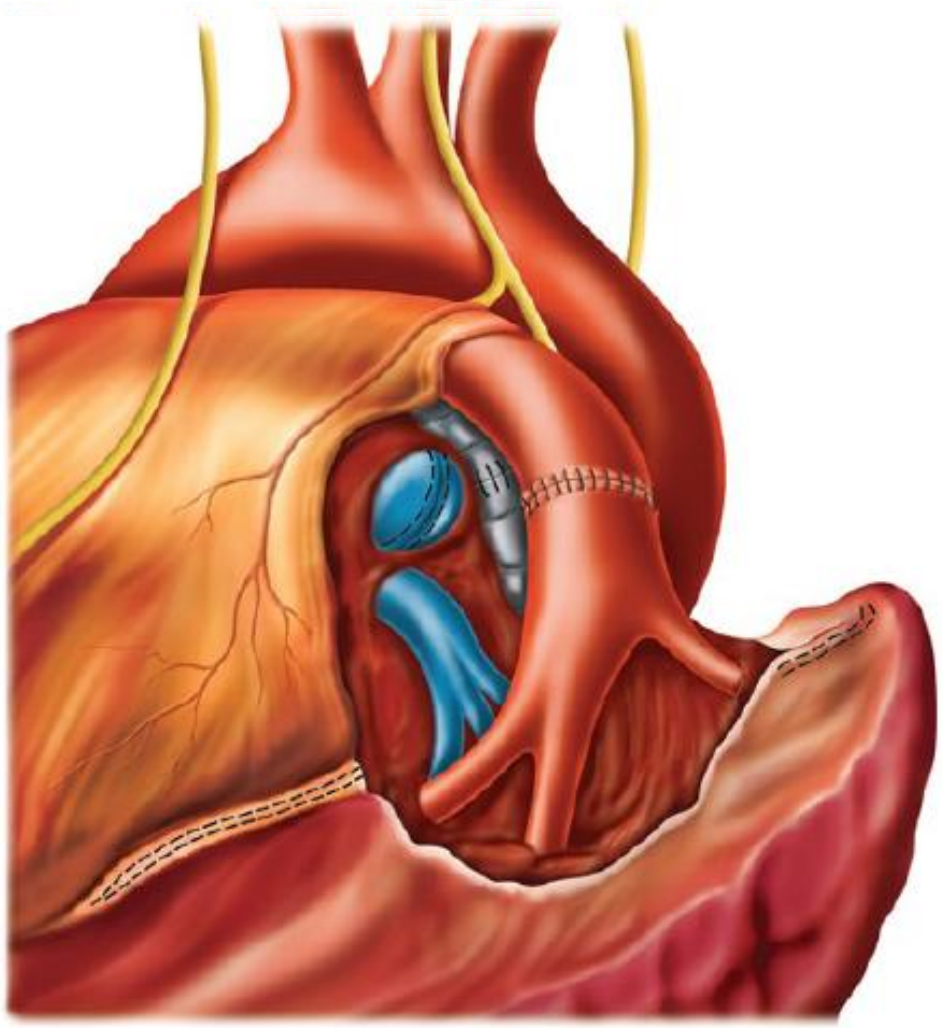

FIGURE 30.23 The anastomosis is completed. bable monofilament suture.

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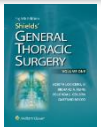

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Intrapericardial Pneumonectomy

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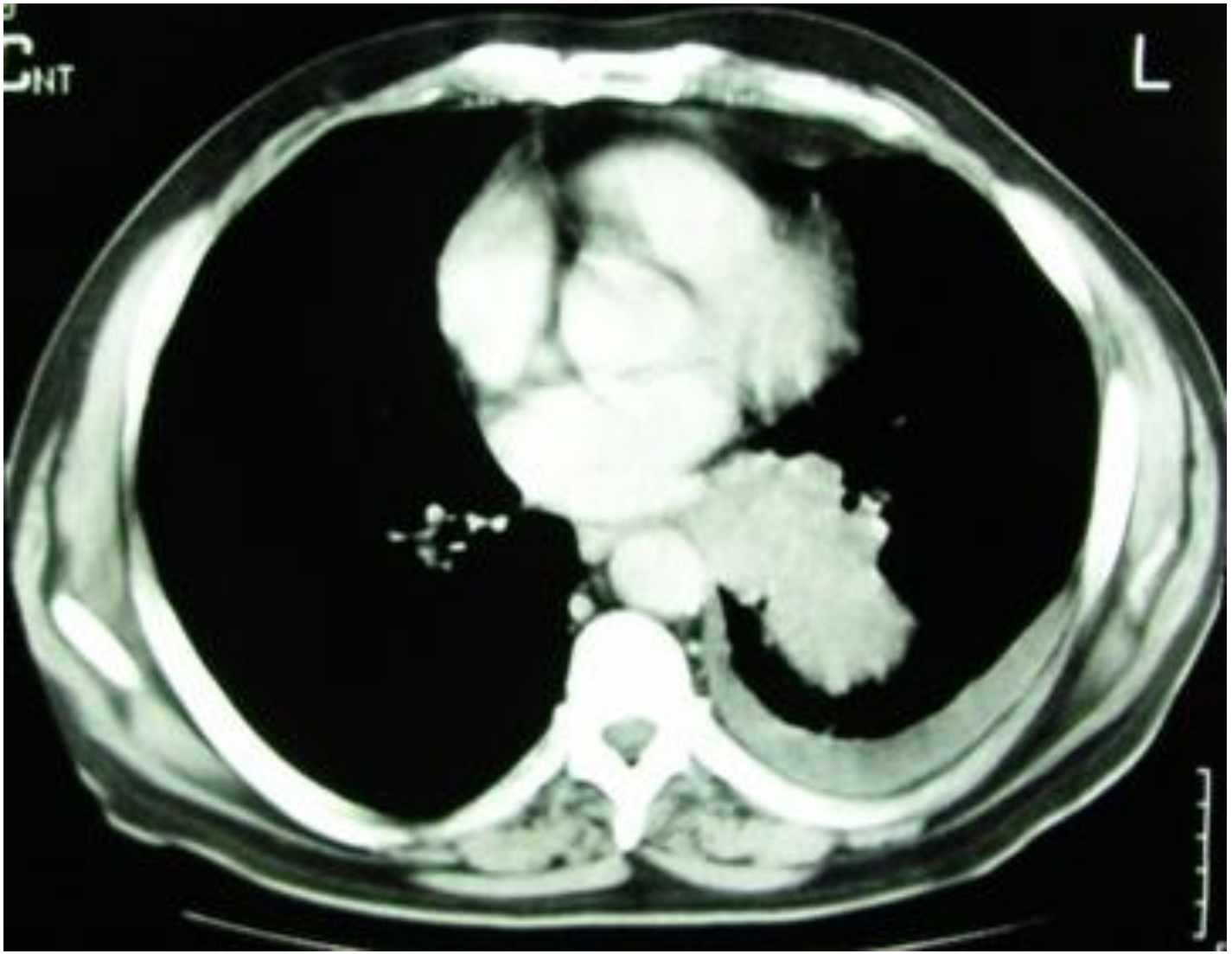

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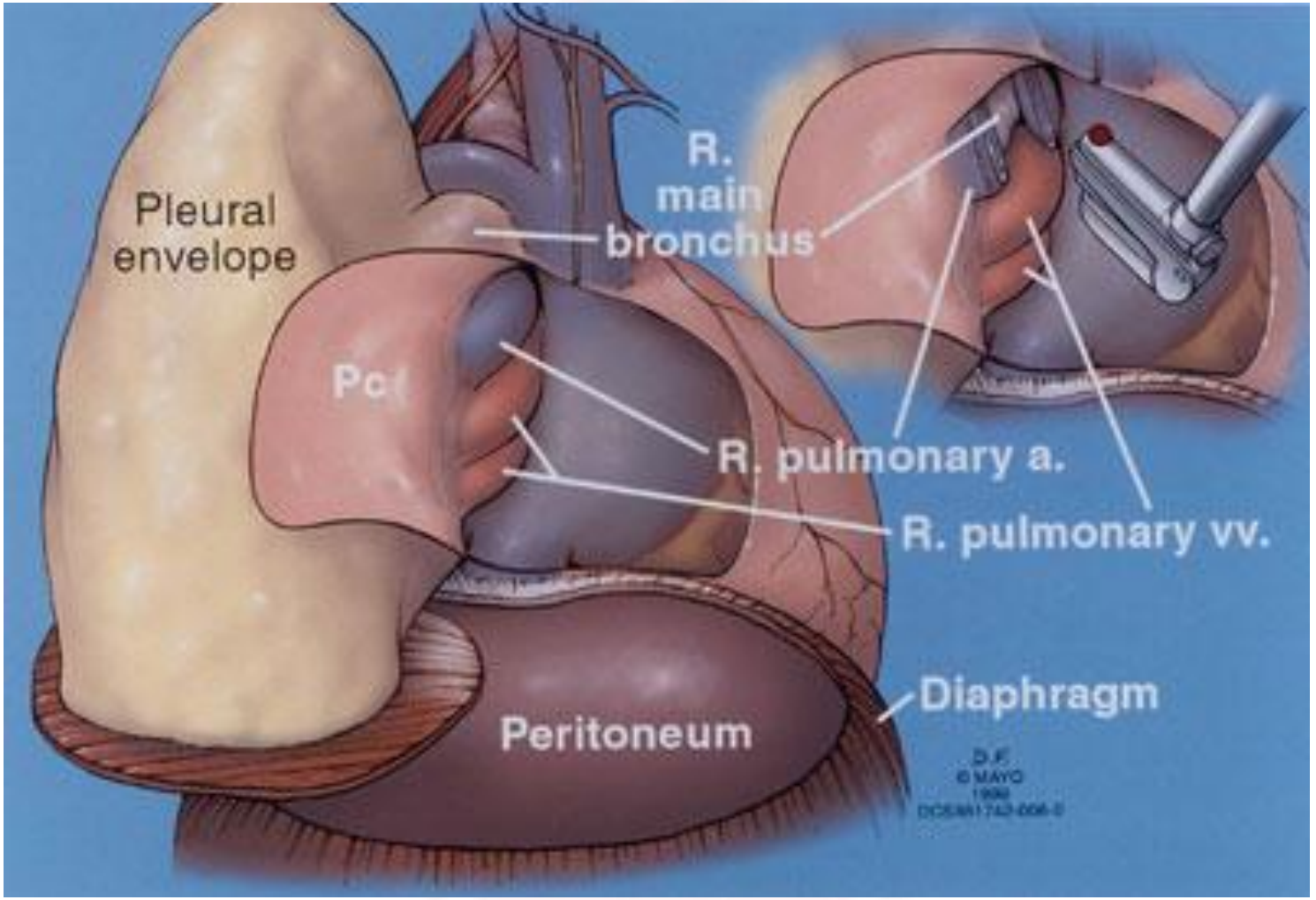

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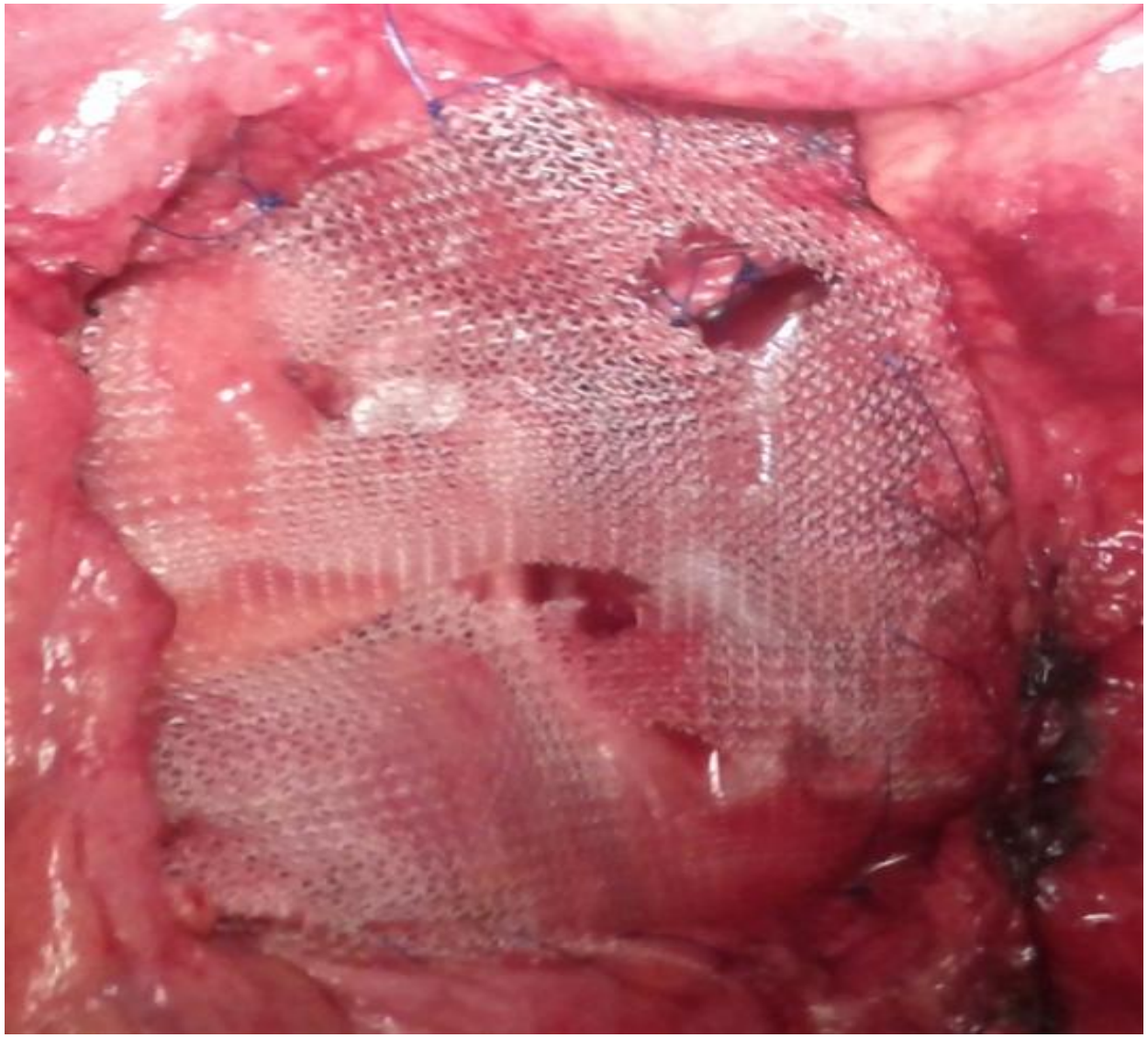

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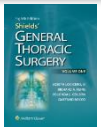
Sleeve Resections

TABLE 30.1 Postoperative Mortality, Morbidity, and Long-Term Survival After Sleeve Resection (Literature Data Since 2000)

Study	Year	No. of Patients	Postoperative Mortality (%)	Early Anastomotic Complications (%)	5-Year Survival Rate (%)	Locoregional Recurrence (%)
Tronc and colleagues[22]	2000	184	1.6	1	52	22
Rendina and colleagues[23]	2000	145	1.4	1.4	37.9	NR
Terzi and colleagues[20]	2002	160	11.2	7.5	NR	NR
De Leyn and colleagues[24]	2003	77	3.9	2.6	45.6	16.8
Ludwig and colleagues[25]	2005	116	4.3	6.9	39	NR
Kim and colleagues[26]	2005	49	6.1	2	53.7	32.6
Yildizeli and colleagues[10]	2007	218	4.1	6.4	53	14.4
Rea and colleagues[27]	2008	199	4.5	5.3	39.7	11.6
Deslauriers and colleagues[18]	2004	184	1.3	1.6	58	22
Yamamoto and colleagues[28]	2008	201	1.4	3.3	57.8	12.9
Merritt and colleagues[29]	2009	196	2	2	44	17.9
Konstantinou and colleagues[30]	2009	45	2	0	57 (4-y)	NR
Storelli and colleagues[15]	2012	103	2.9	1	63	7.8

NR, not reported.



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Chest Wall Invasion

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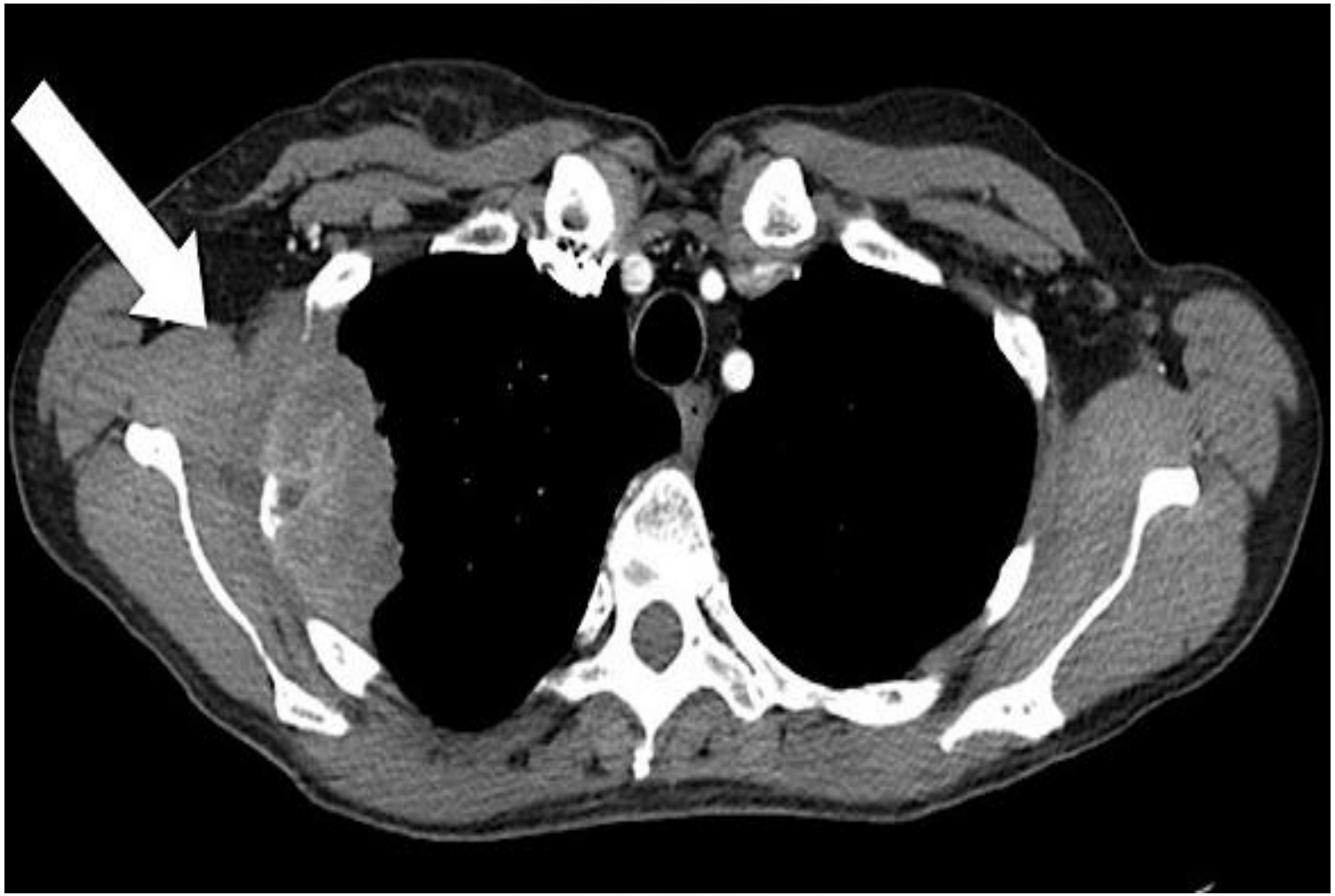

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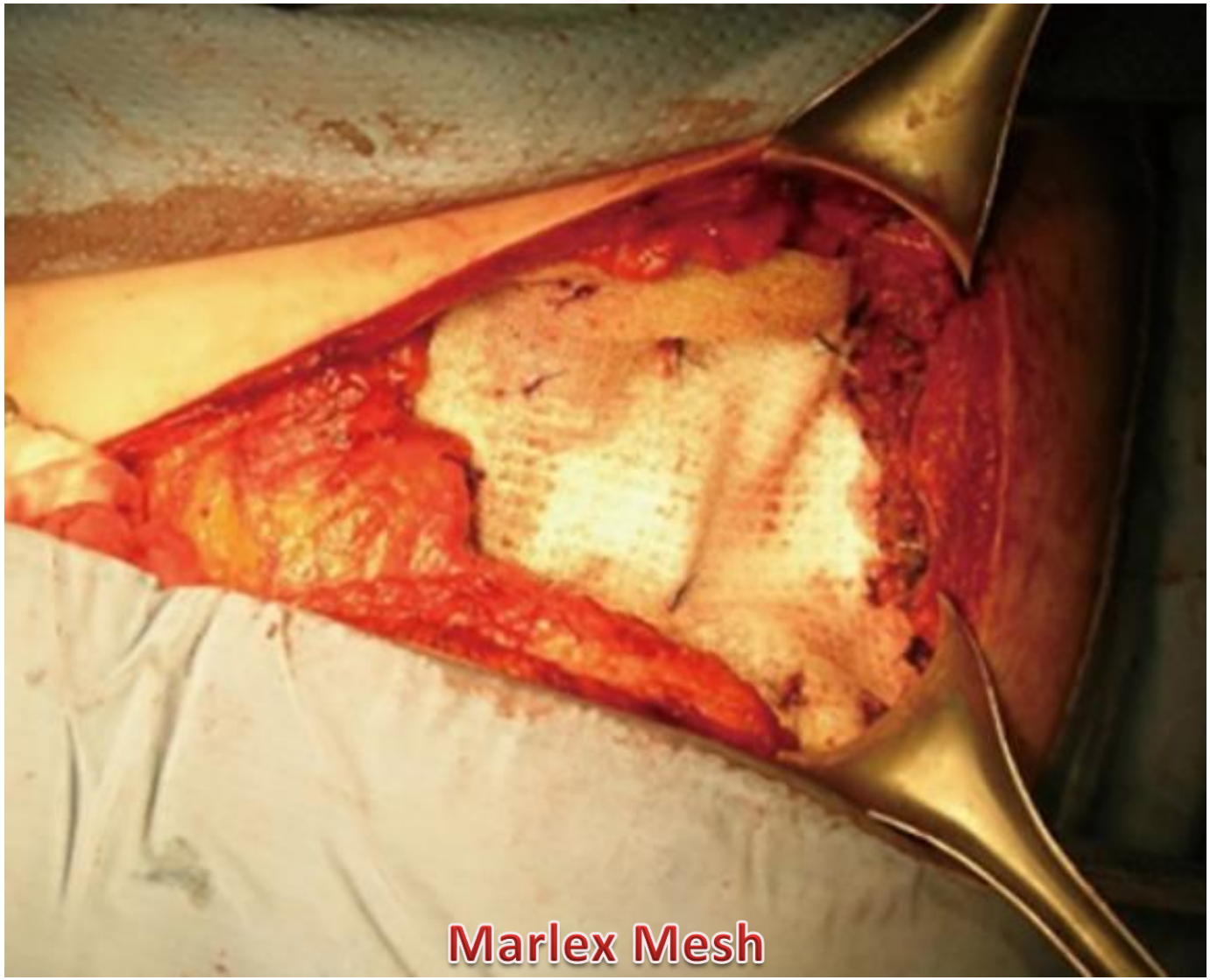
http://staginglungcancer.org/stages/IIIA-T3InvN1

Chest Wall Invasion



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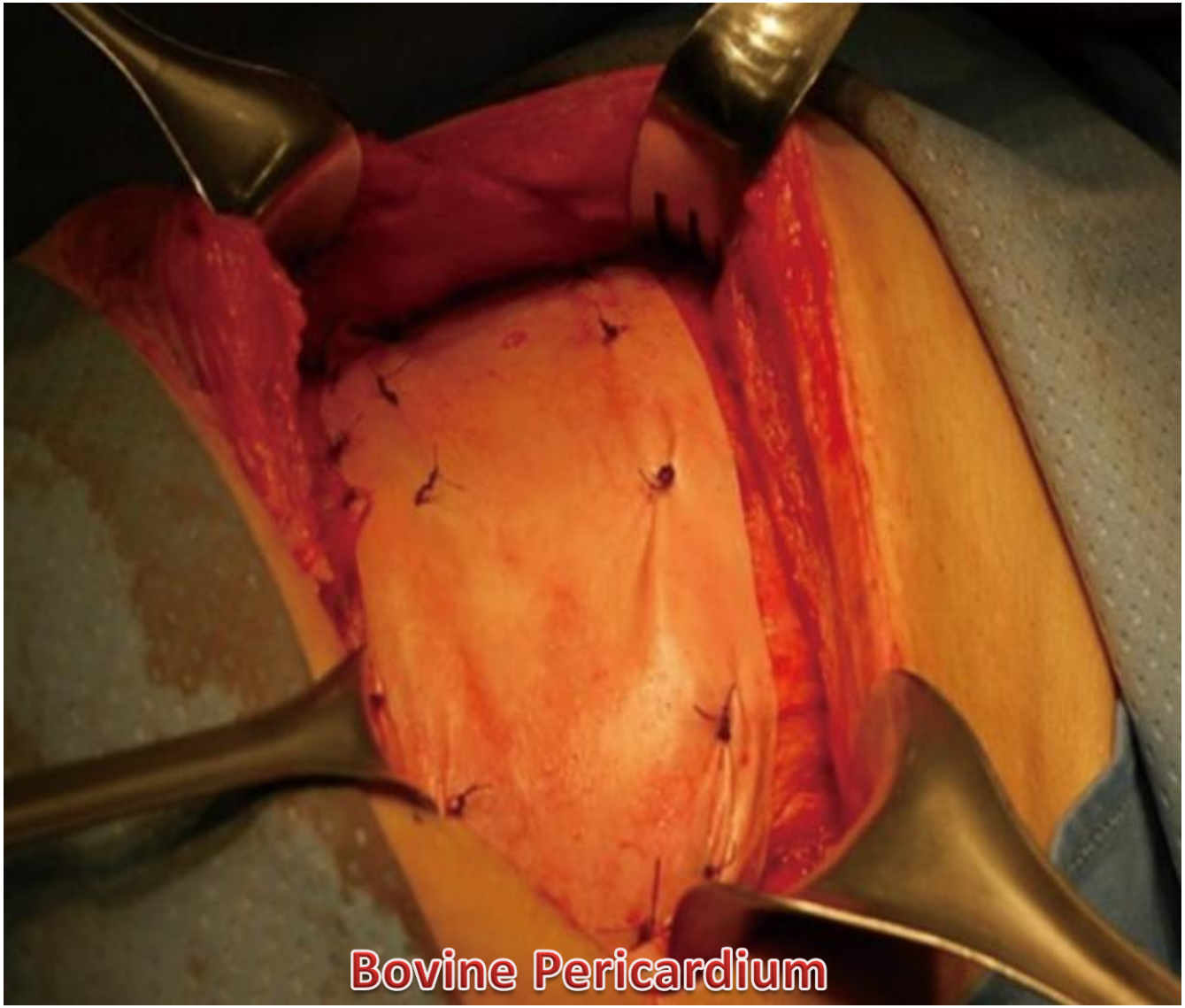

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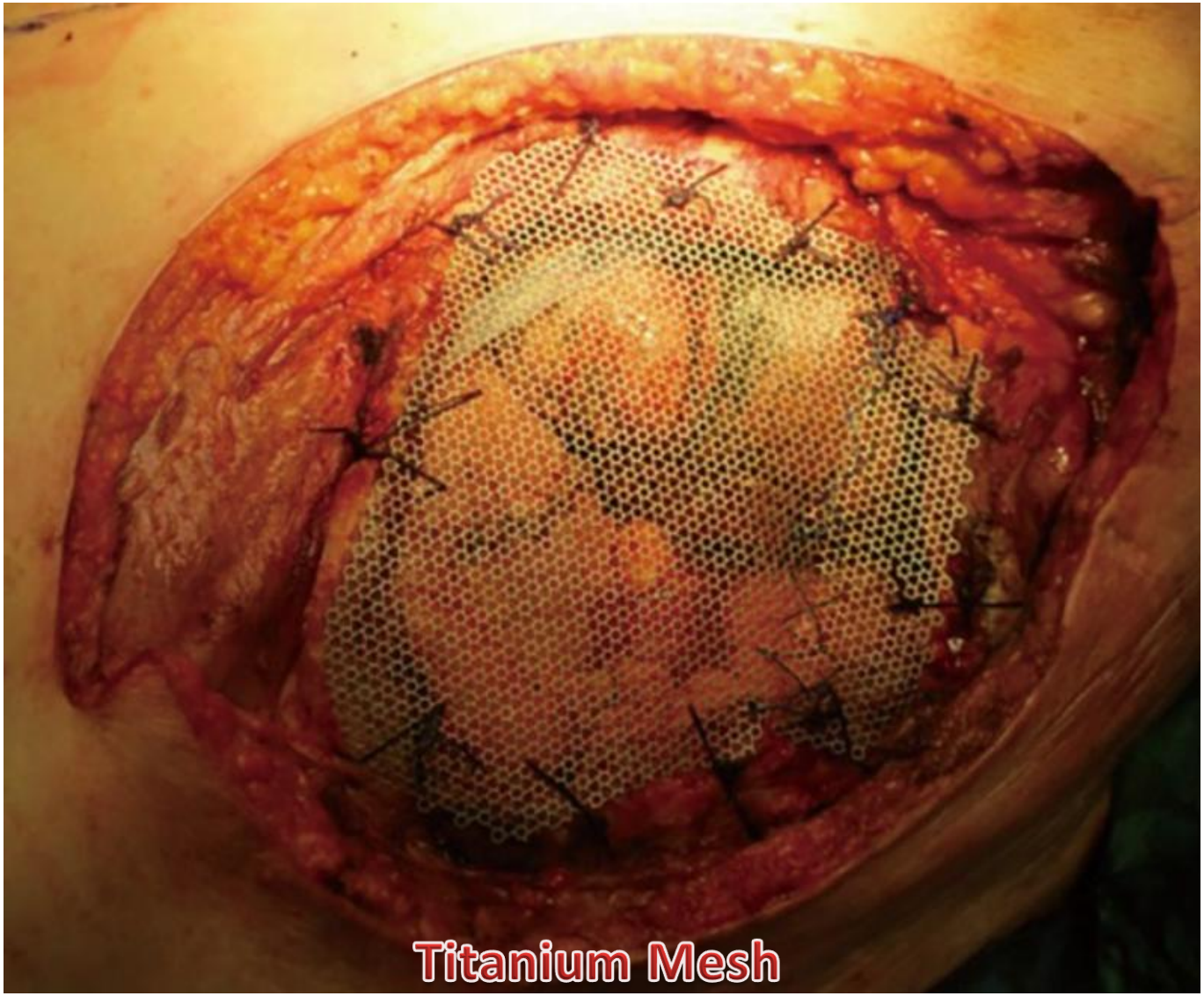

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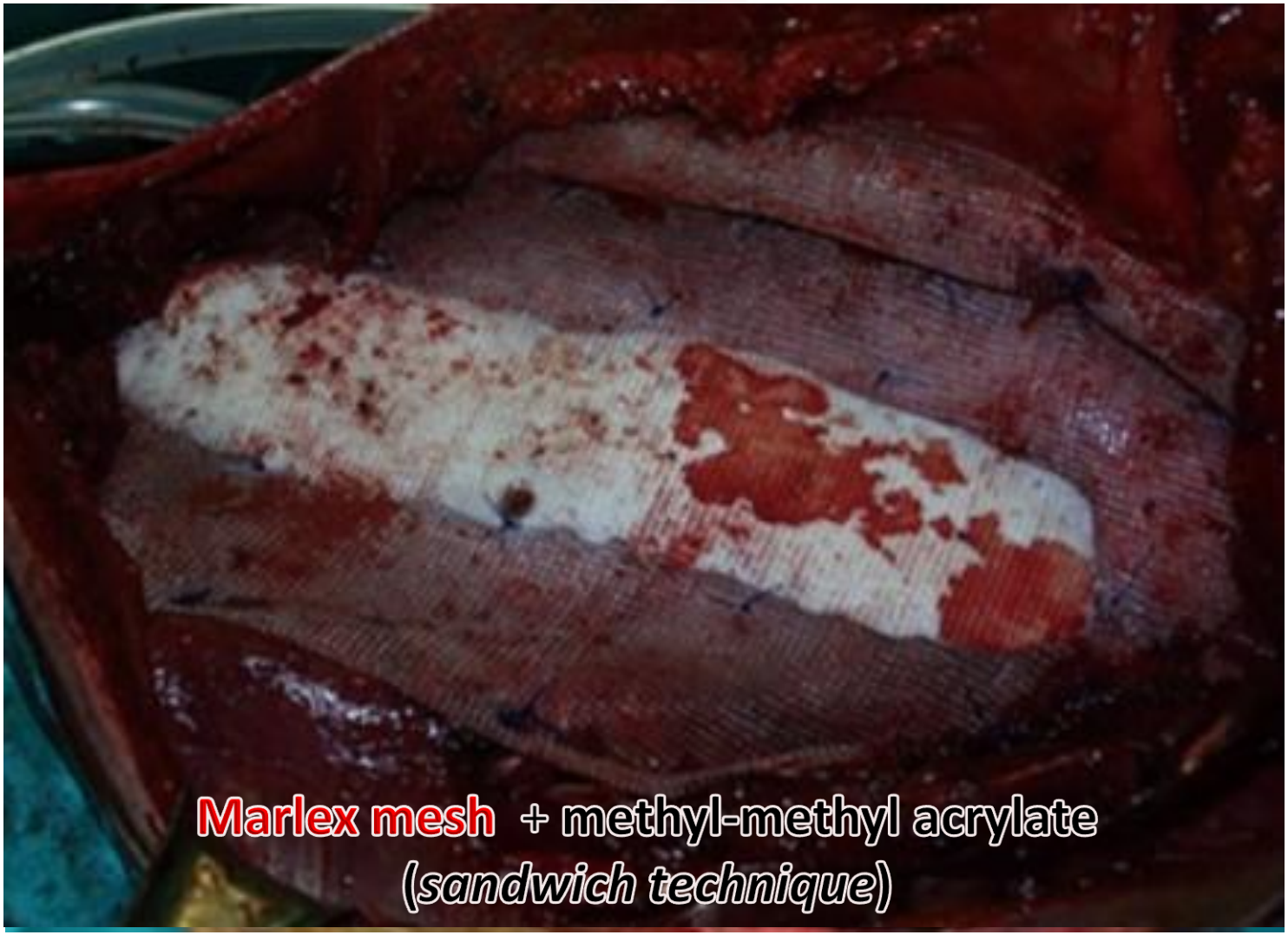

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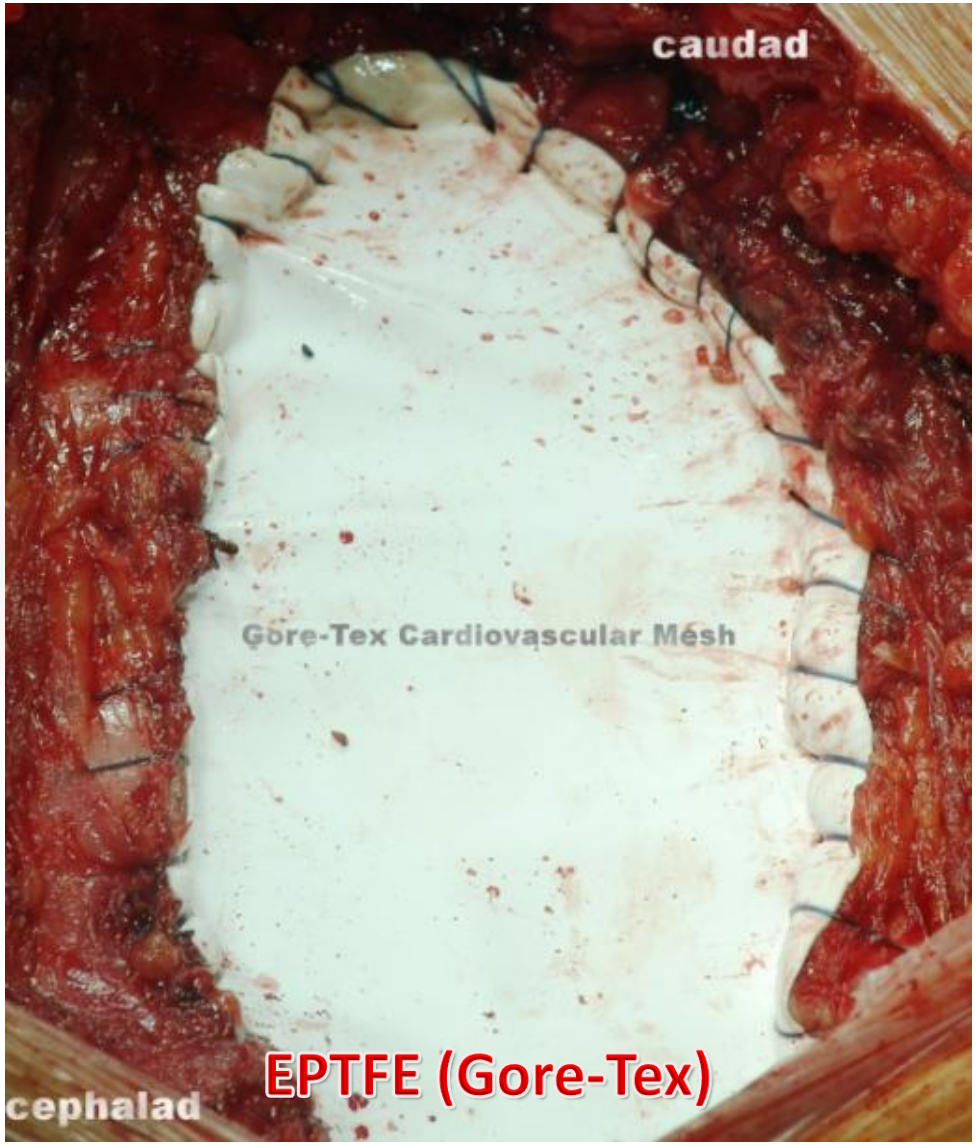

https://www.google.gr/search?q=PTFE+(GORE-TEX)+chest+wall&source=lnms&tbm=isch&sa=X&ved=0ahUKEwivn8HQq-rdAhWjtIsKHcQwAXYQ_AUIDigB&biw=1689&bih=845#imgrc=_

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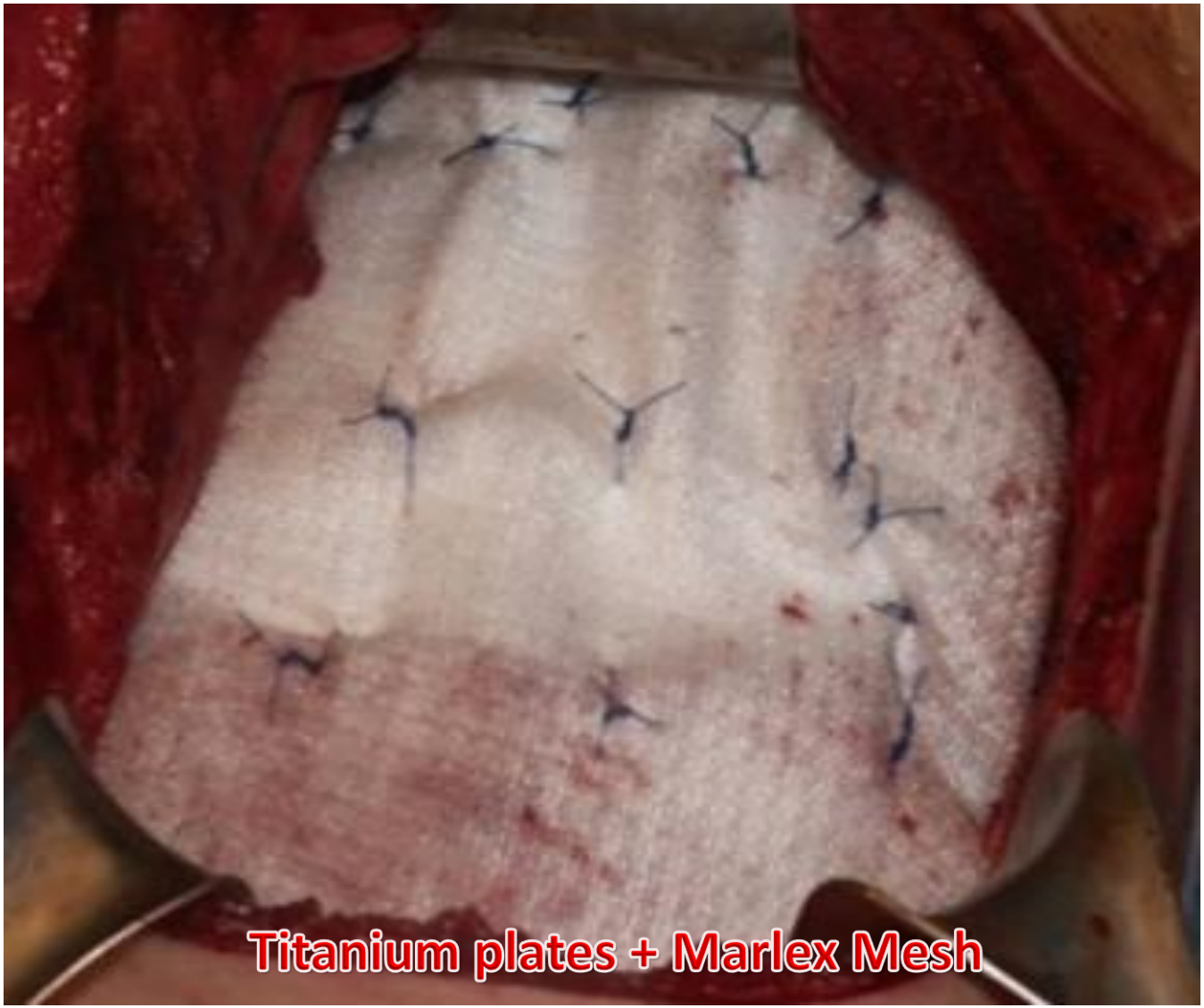

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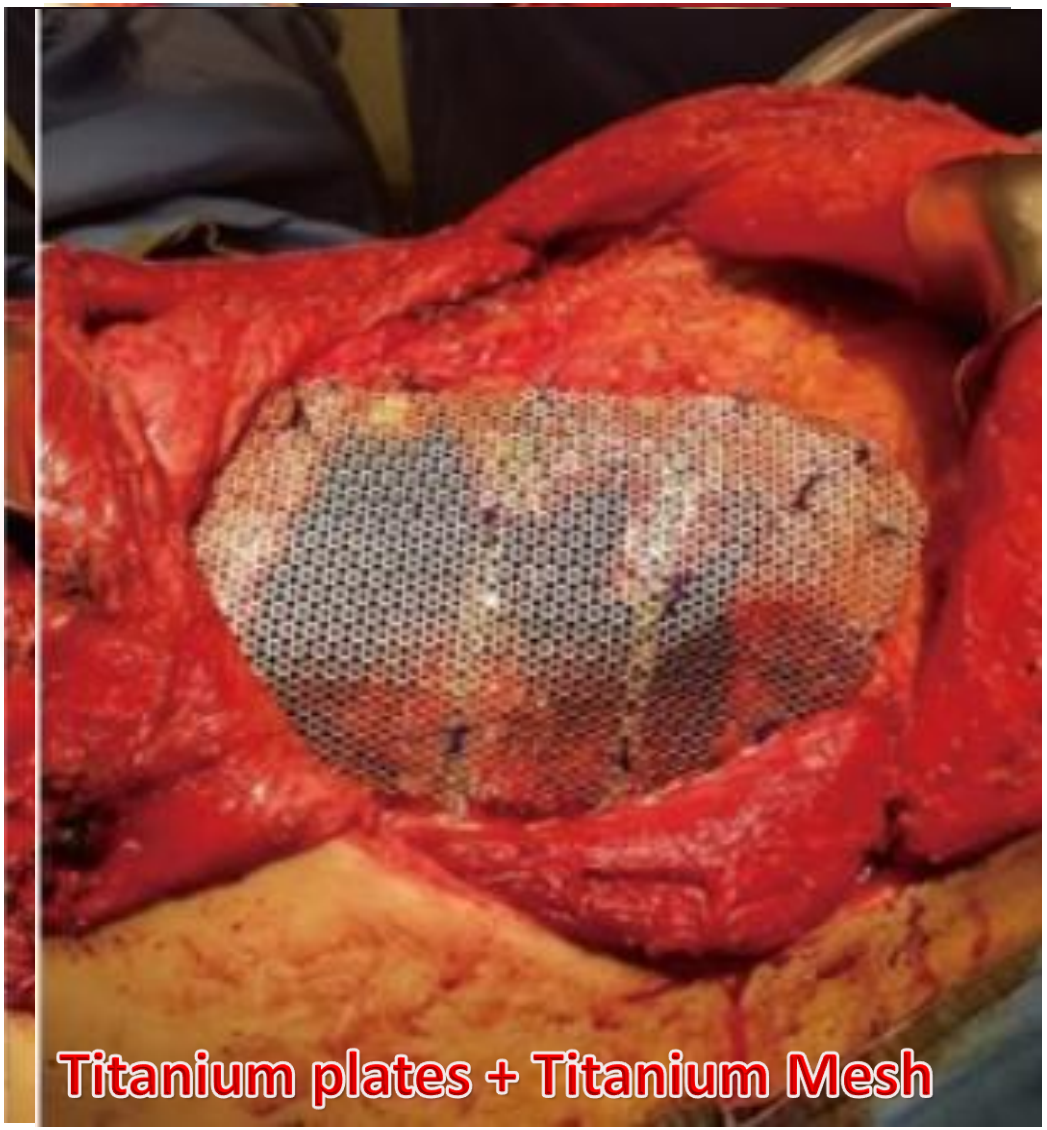
Chest Wall Invasion



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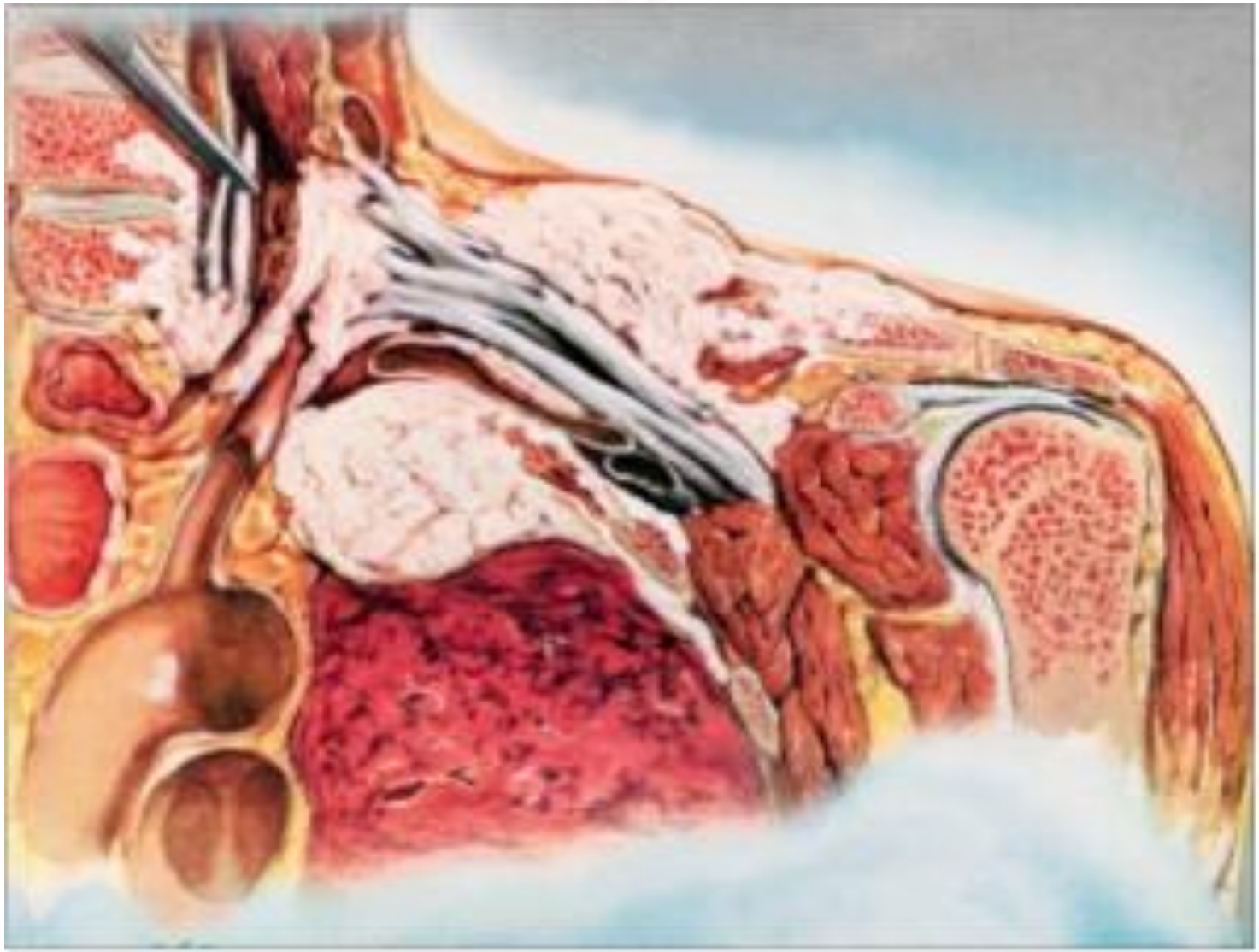
Superior Sulcus (Pancoast)



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https://www.physio-pedia.com/Pancoast_Tumor

Superior Sulcus (Pancoast)

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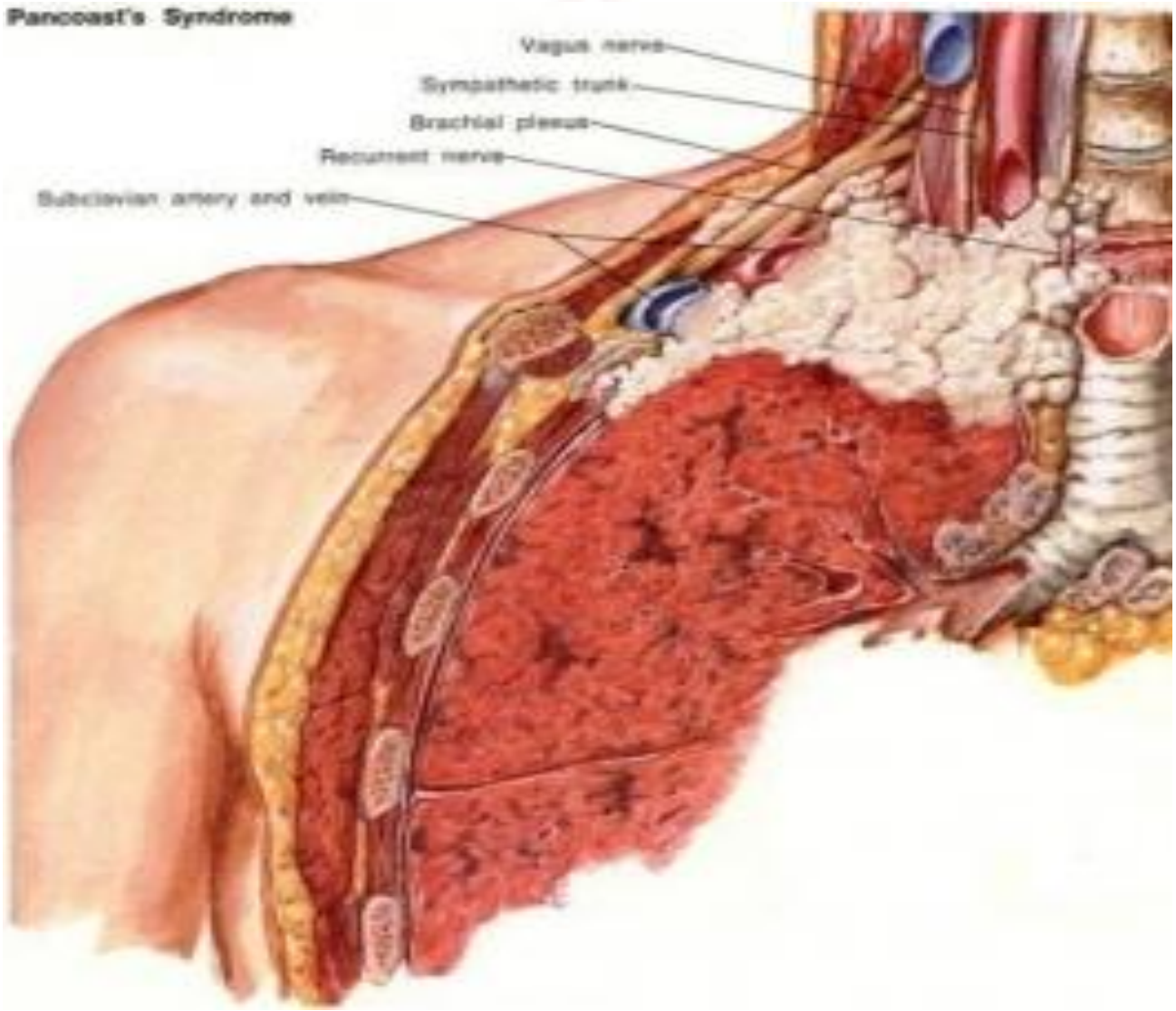

http://www.raynersmale.com/blog/2016/6/16/pancoast-tumour-red-flags-for-the-upper-limb

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Superior Sulcus (Pancoast)

- Superior/Posterior Sulcus tumor
- Apex of the lung (a "blind spot")
- **Usually (95%) a non-small cell lung cancer**
  - 52% squamous cell carcinoma (SCC)
  - 23% adenocarcinoma
  - 23% large cell carcinoma (LCLC)
  - < 5% are small cell carcinoma
- Named for Henry Khunrath Pancoast
  - from University of Pennsylvania
  - 1st American Professor of Roentgenology

https://www.physio-pedia.com/images/7/7c/PT_stage_algorithm.jpg

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Superior Sulcus (Pancoast)

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- Treatment options include:
  - Staging (MR/CT, including brain, PET)
  - Lymph node Bx, Cervical & Mediastinoscopy
  - Pre-operative Radiation Tx, Surgery, Post-Op RT
- 5 yr. survival ~30%, negative factors include:
  - Horner syndrome
  - Involvement of mediastinal lymph nodes
  - Involvement of supraclavicular lymph nodes
  - Involvement of vertebrae and spinal cord

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https://www.physio-pedia.com/images/7/7c/PT_stage_algorithm.jpg

Superior Sulcus (Pancoast)

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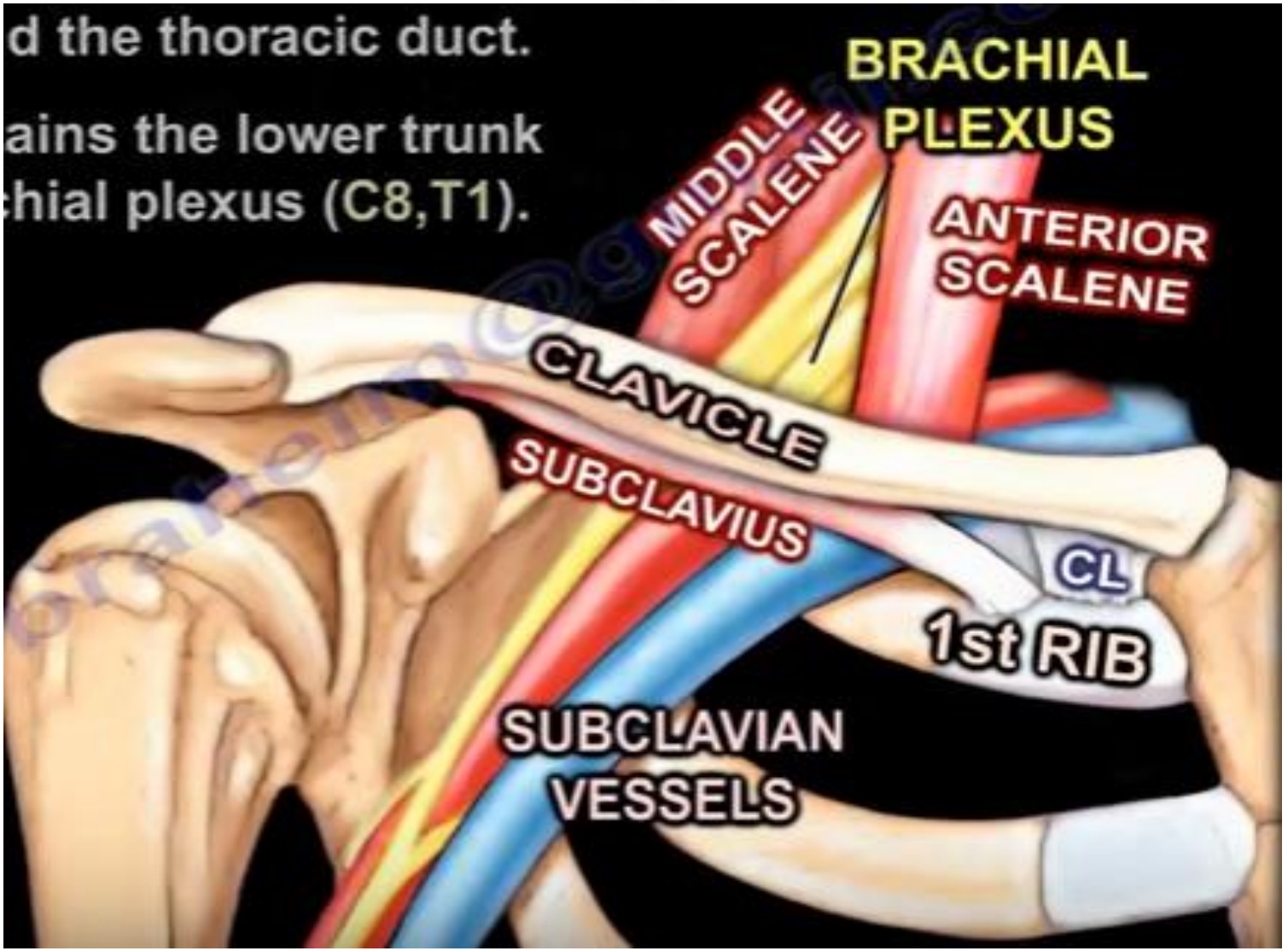

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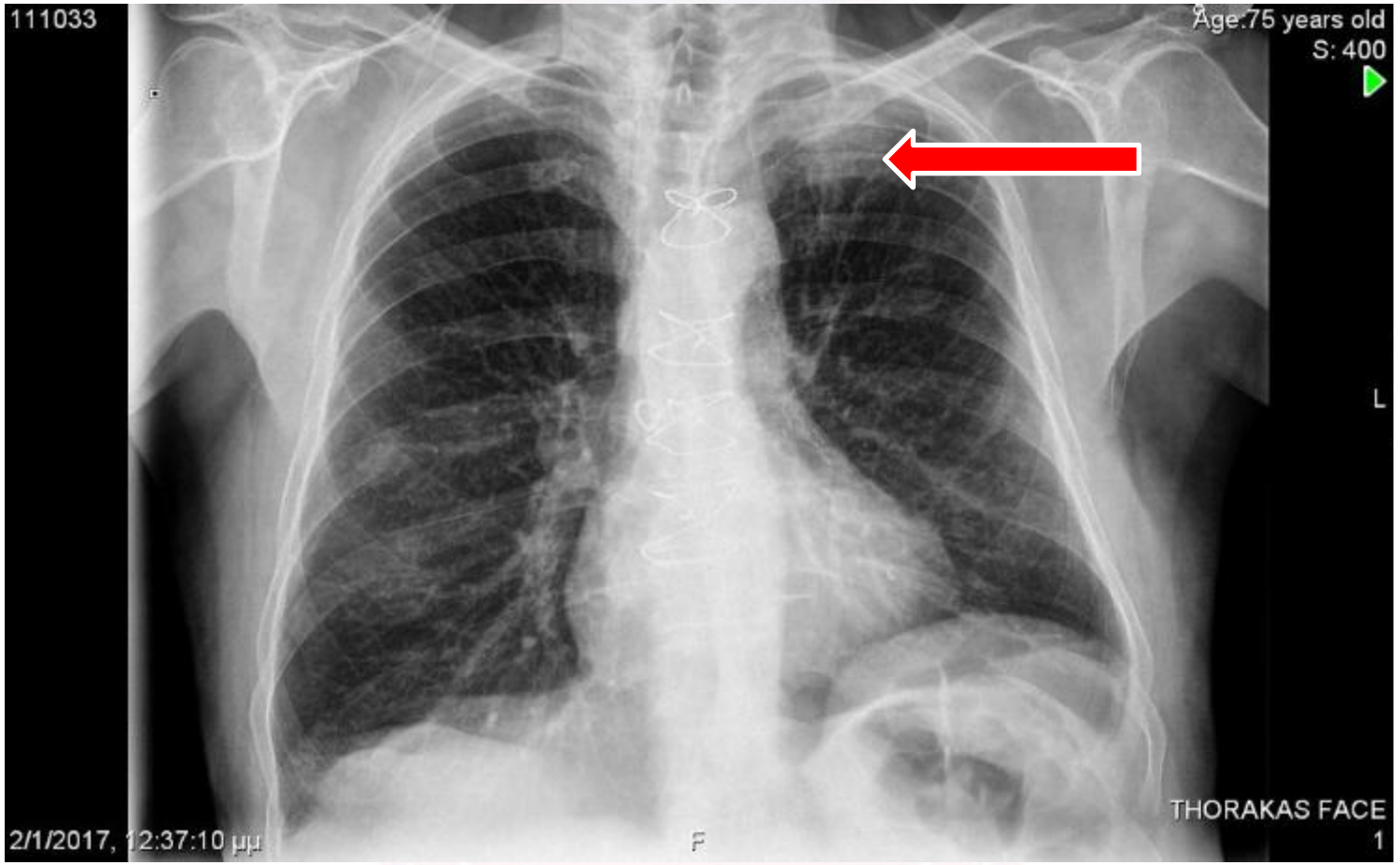

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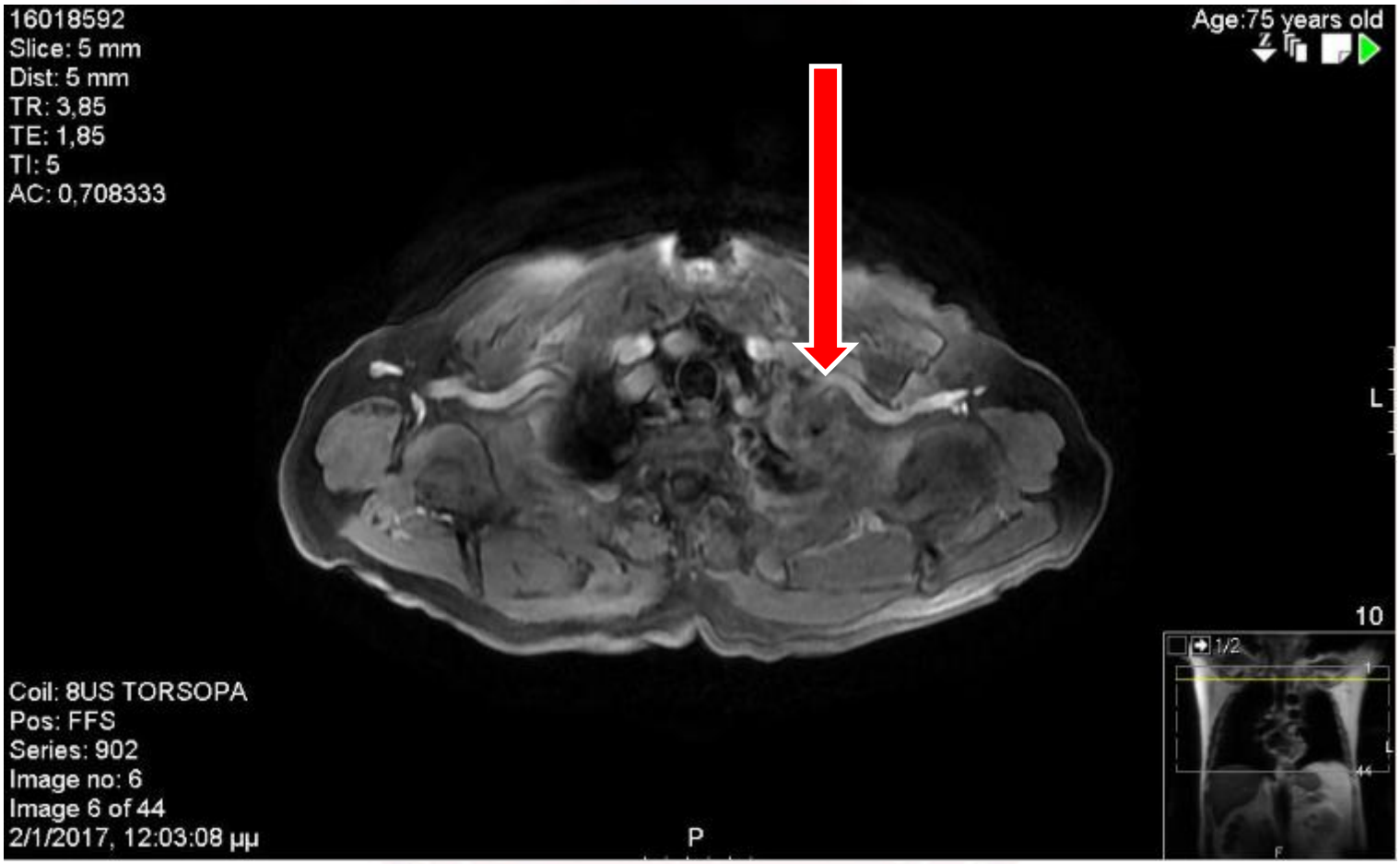

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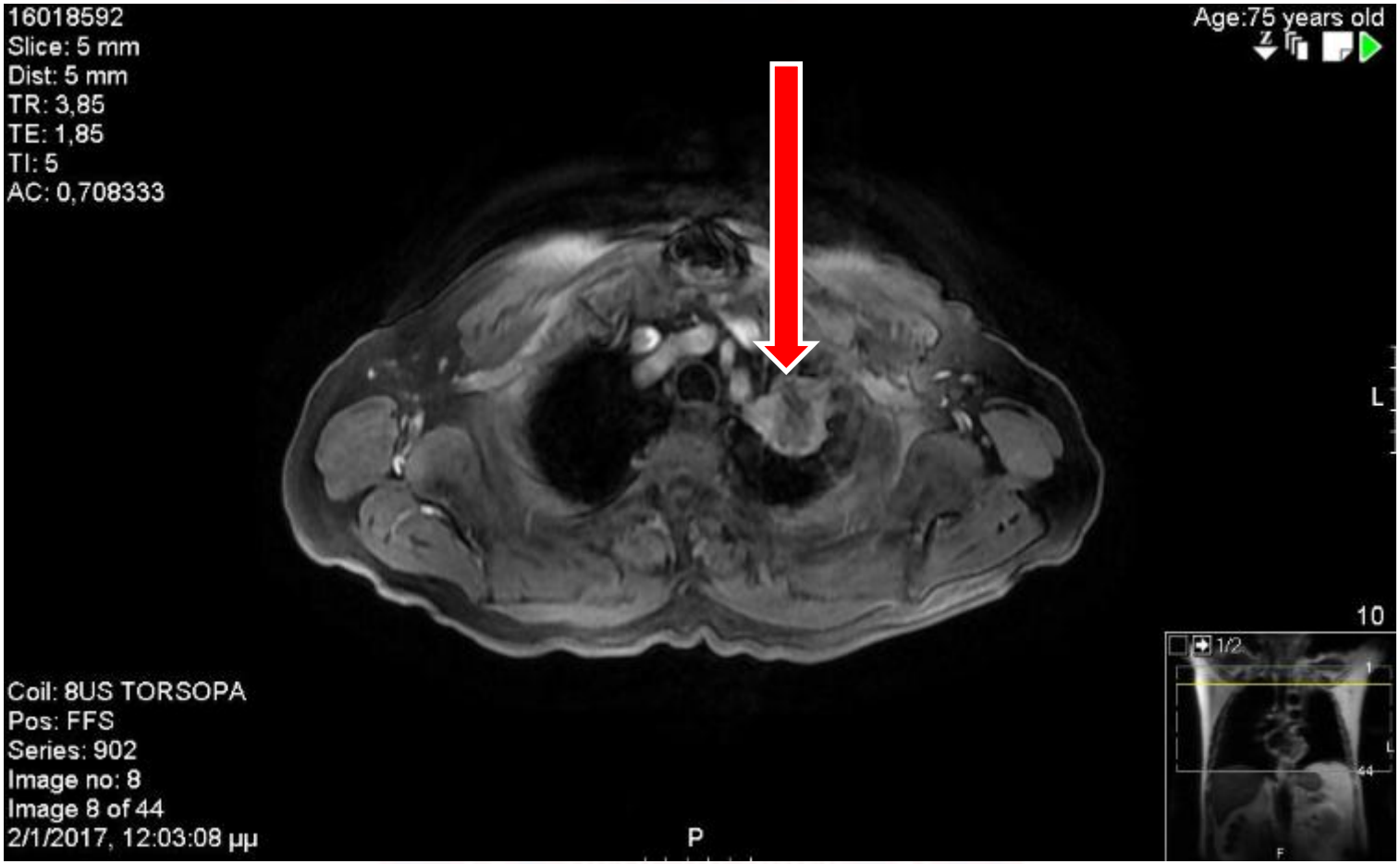

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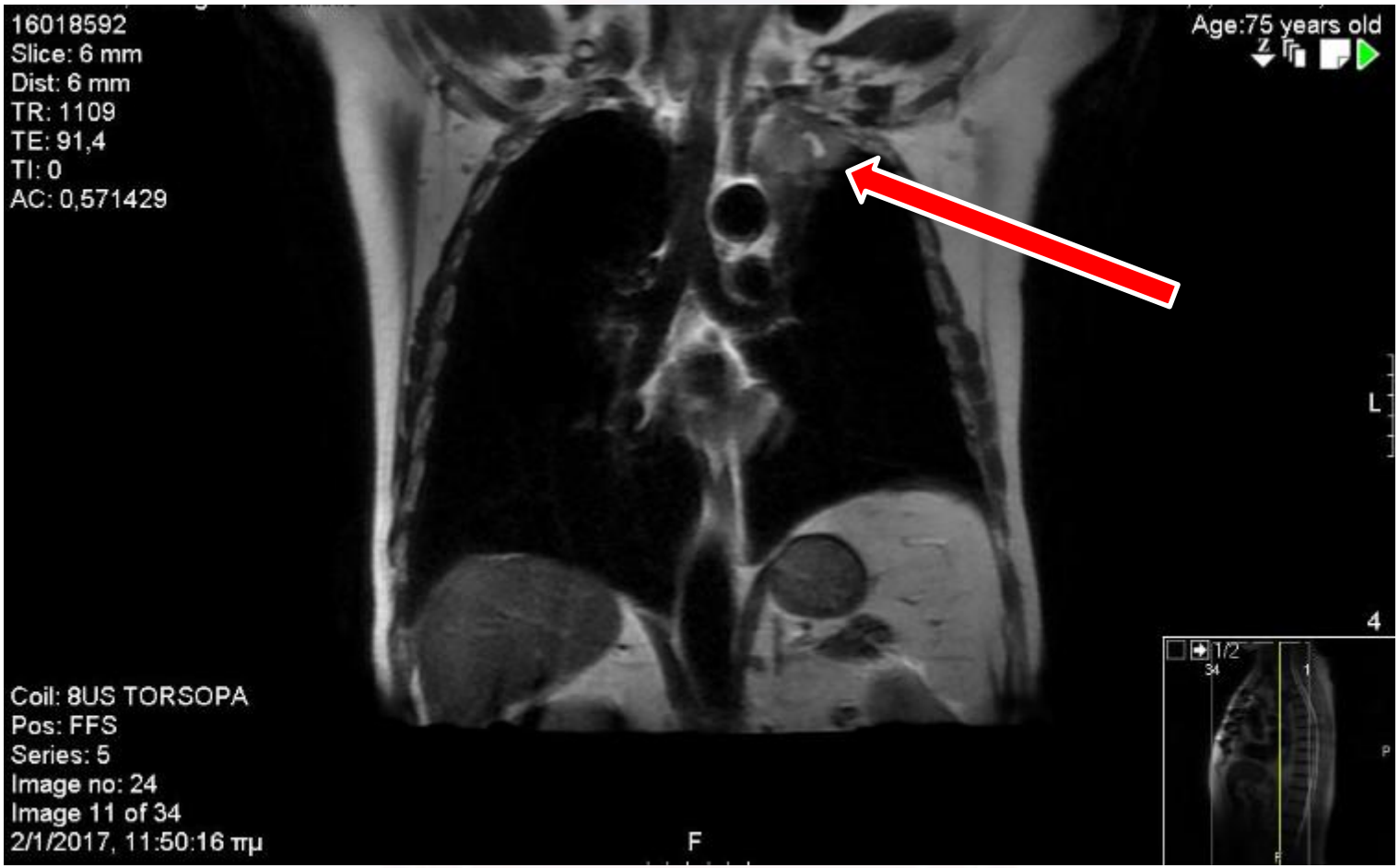

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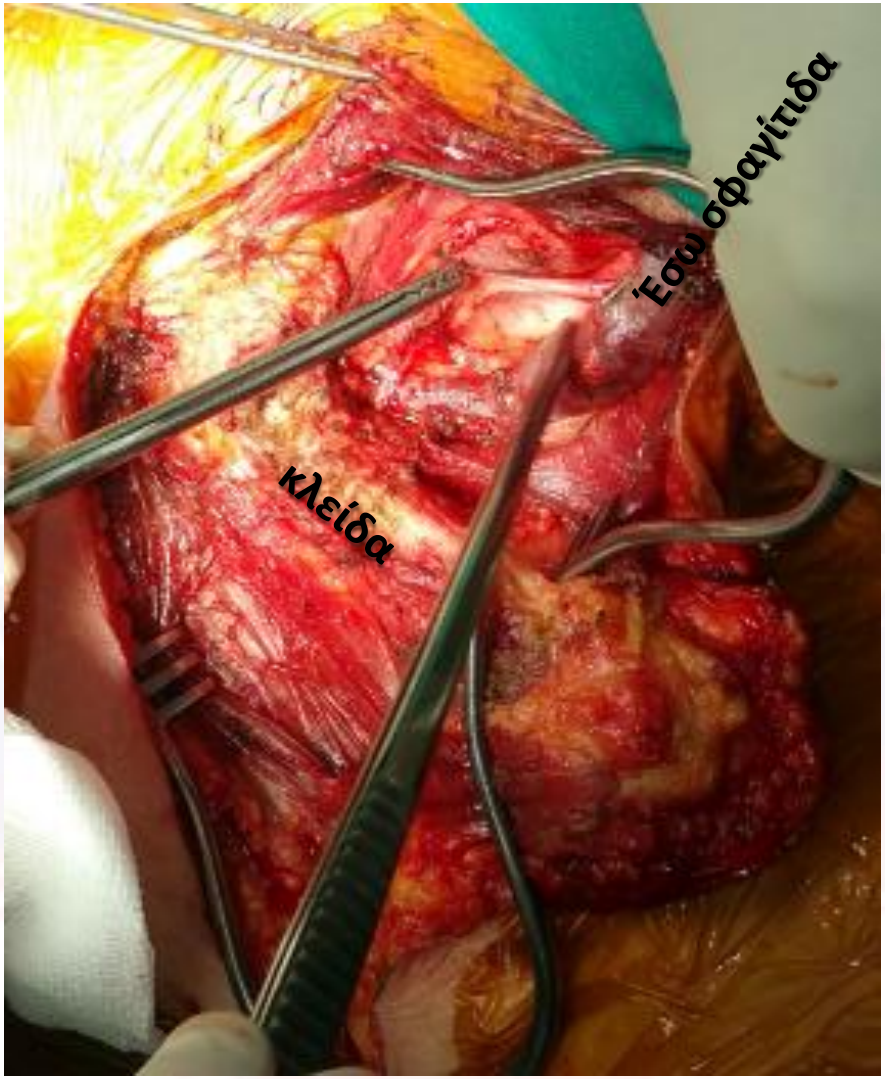

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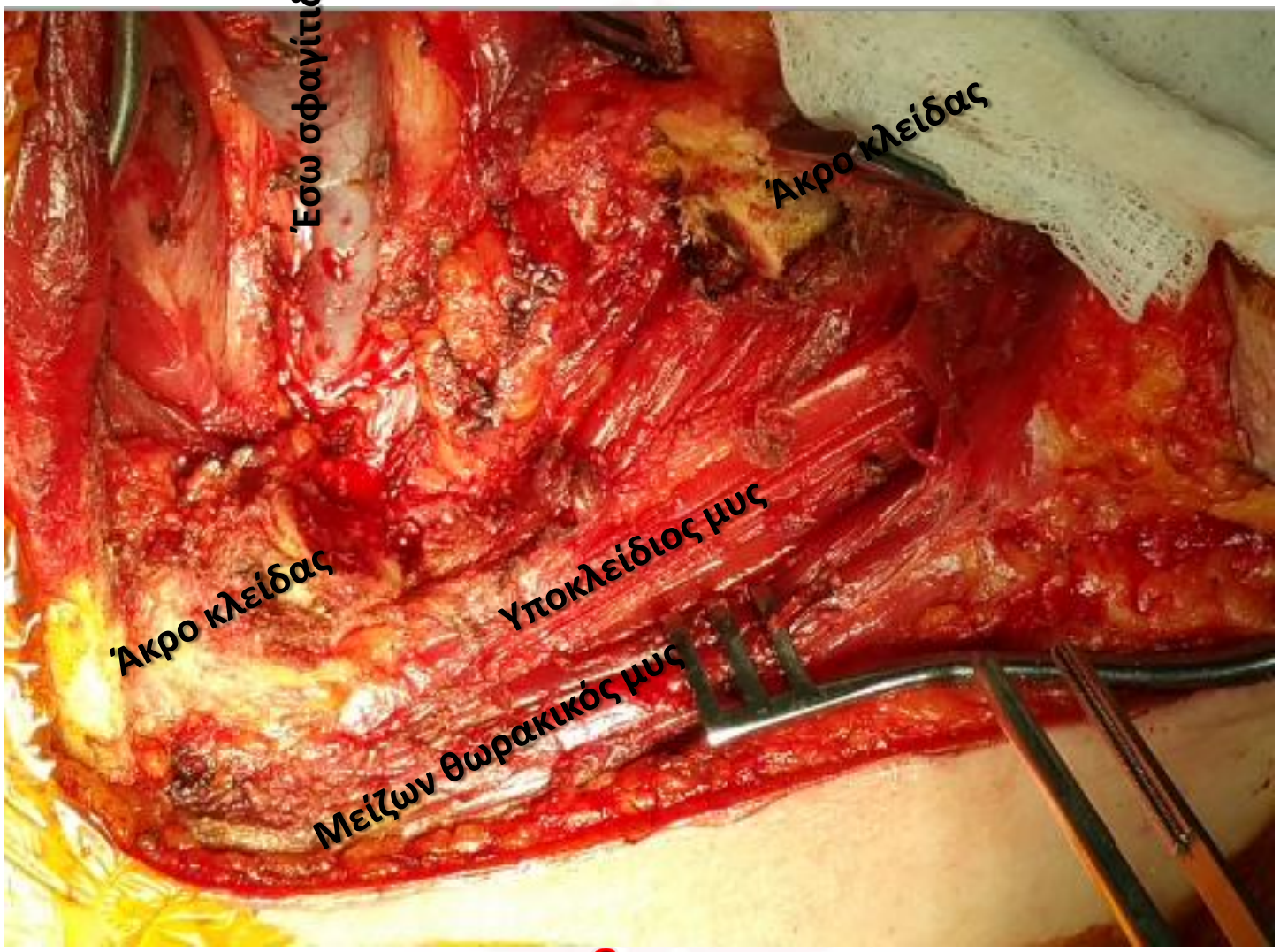

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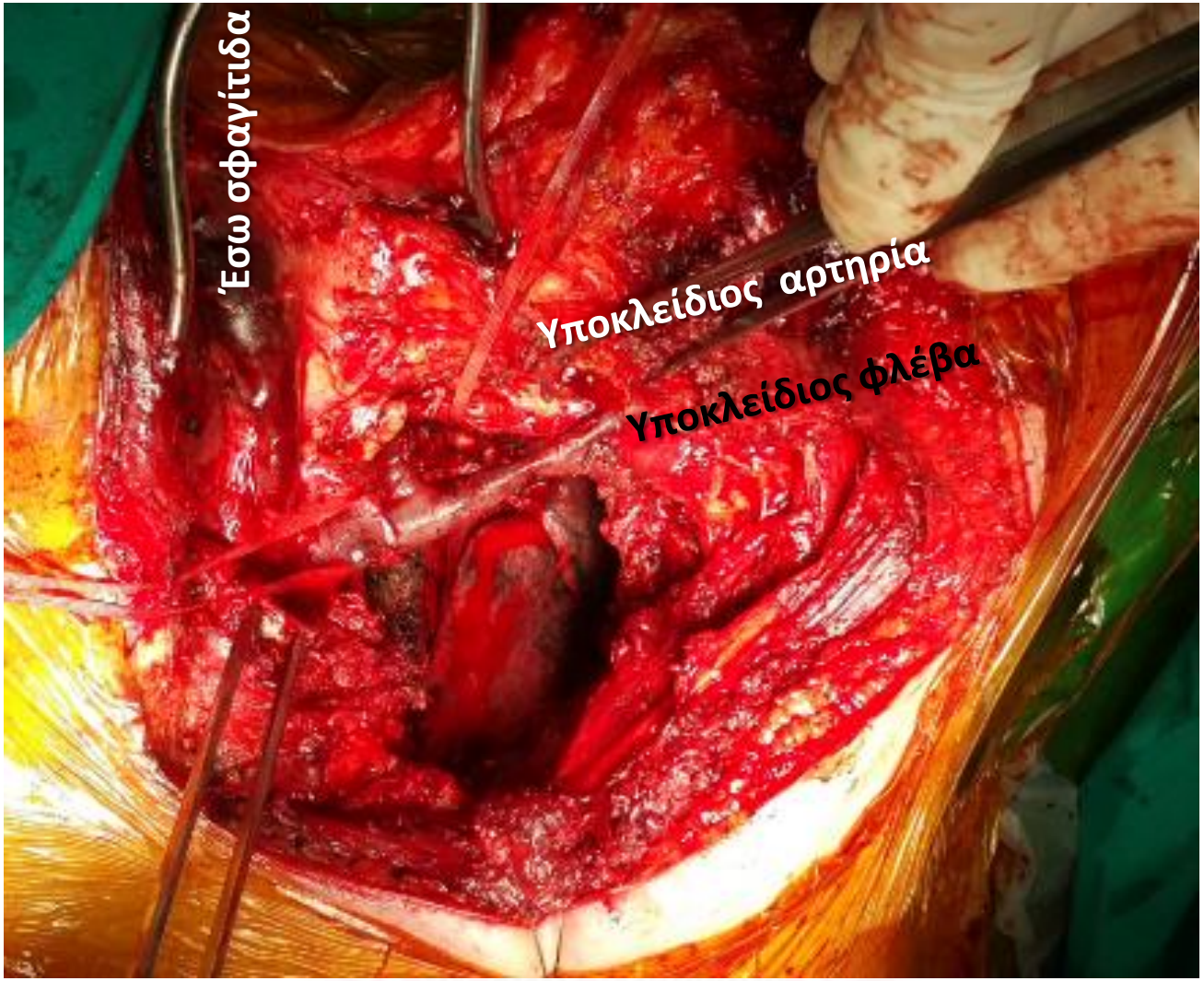

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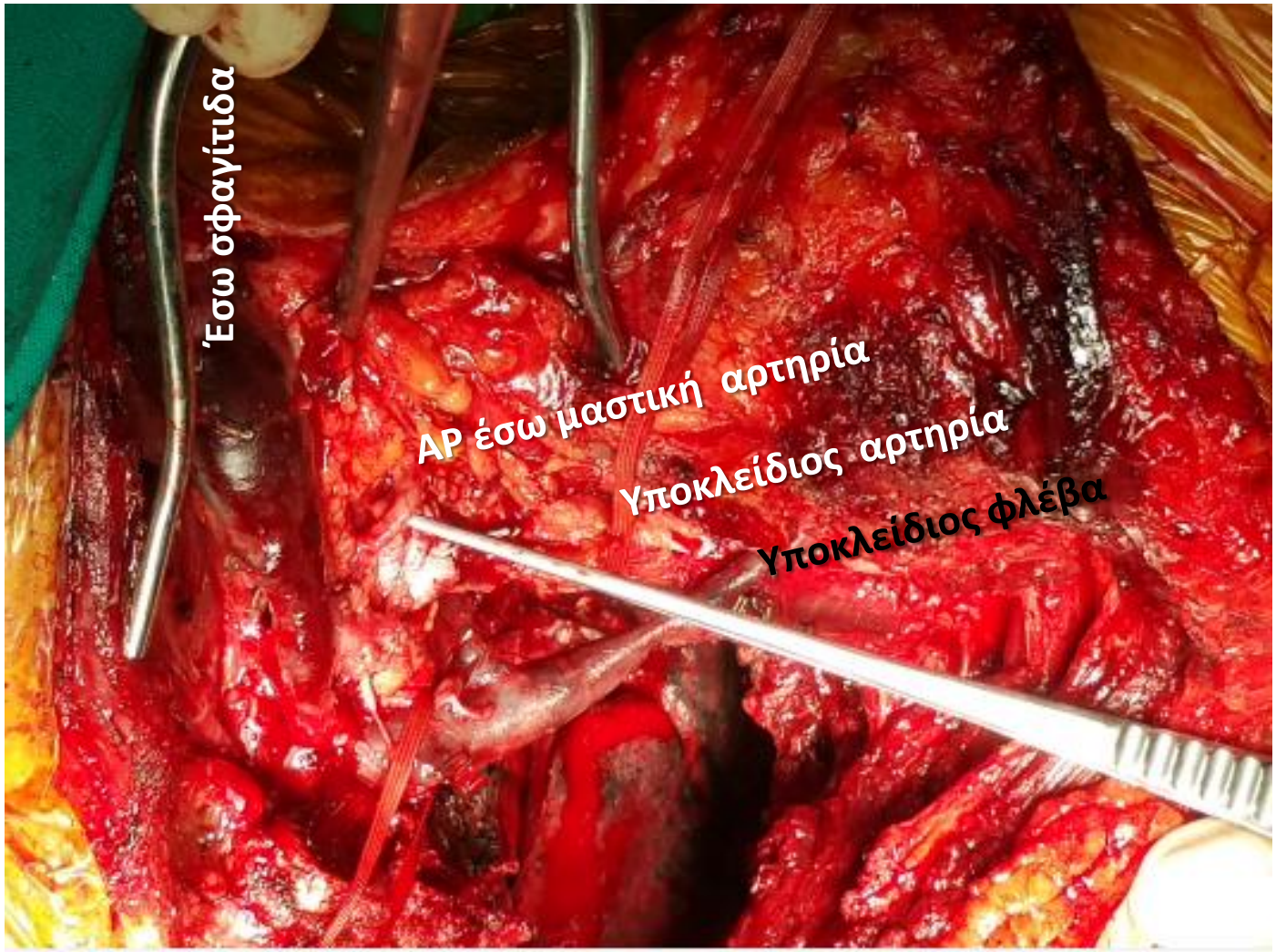

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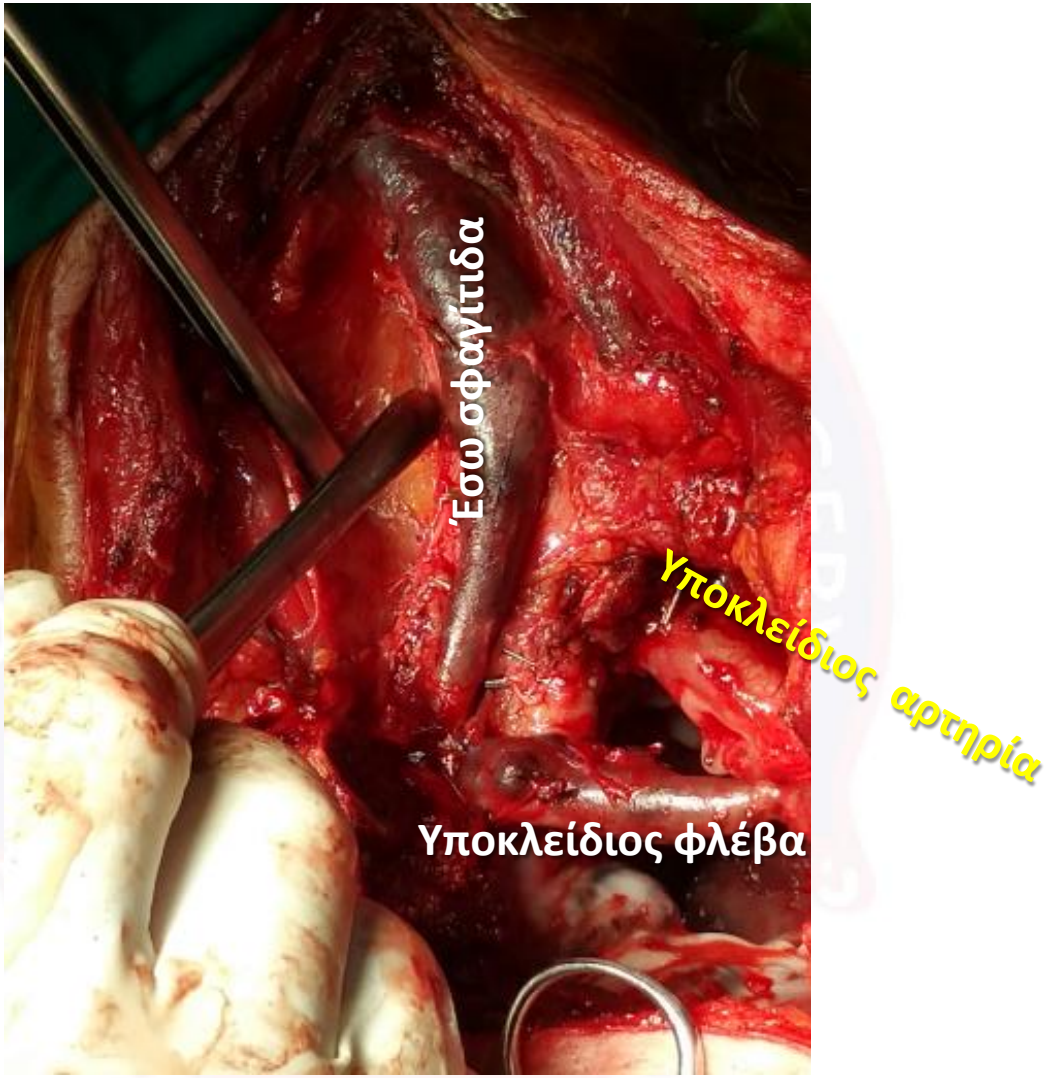

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Superior Sulcus (Pancoast)

Sublobar resection LUL with tumor

Case

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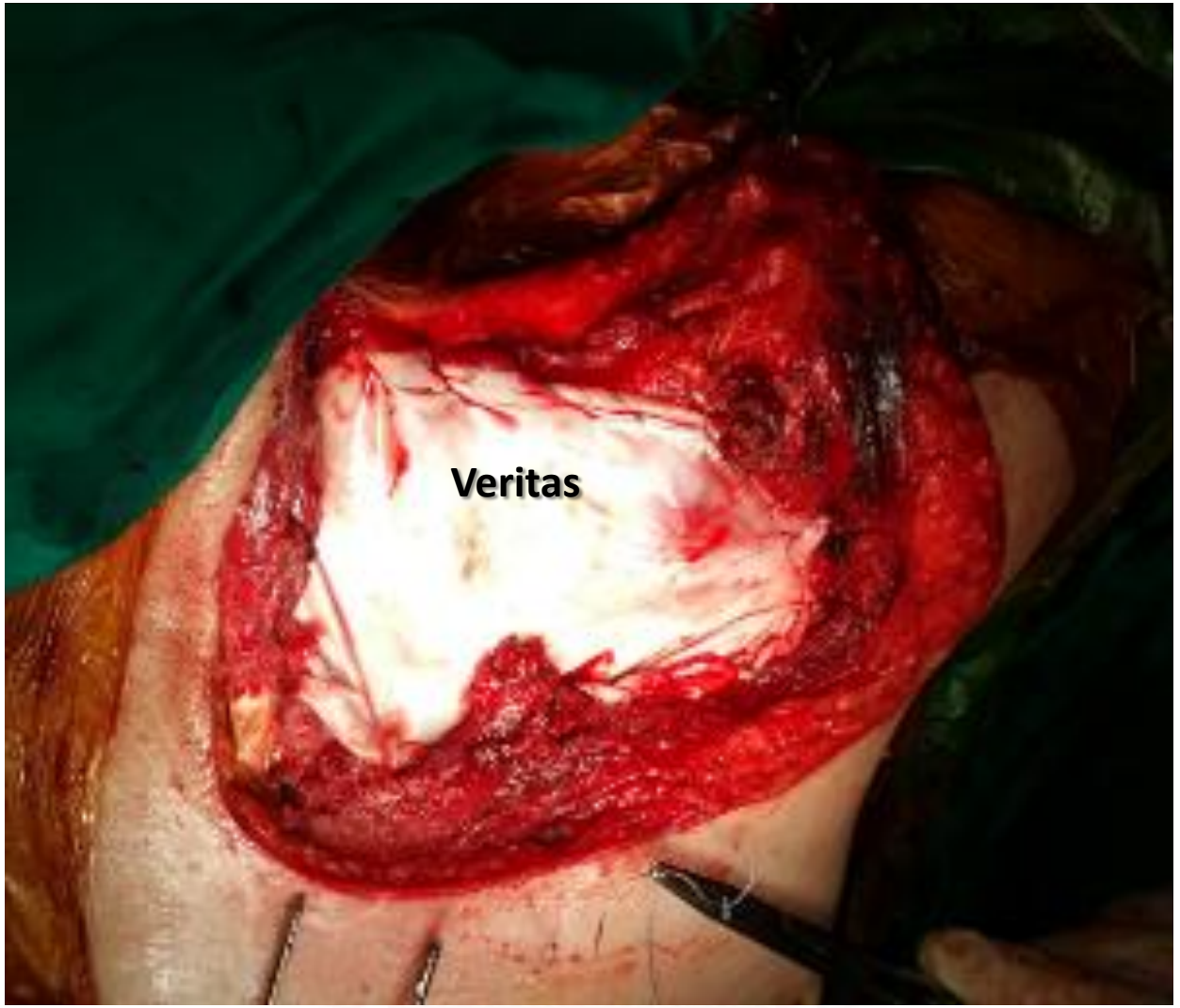
Superior Sulcus (Pancoast)



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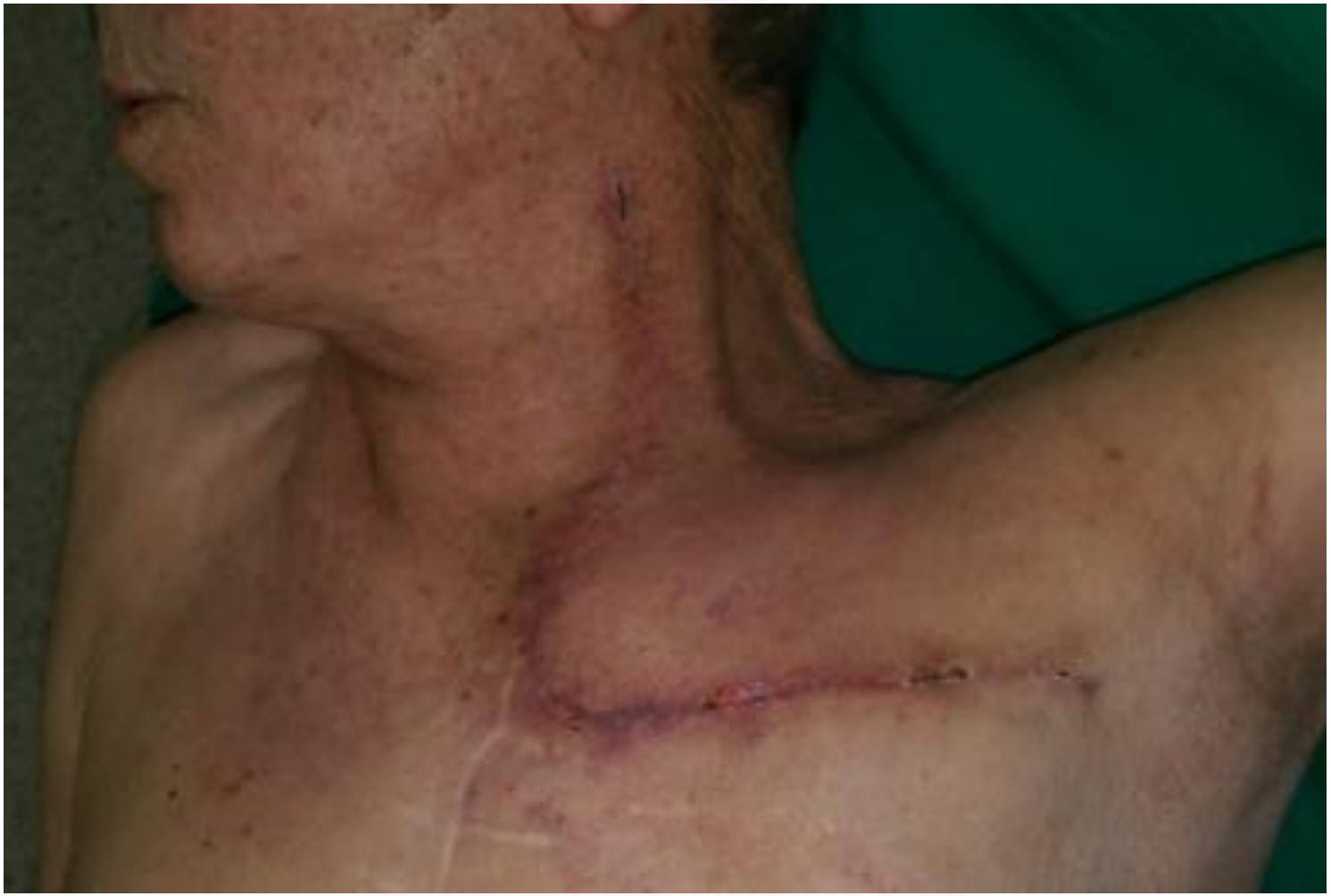

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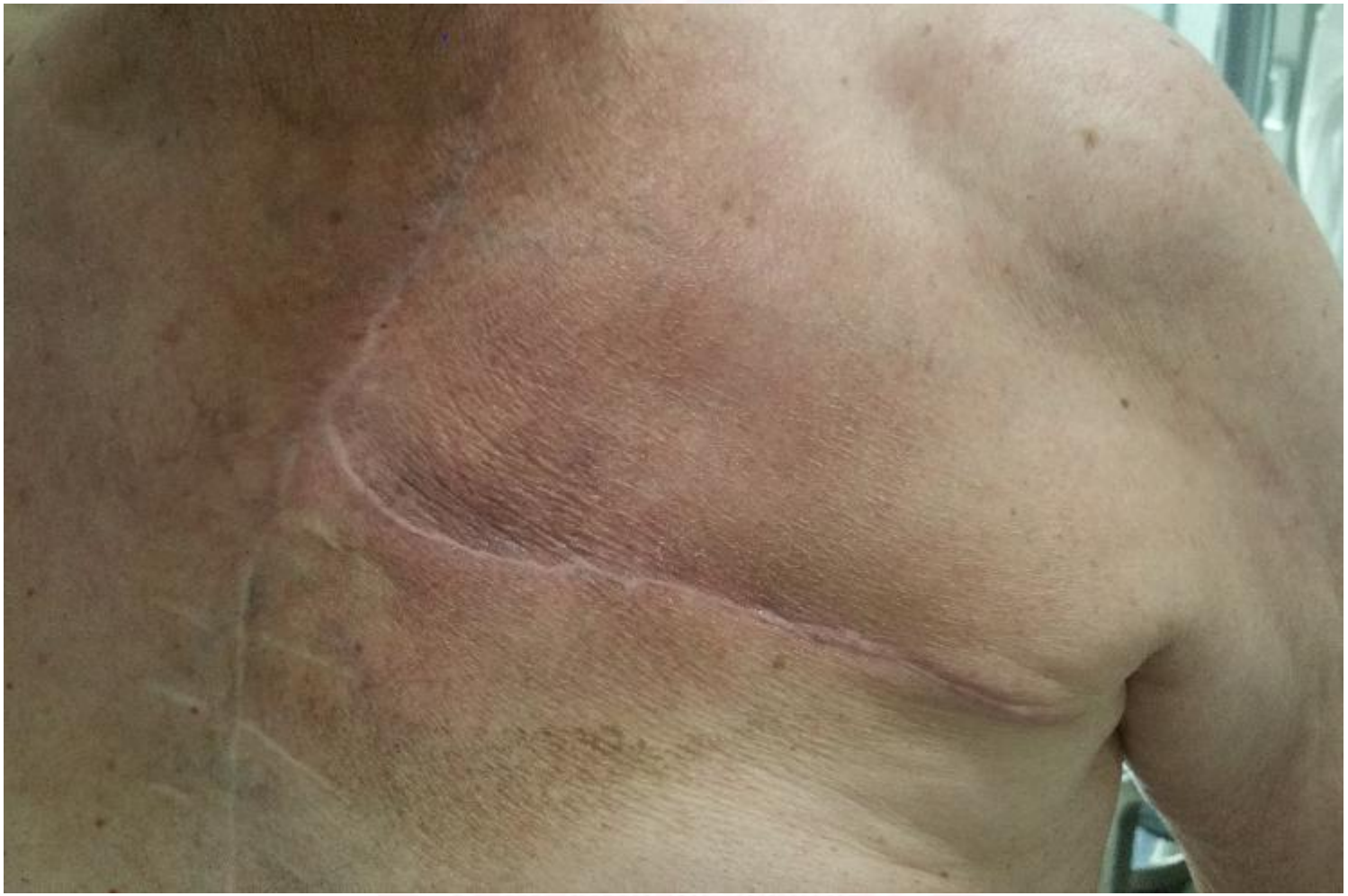

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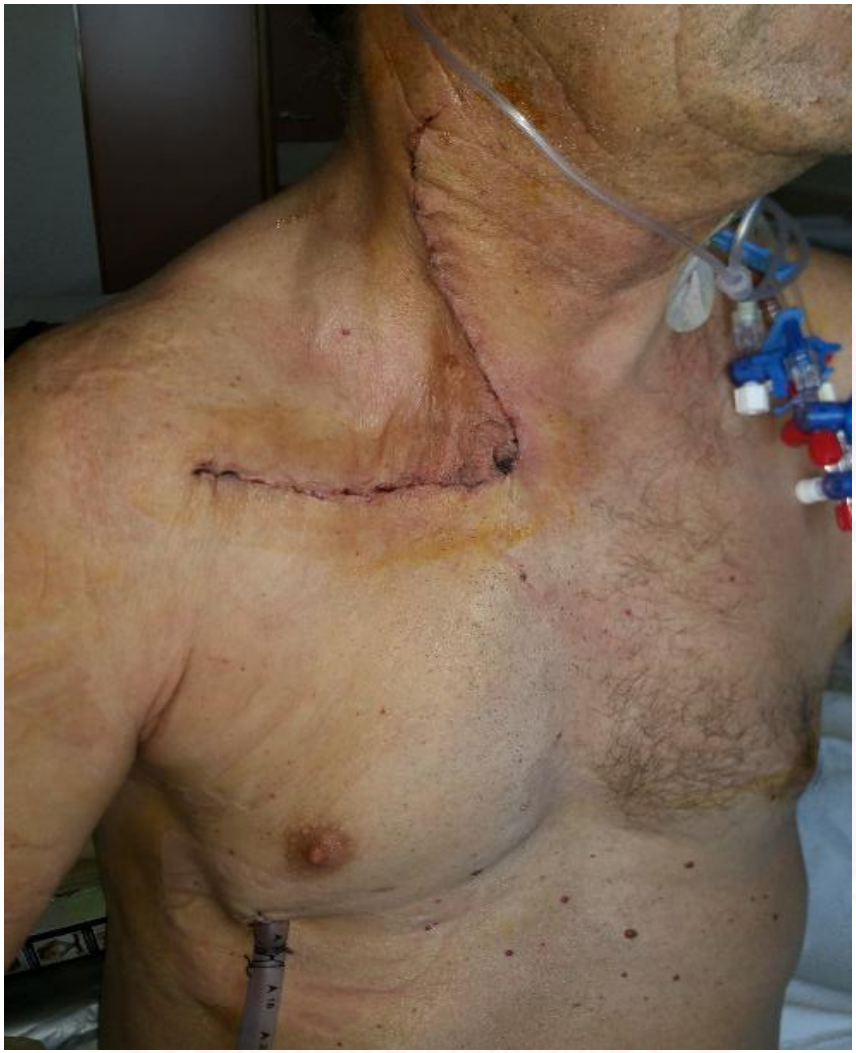

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Superior Sulcus (Pancoast)

Study	Kwong *et al.*, 2005 (USA)	Goldberg *et al.*, 2005 (USA)	Mara *et al.*, 2007 (Germany)	Fischer *et al.*, 2008 (Canada)	Kappers *et al.*, 2009 (Netherlands)
Years	1993-2003	1993-2000	1993-2001	1996-2007	1994-2006
Patients	37	39	31	44	Eligible for combined modality =39
T-stage	T3 =32* T4 =5	T3 =36** T4 =3	T3 =25 T4 =6	T3 =30 T4 =14	T3 =21 T4 =18
N-stage	N0 =27 N1 =0 N2 =9 N3 =1	N0 N1 N2 N3	N0 =21 N1 =1 N2 =8 N3 =1	N0 =39 N1 =4 N2 =1	N0 =32 N1 =2 N2 =4 N3 =1
Preop. treatment	Chemo-radiotherapy	Chemo-radiotherapy =27† Radiotherapy =4 None (primary surgery) =8	Chemo-radiotherapy	Chemo-radiotherapy	Chemo-radiotherapy =27 Radiotherapy =6 Chemotherapy =5 None =1
Eligible for surgery	37	39	29	44	22
Resection	R0 =36 (97.2%) R1 =1	R0 =26 (76%) R1 =8 (24%)	R0 =29 (100%)	R0 =39 (88.6%) R2 =5	R0 =22 (100%)
Surgical mortality	2.7% (1:37)	5% (2:39)	6.9% (2:29)	5% (2:44)	0%

Superior sulcus (Pancoast) tumors: current evidence on diagnosis and radical treatment
C. Foroulis et al - *Thorac Dis 2013 Apr 09*

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Superior Sulcus (Pancoast)

Study	Kwong *et al.*, 2005 (USA)	Goldberg *et al.*, 2005 (USA)	Mara *et al.*, 2007 (Germany)	Fischer *et al.*, 2008 (Canada)	Kappers *et al.*, 2009 (Netherlands)
Pathologic response	CR =15 (40.5%)	CR =9 out of 31 patients who received induction chemo-radiotherapy (29%)	CR =13 PR =7 Downstaging =4 Non response =5	CR =13 (30%) Minimal microscopic residual disease =15 (34%) Non responders =16	CR =13 PR =4 SD =3 PD =1
Survival	Overall median survival time =31.6 months Median survival time for patients with CR =93.1 months	Overall 5-year survival =47.9% (median 40 months) 5-year survival for patients responding to induction therapy =60.6%	Overall 2-year =74% Overall 5-year =46% 5-year for CR =63% 5-year for PR =35%	Overall 5-year survival =59% 5-year for CR =90% 5-year survival for minimal residual microscopic disease =69% 5-year for non responders =12%	Overall 2-year =77% Overall 5-year =37%
Recurrence	50% (18:36)	32.4% (12:37)	29% (9:29)	33% after R0 resection (13:39)	N/A
Site of recurrence/%	Distant =13 (brain =9)/72.2% Local =5/28%	Distant =8/66.5% Local =4/33,5%	Distant =7 (brain =4)/77.7% Local =1/11.1% Local + distant =1/11.1%	Distant =9 (brain =3)/69.2% Local =4/30.8% (in patients with CR)	N/A

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C. Foroulis et al - *Thorac Dis 2013 Apr 09*

Hemi-diaphragm Invasion

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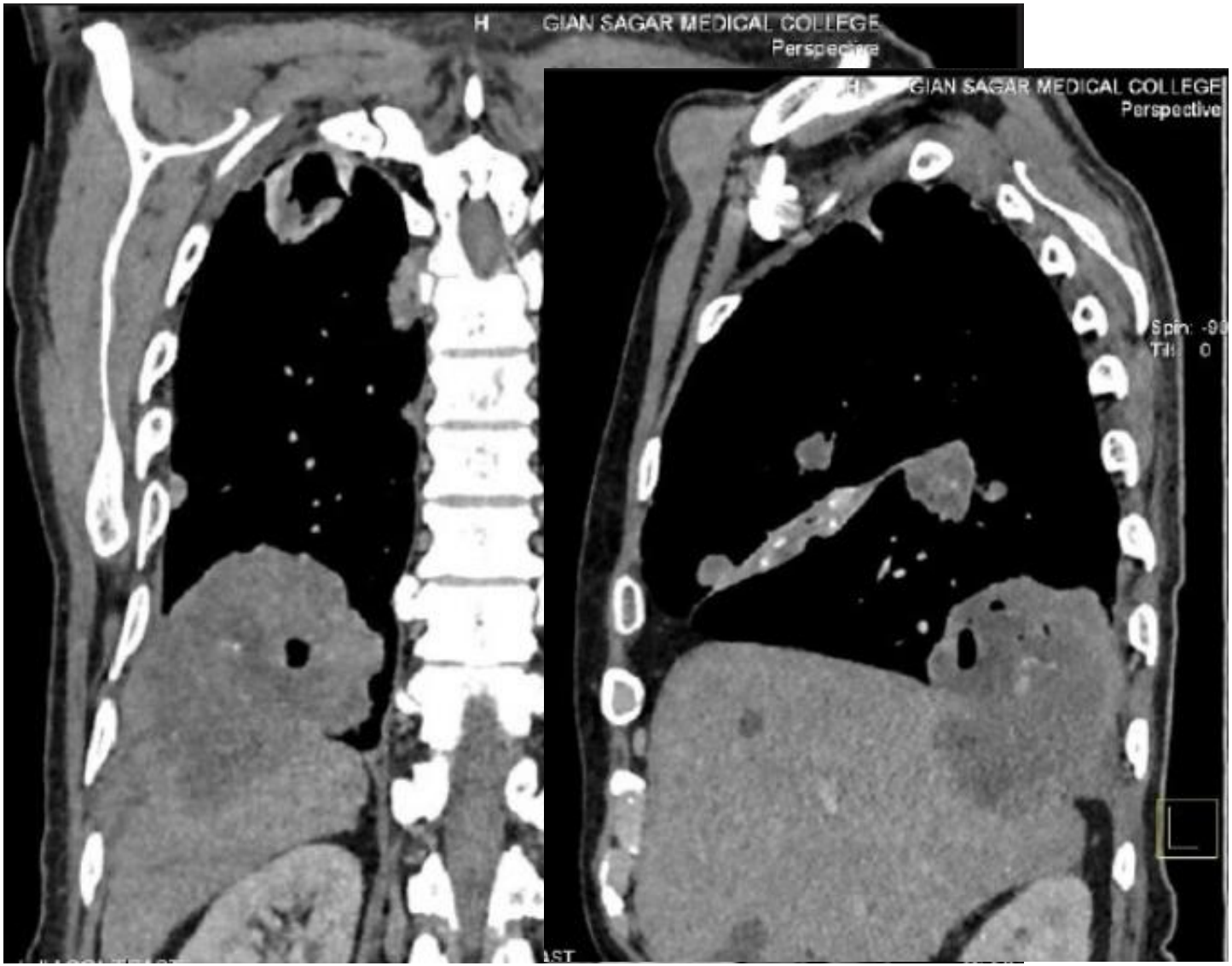

Image finding from pulmonary carcinosarcoma
Aditi Vohra, Harneet Narula
Lung India 2014 Vol.31 Issue.2 p.164-167

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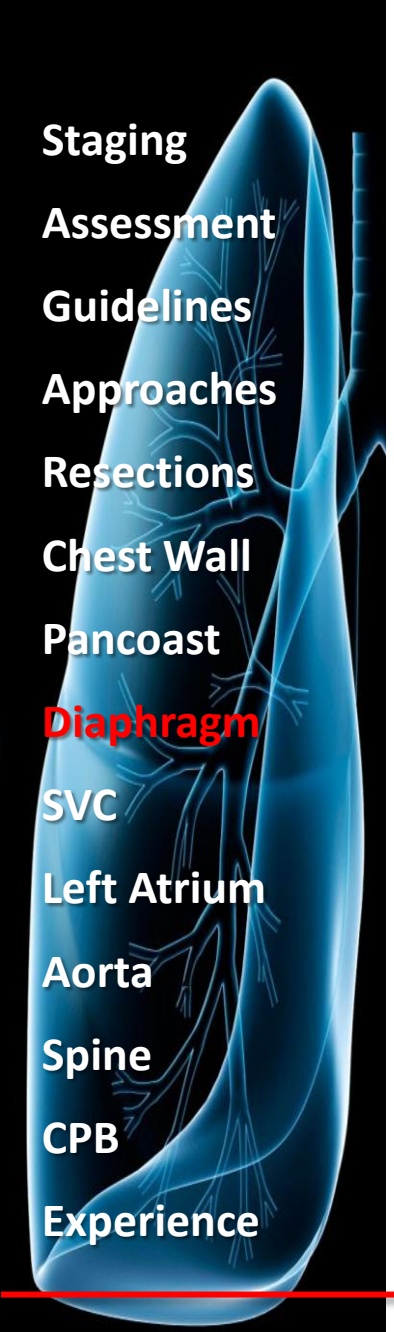

Hemi-diaphragm Invasion

Involved structure	Patients (n)	3-y survival (%)	5-y survival (%)	MST (mo)
Diaphragm				
All	31	49.7	42.6	35
N0	20	65.0	55.0	65
N1	3	0	0	10
N2	8	18.8	18.8	11
Pericardium				
All	20	54.2	54.2	63
N0	8	50.0	50.0	13
N1	5	80.0	80.0	NR
N2	7	38.1	38.1	31

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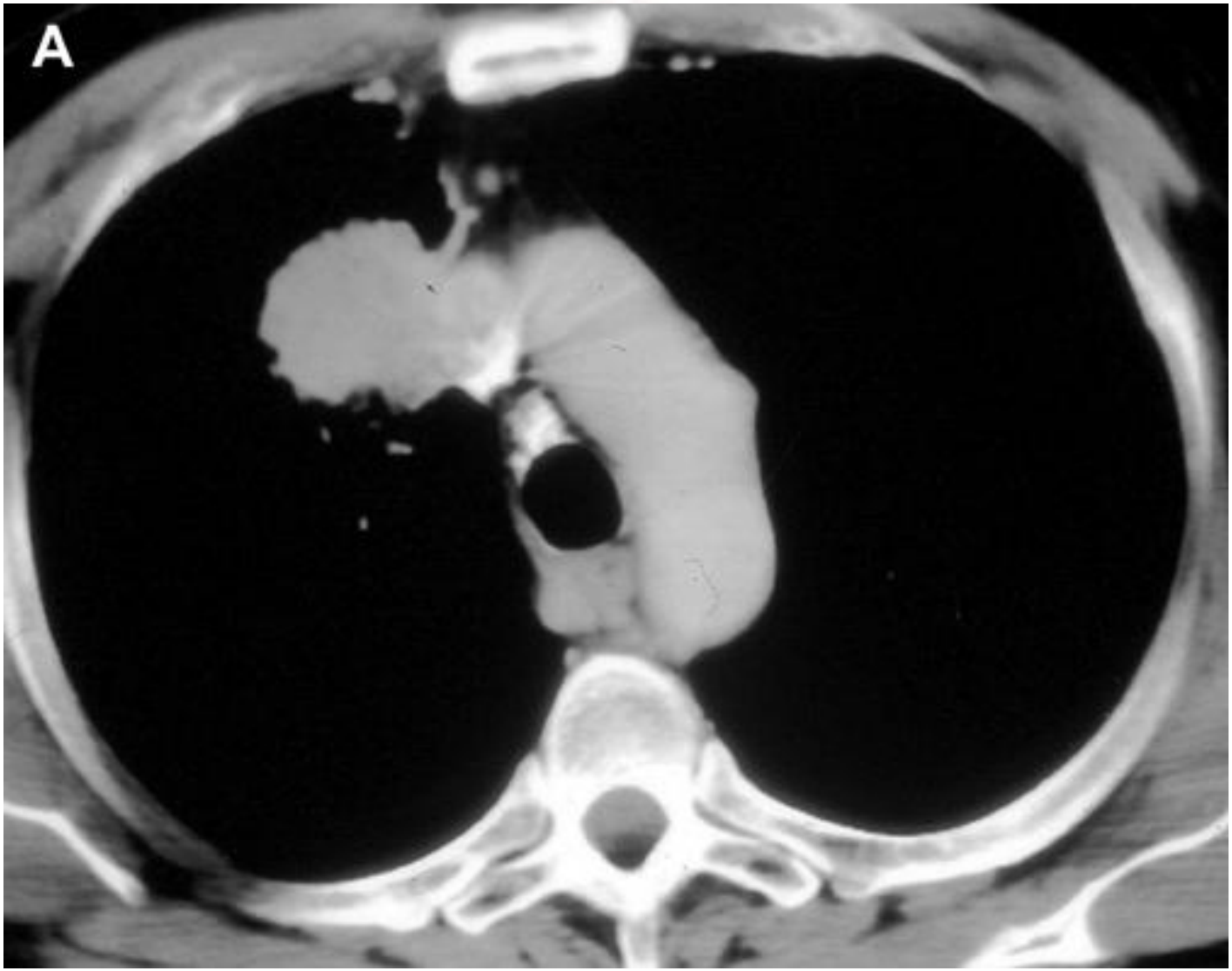
Modern surgical results of lung cancer involving neighboring structures:
A retrospective analysis of 531 pT3 cases in a Japanese Lung Cancer Registry Study
Koji Kawaguchi et al - JTCVS 2012 Volume 144, Issue 2, p. 431–437

SVC Invasion



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Thoracic Surgery
2018

http://www.ctsnet.org/article/surgery-superior-vena-cava-resection-and-reconstruction

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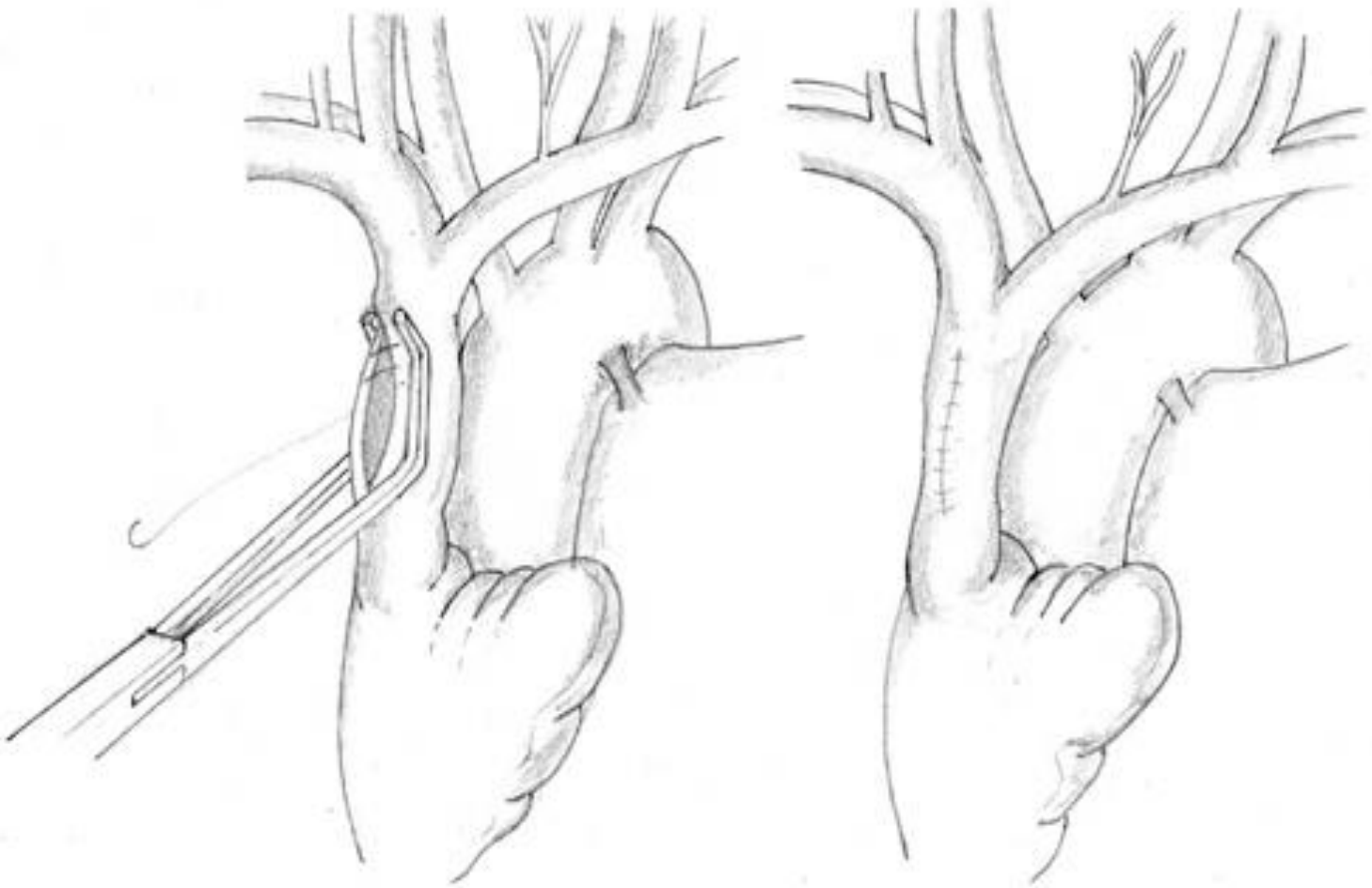

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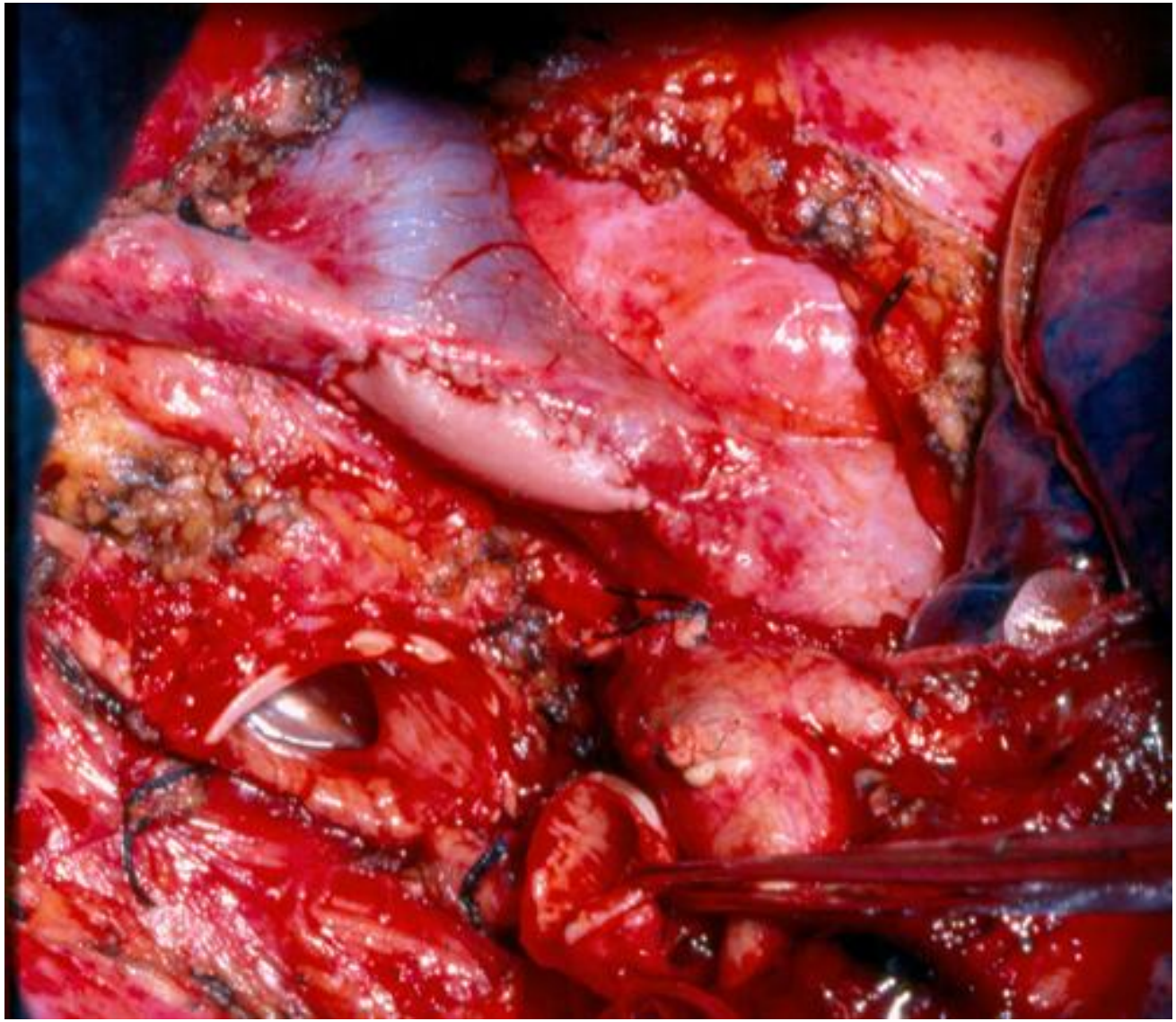

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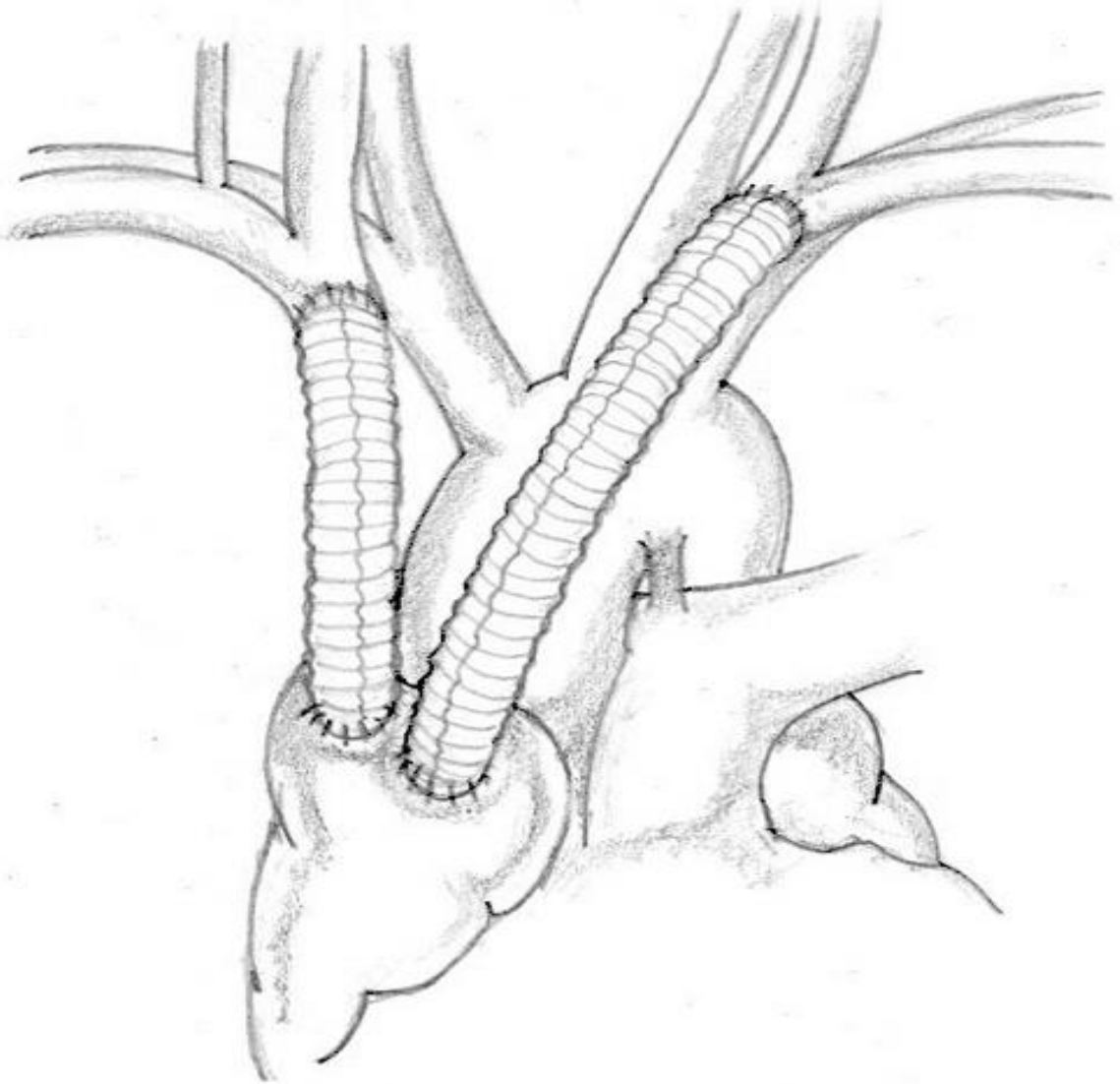

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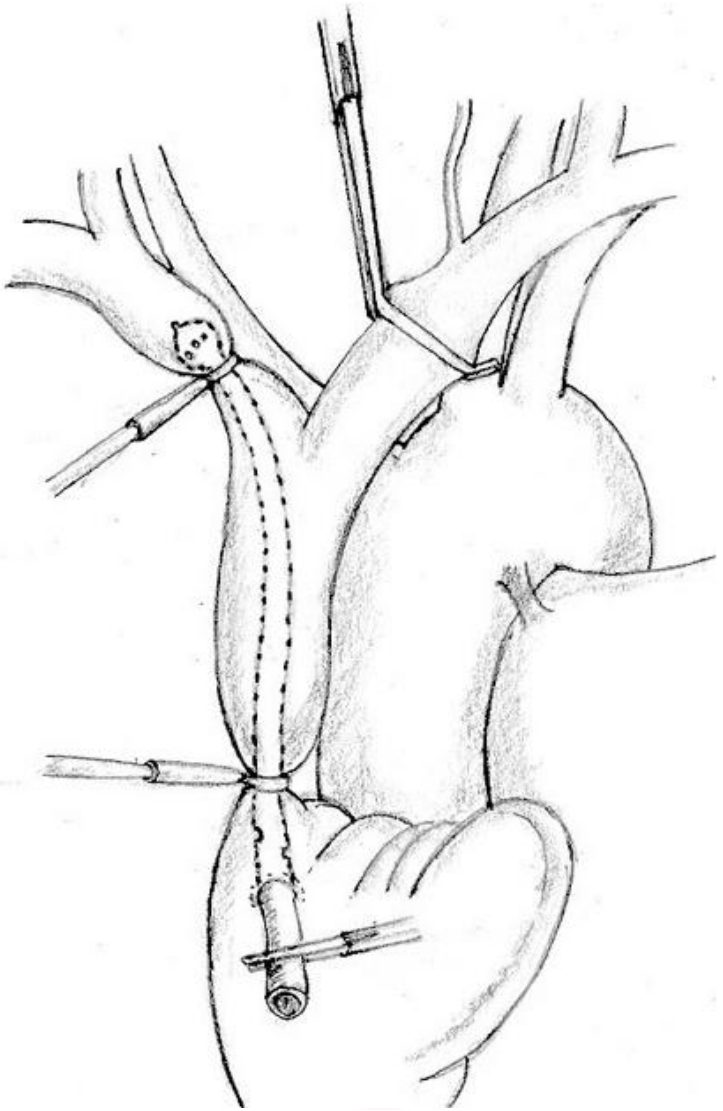

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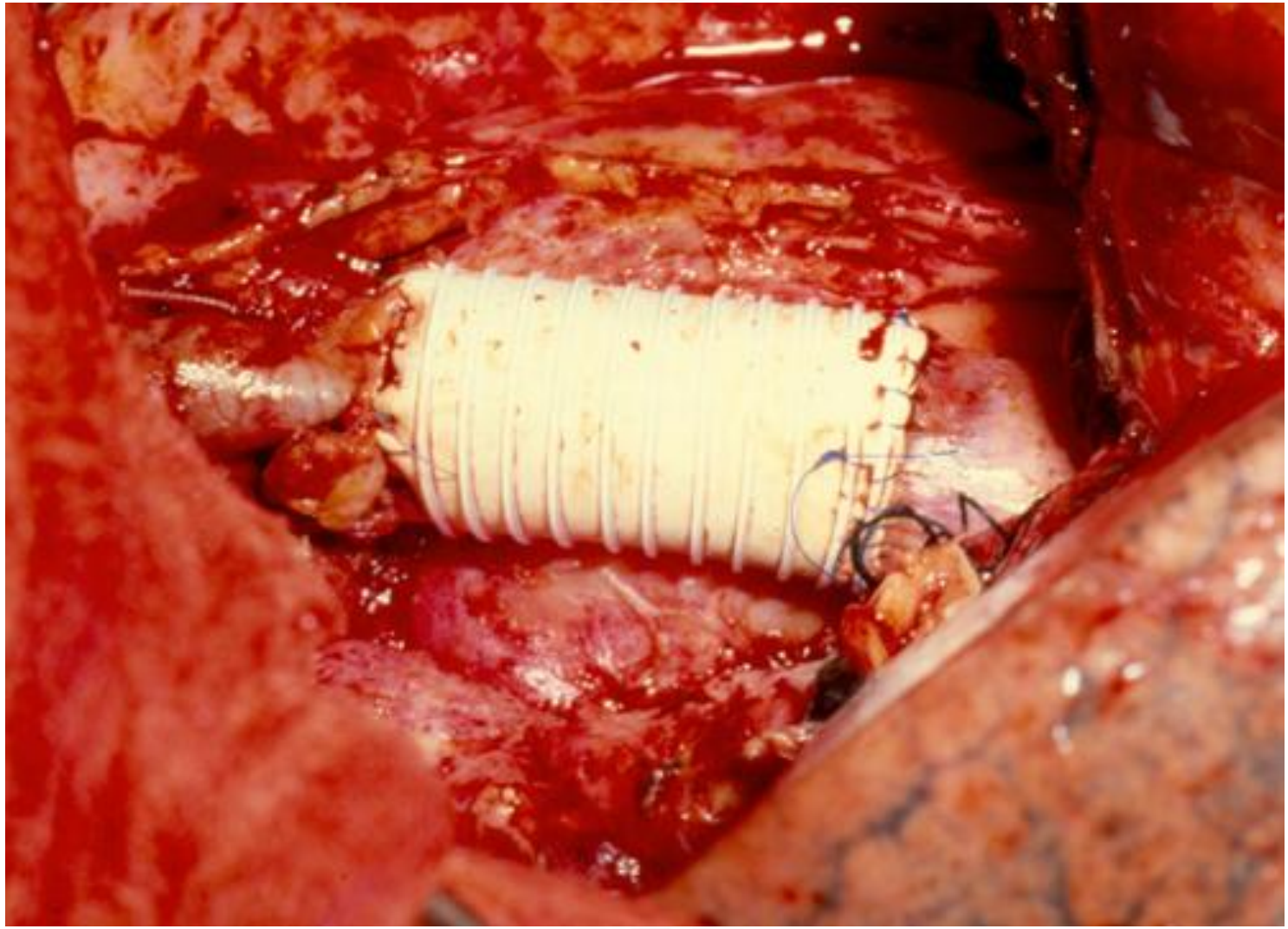

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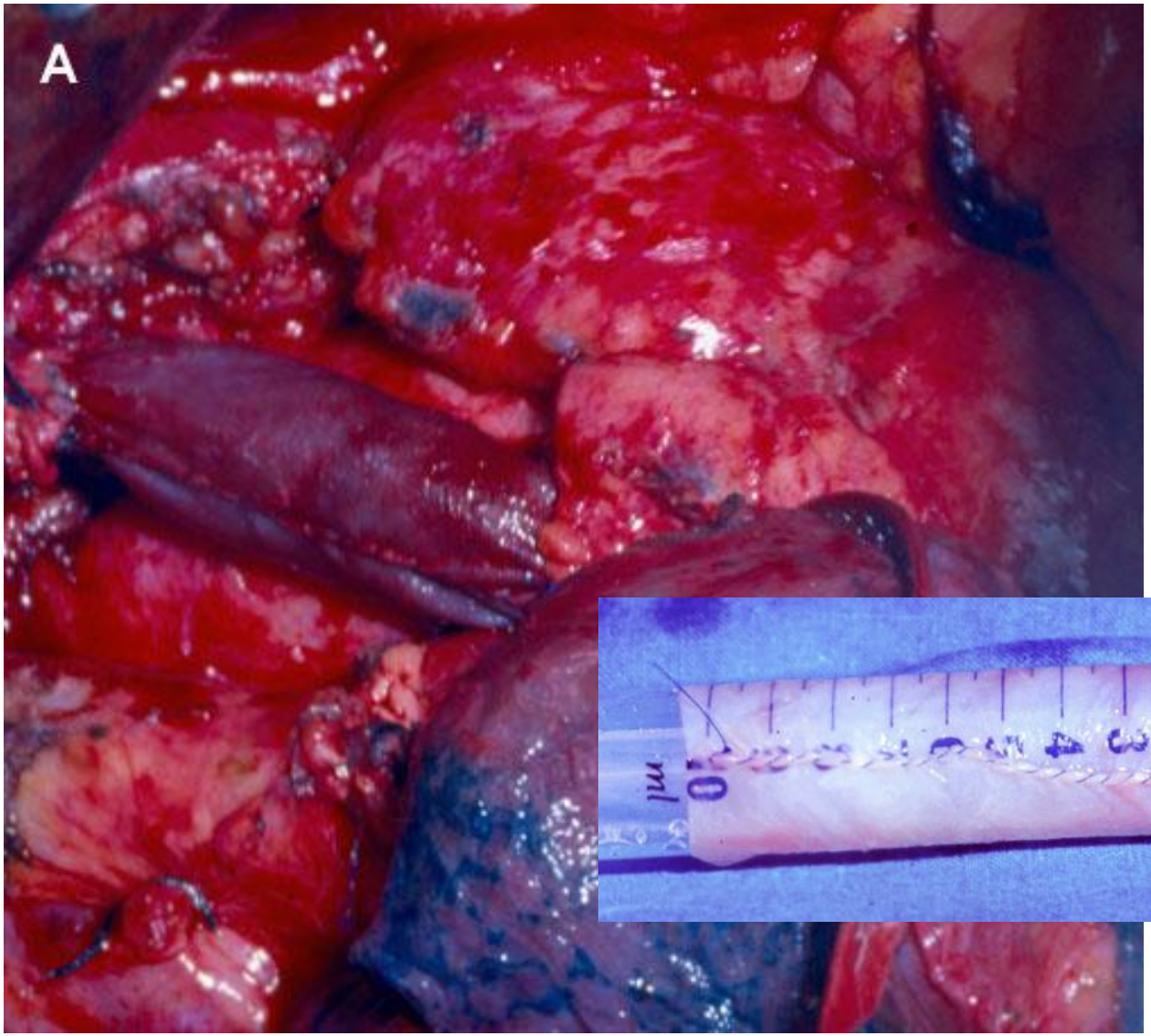

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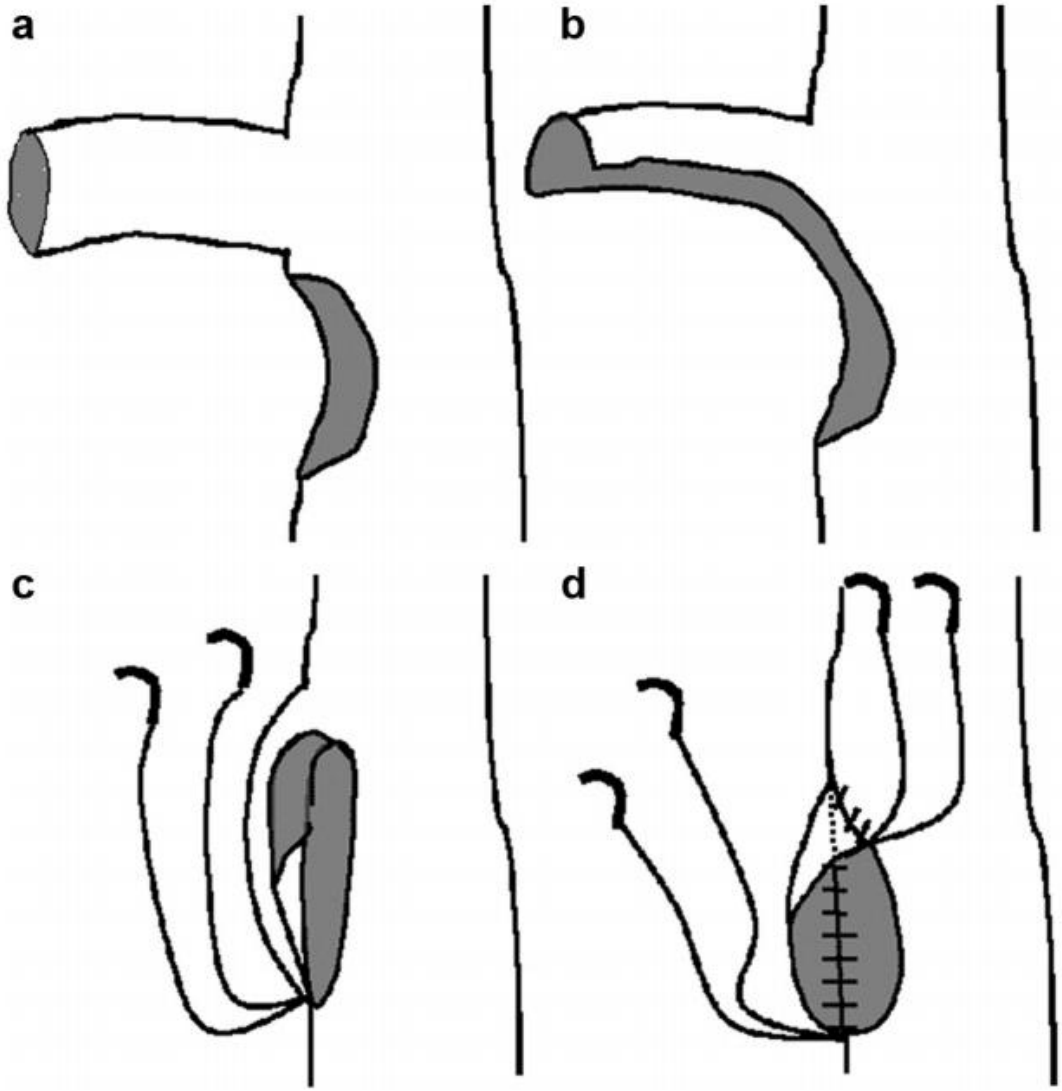

Azygos flap as a novel method for superior vena cava reconstruction
Norihisa Ohata et al
Interactive CardioVascular and Thoracic Surgery 11 (2010) 519–521

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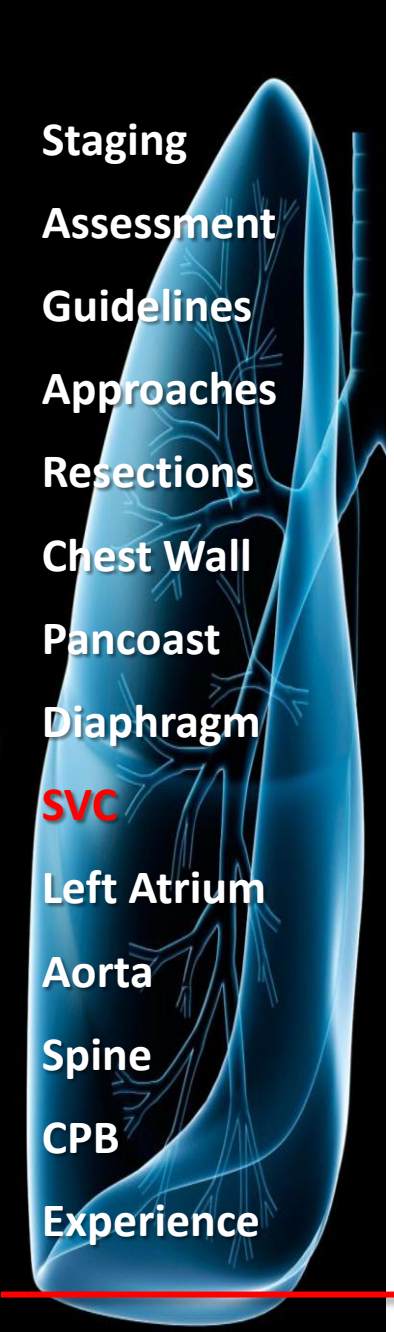

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Table 1. English-Language Literature Review (1990–2005): Full Papers With More Than 6 Patients [2–12]

Author, Year of Publication	Patients	Prosthetic Graft	Mortality	5-Year Survival
Piccione, 1990	6	0	17%	NR
Thomas, 1994	15	4	7%	24%
Tsuchiya, 1994	32	7	22%	NR
Dartevelle, 1997	14	14	7%	31%
Fukuse, 1997	8	3	NR	NR
Spaggiari, 2000[a]	25	7	12%	29%
Spaggiari, 2000[b]	11	3	0	NR
Bernard, 2001	8	2	NR	25%
Spaggiari, 2004[c]	109	26	12%	21%
Shargall, 2004	15	9	14%	57% (3 years)
Suzuchy, 2005	40	11	10%	24%

Ann Thorac Surg 2007;83:223-230

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Left Atrium Invasion

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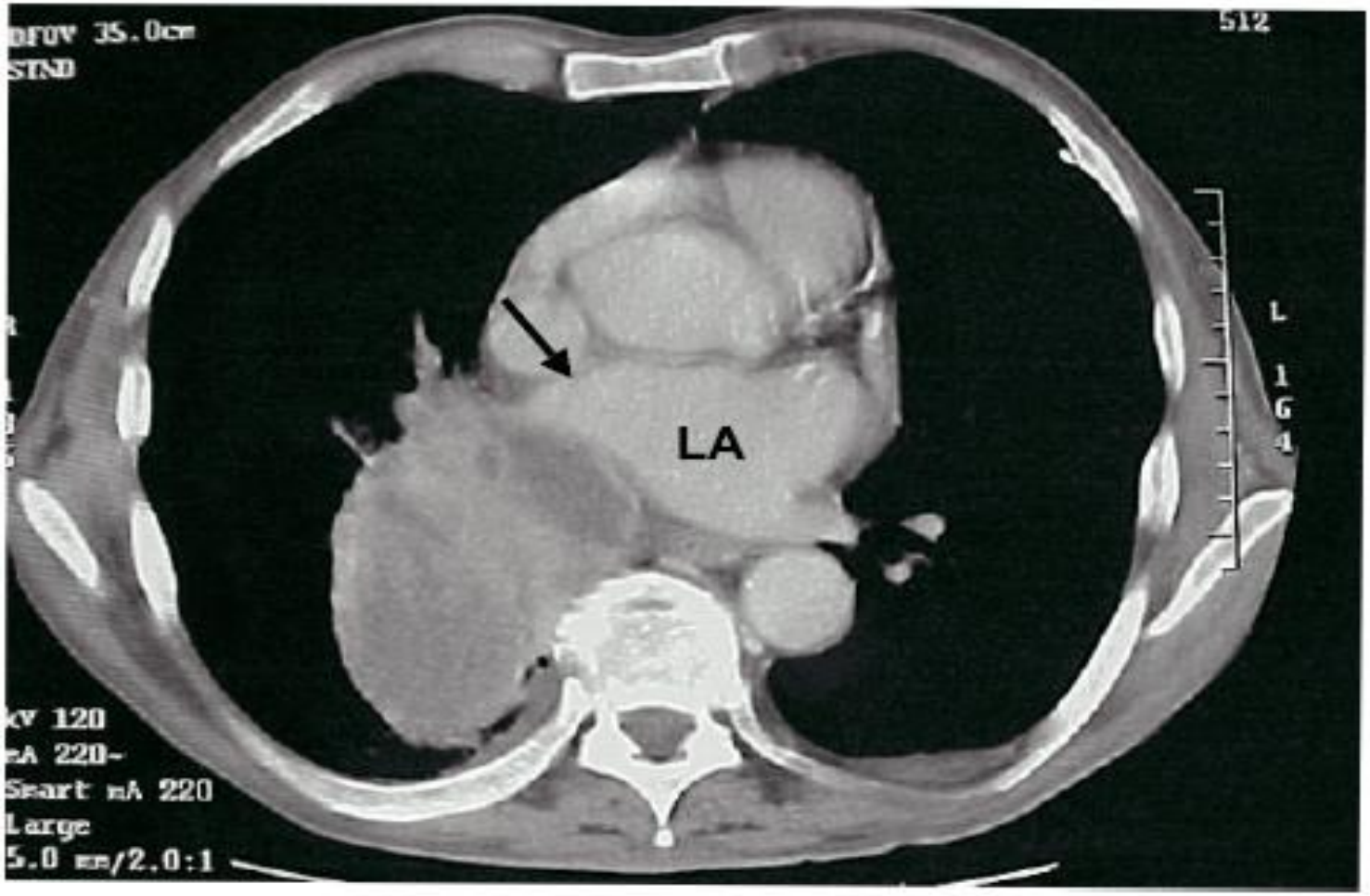

Ann Thorac Surg 2005;79:234-240

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Left Atrium Invasion

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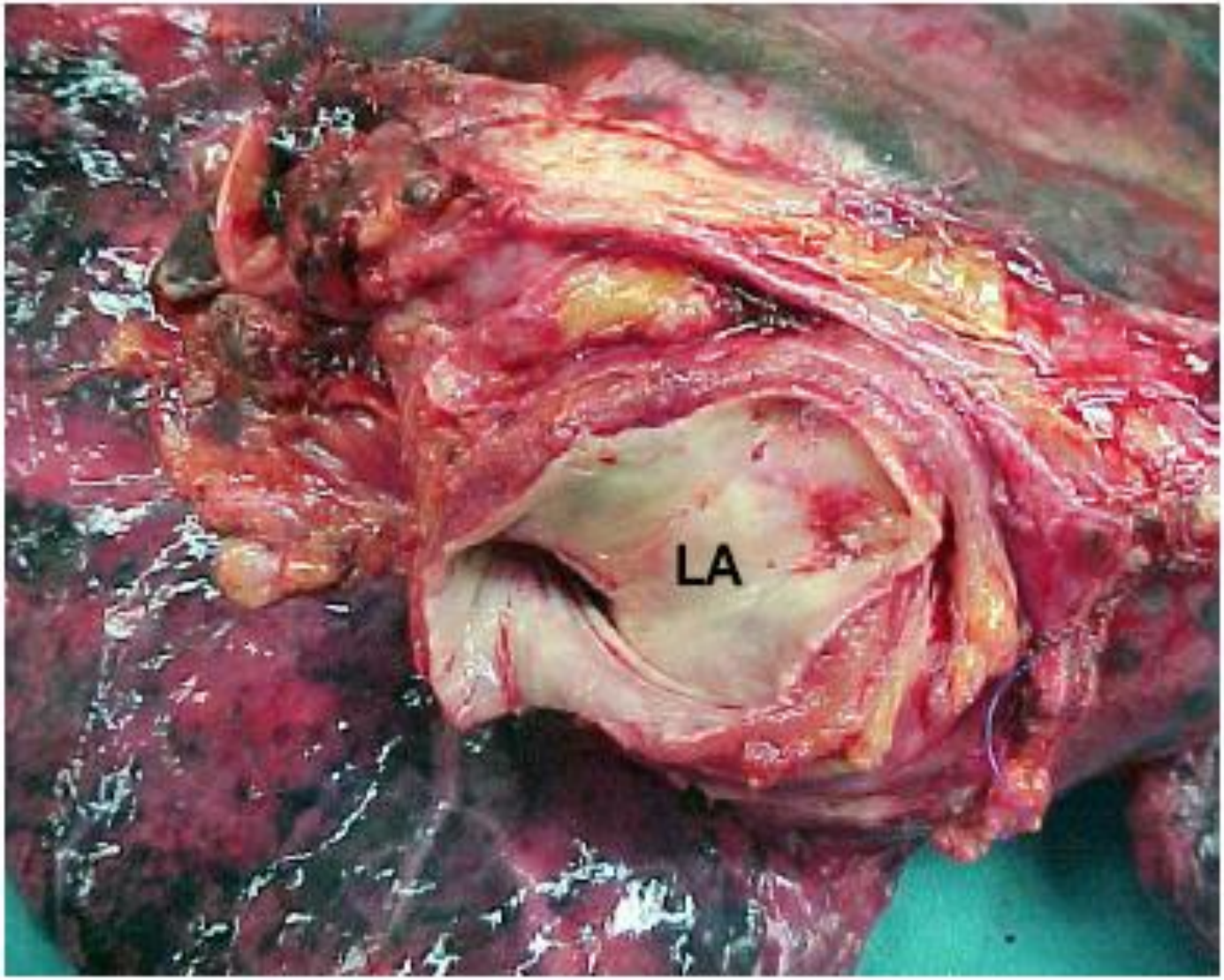

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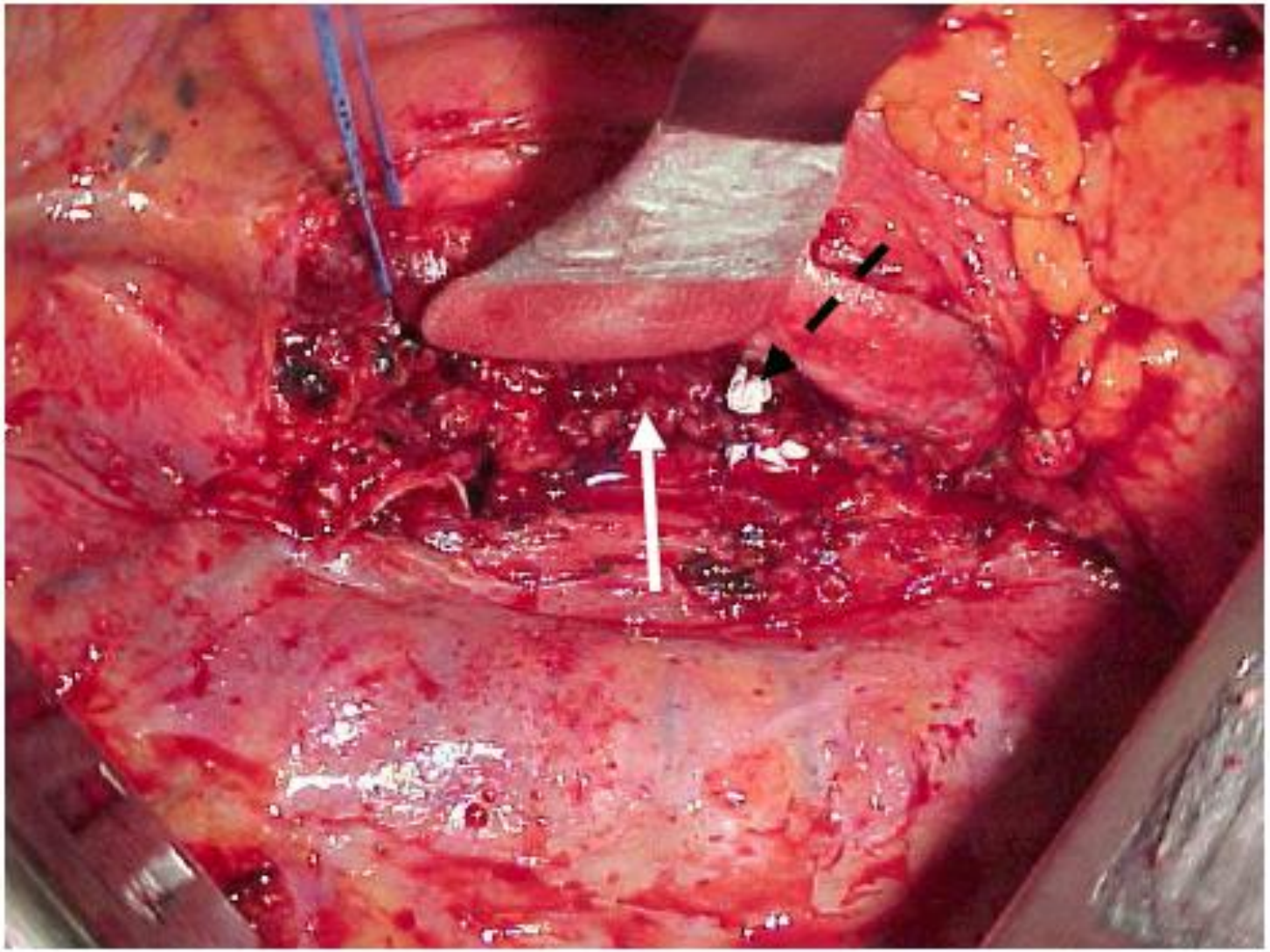

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Left Atrium Invasion

Table 1 The main results of reported retrospective studies involving pulmonary resection extended to the left atrium

Authors	n	Neoadj (%)	PN0 (%)	PN1 (%)	PN2-3 (%)	R0 (%)	R+ (%)	Mortality (%)	Morbidity (%)	5-year SR (%)
Fukuse (9)	42	14	14	6	22	35	65	2.4	NR	17 (3-year SR)
Ratto (10)	19	15	15	26	57	58	42	0	36	14
Bobbio (11)	23	17	56	22	17	83	17	9	22	10
Spaggiari (12)	15	60	13	33	53	100	0	0	16.5	39 (3-year SR)
Wu (13)	46	NR	30.5	47.8	21.7	NR	NR	0	52.1	22
Wang (14)	25	NR	20	48	32	92	8	NR	NR	36
Galvaing (5)	19	68.5	5.2	57.9	36.9	89.4	10.6	52.6	10.5	43.7

Neoadj, neoadjuvant therapy; NR, non-reported; SR, survival rate.

Extended resection of non-small cell lung cancer invading the left atrium, is it worth the risk?
Geraud Galvaing et al - *Chin Clin Oncol 2015;4(4):43*

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Descending Aorta Invasion

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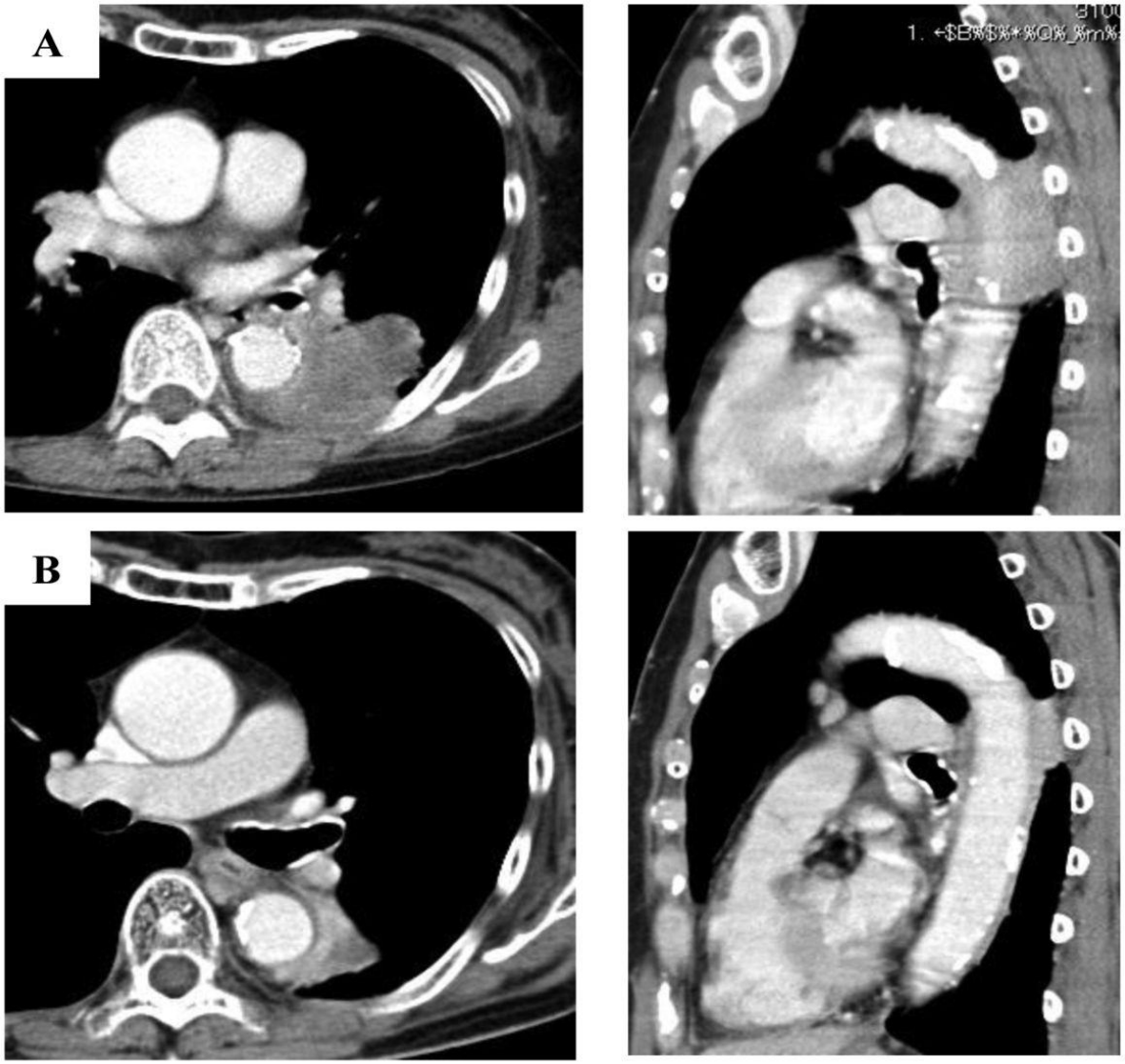

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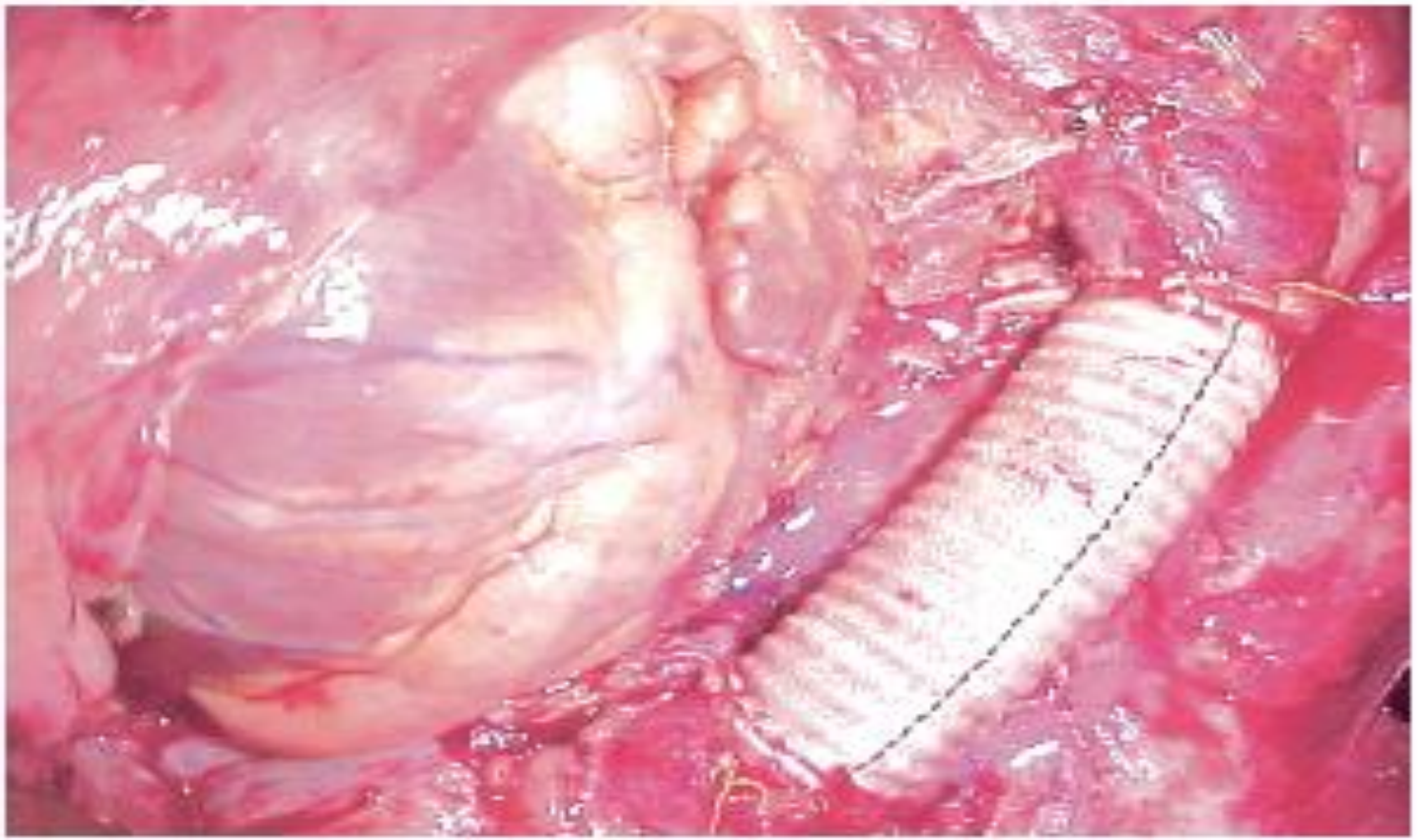
http://ar.iiarjournals.org/content/36/5/2391/F1.expansion.html

Descending Aorta Invasion



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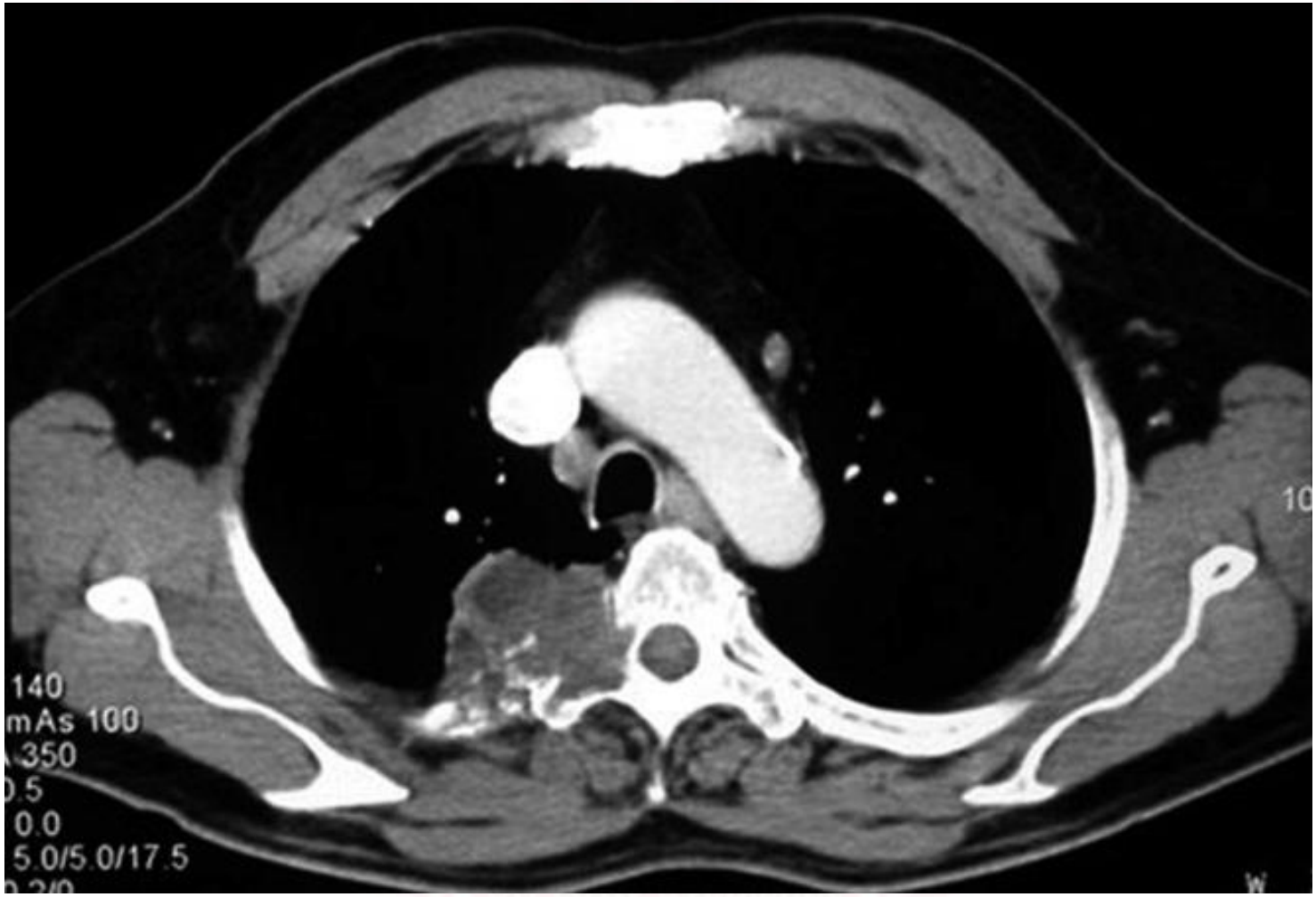
Spine Invasion



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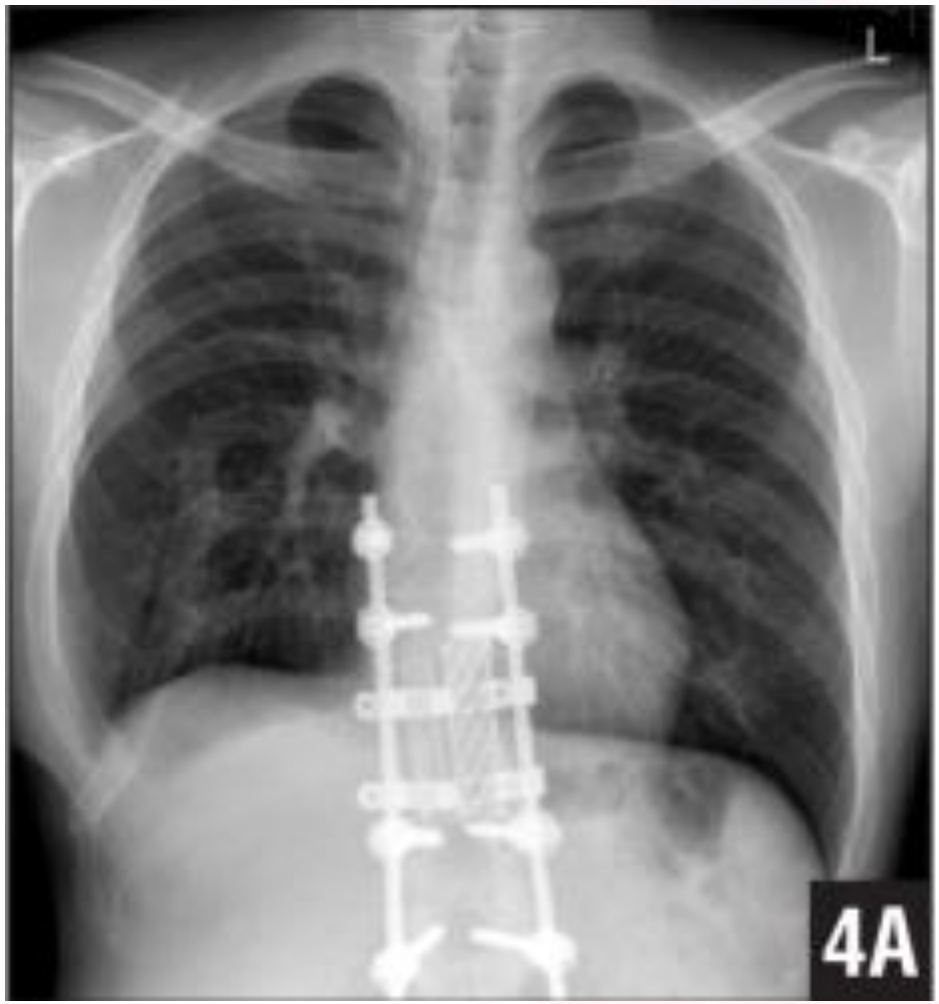
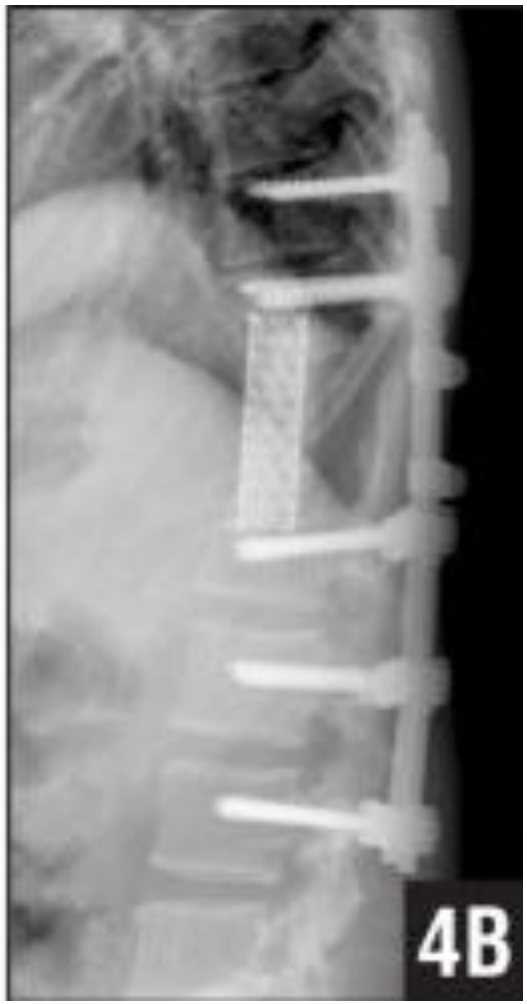
Surgical management of advanced non-small cell lung cancer
Gonzalo Varela, Pascal Alexandre Thomas
J Thorac Dis 2014;6(S2):S217-S223

Spine Invasion





Giant Cell Tumor Expanded Into the Thoracic Cavity With Spinal Involvement
Satoru Demura et al
Orthopedics March 2012 - Volume 35 · Issue 3: e453-e456

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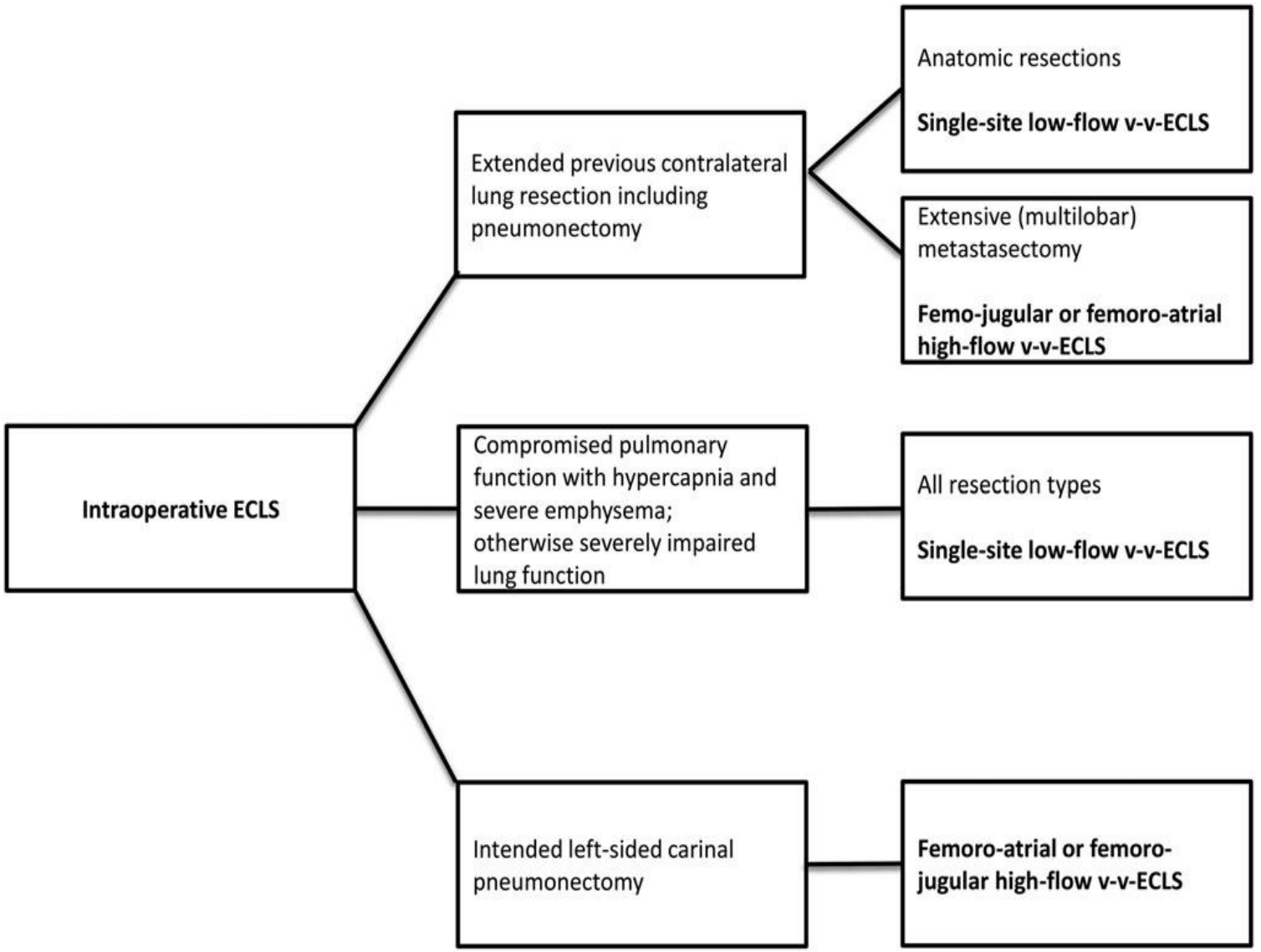
Spine Invasion

TABLE 2. Two-year survivals of present and previously reported series of patients treated surgically for tumors fixed to the spine

Authors	No.	En bloc resection	Vertebrectomy		Two-year survival (%)
			Partial	Total	
DeMeester and colleagues, 1989[8]	12	Yes	12	–	42
Gandhi and colleagues, 1999[14]	14	No	7	7	54
Present series	19	Yes	15	4	53

The Journal of Cardiovascular Surgery
Volume 123, Number 2

ECLS & Extended Resections



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Intraoperative veno-venous extracorporeal lung support in thoracic surgery: a single-centre experience
B. Redwan et al. - ICVTS 21 (2015) 766–772

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Table 1. Patient Demographics and comorbidities - Tumor characteristics

		Total		no CPB or standby		on CPB		p Value
Demographic								
	Patient number	42	(100.0%)	30	(71.4%)	12	(28.6%)	
	Age years (median)	64.5±12.0		63.5±11.8		65.0±12.8		0.811
	Sex (male)	31	(73.8%)	21	(50.0%)	10	(23.8%)	0.464
	Sex (female)	11	(26.2%)	9	(21.4%)	2	(4.8%)	
	Center (GR)	29	(69.0%)	17	(40.5%)	12	(28.6%)	**0.007**
	Center (UK)	13	(31.0%)	13	(31.0%)	0	(0.0%)	
Medical comorbidities								
	COPD	14	(33.3%)	9	(21.4%)	5	(11.9%)	0.491
	Hypertension	3	(7.2%)	2	(4.8%)	1	(2.4%)	1.000
	CAD	2	(4.8%)	2	(4.8%)	0	(0.0%)	1.000
	MI	2	(4.8%)	2	(4.8%)	0	(0.0%)	1.000
	Diabetes	3	(7.1%)	3	(7.1%)	0	(0.0%)	0.541
	Stroke	1	(2.4%)	1	(2.4%)	0	(0.0%)	1.000
	Renal dysfunction	0	(0.0%)	0	(0.0%)	0	(0.0%)	
	Smoking	30	(71.4%)	21	(50.0%)	9	(21.4%)	1.000

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Table 1. Patient Demographics and comorbidities - Tumor characteristics

	Total	no CPB or standby	on CPB	p Value
Tumor Characteristics				
Size cm (median)	4.5±2.0	4.0±1.9	6.0±2.2	0.530
Pathology				
Squamous	21 (50.0%)	18 (42.8%)	3 (7.2%)	**0.040**
Adenocarcinoma	15 (35.7%)	8 (19.0%)	7 (16.7%)	0.053
Large cell	1 (2.4%)	1 (2.4%)	0 (0.0%)	0.522
Atypical carcinoid	2 (4.8%)	2 (4.8%)	0 (0.0%)	0.359
Adenocystic	2 (4.8%)	1 (2.4%)	1 (2.4%)	0.492
Glomus	1 (2.4%)	0 (2.4%)	1 (0.0%)	0.110
Adjacent anatomic structure invasion				
Thoracic inlet	4 (9.8%)	3 (0.0%)	1 (0.0%)	0.931
SVC	8 (19.0%)	6 (14.2%)	2 (4.8%)	0.804
IVC	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Trachea	2 (4.8%)	0 (0.0%)	2 (4.8%)	**0.022**
Carina	6 (14.3%)	4 (9.5%)	2 (4.8%)	0.780
Pericardium	7 (16.7%)	2 (4.8%)	5 (11.9%)	**0.006**
Pulmonary artery	9 (21.4%)	8 (19.0%)	1 (2.4%)	0.191
Inrapericardial PA	4 (9.5%)	1 (2.4%)	3 (7.1%)	**0.031**
Left atrium	3 (7.1%)	1 (2.4%)	2 (3.7%)	0.130
Right atrium	1 (2.4%)	0 (0.0%)	1 (2.4%)	0.110
Thoracic aorta	3 (7.1%)	0 (0.0%)	3 (7.1%)	**0.004**
Esophagus	1 (2.4%)	0 (0.0%)	1 (2.4%)	0.110
Diaphragram	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Vertebra	2 (4.8%)	2 (0.0%)	1 (4.8%)	0.359

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Table 1. Patient Demographics and comorbidities - Tumor characteristics

		Total		no CPB or standby		on CPB		p Value
Surgical approach								
	Thoracotomy	33	(78.6%)	26	(61.9%)	7	(16.7%)	0.086
	Sternotomy	1	(2.4%)	0	(0.0%)	1	(2.4%)	0.110
	Cervical	2	(4.8%)	0	(0.0%)	2	(4.8%)	**0.022**
	Clamshell	2	(4.8%)	0	(0.0%)	2	(4.8%)	**0.022**
	hemi-Clamshell	1	(2.4%)	1	(2.4%)	0	(0.0%)	0.522
	Dartevelle	1	(2.4%)	1	(2.4%)	0	(0.0%)	0.522
	Shaw-Paulson	2	(4.8%)	2	(4.8%)	0	(0.0%)	0.359
Pulmonary resection								
	Lobectomy	14	(33.3%)	11	(26.2%)	3	(7.1%)	0.469
	Sleeve lobectomy	8	(19.0%)	7	(16.6%)	1	(2.4%)	0.263
	Double sleeve lobectomy	6	(14.3%)	6	(14.3%)	0	(0.0%)	0.094
	Pneumonectomy	7	(16.7%)	2	(4.8%)	5	(11.9%)	0.006
	Sleeve pneumonectomy	4	(9.5%)	3	(7.1%)	1	(2.4%)	0.868
	Resection of trachea	3	(7.1%)	1	(2.4%)	2	(4.7%)	0.130
CBP details								
	Cannulation site					femo - femoral		
	Time (min)					45±7		

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Table 2. Patient postoperative characteristics

	Total	no CPB or standby	on CPB	p Value
Adjuvant therapy				
Chemotherapy	32 (76.2%)	22 (52.4%)	10 (23.8%)	0.696
Radiotherapy	17 (40.5%)	11 (26.2%)	6 (14.3%)	0.498
In hospital stay (days) median				
	8.0±4.7	8.0±5.5	8.0±1.5	0.590
Postoperative complications				
AF	6 (14.3%)	3 (7.1%)	3 (7.1%)	0.329
MI	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Pneumonia	4 (9.5%)	3 (7.1%)	1 (2.4%)	1.000
Respiratory failure	2 (4.8%)	2 (4.8%)	0 (0.0%)	1.000
Atelectasis	6 (14.3%)	5 (11.9%)	1 (2.4%)	0.655
Reoperation	1 (2.4%)	1 (2.4%)	0 (0.0%)	1.000
Pulmonary edema	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Renal hemodialysis	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Blood transfusion (units)				
	1.3±1.1	0.8±1.0	2.4±0.6	**0.010**
30 day mortality				
	0 (0.0%)	0 (0.0%)	0 (0.0%)	

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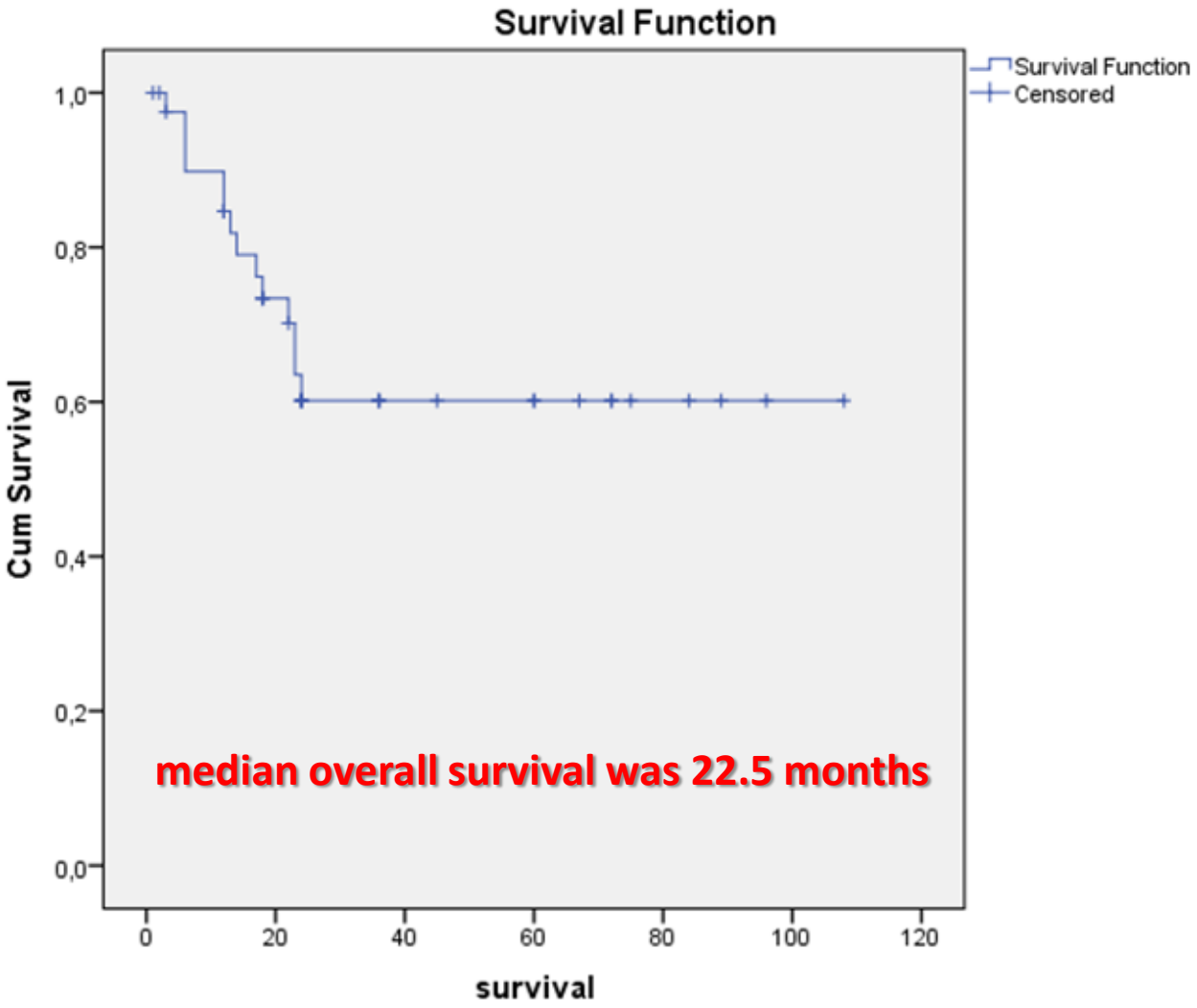

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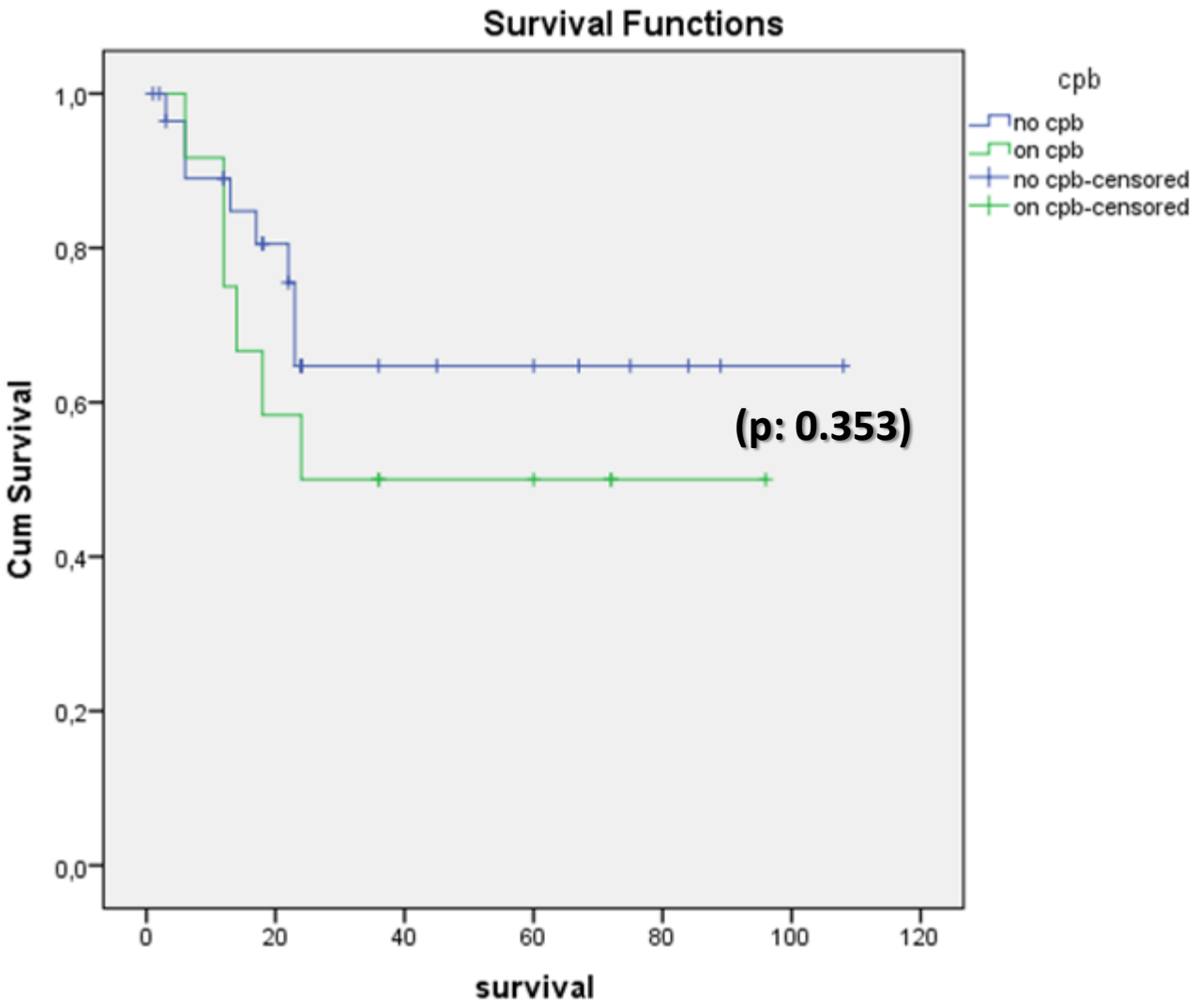

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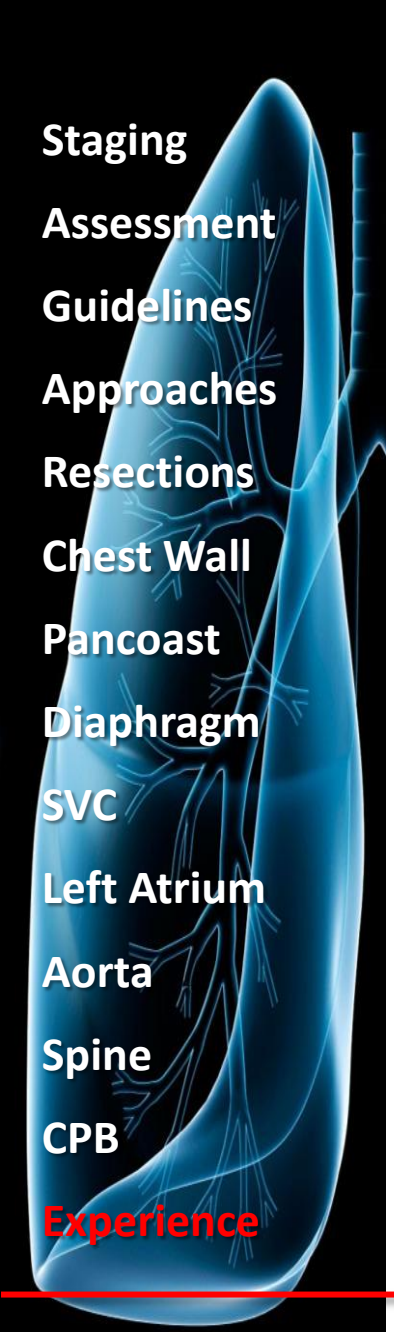

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Table 3. Cox regression in Survival

Variable		p Value
Demographic		
	Age (years)	**0.027**
Medical comorbidities		
	COPD	**0.001**
	Hypertension	0.999
	CAD	0.390
	MI	0.390
	Diabetes	0.999
	Stroke	0.257
	Renal dysfunction	
	Smoking	0.244
Tumor Characteristics		
	Size (cm)	**0.001**
	Pathology	0.288
	Adjacent anatomic structure invasion	0.648
Surgical		
	Approach	0.124
	CPB	0.359
	Resection type	0.345
Postoperative		**0.017**
	AF	0.224
	Pneumonia	0.085
	Respiratory dysfunction	**0.001**
	Atelectasis	0.030
Adjuvant therapy		
	Chemotherapy	0.886
	Radiotherapy	0.775

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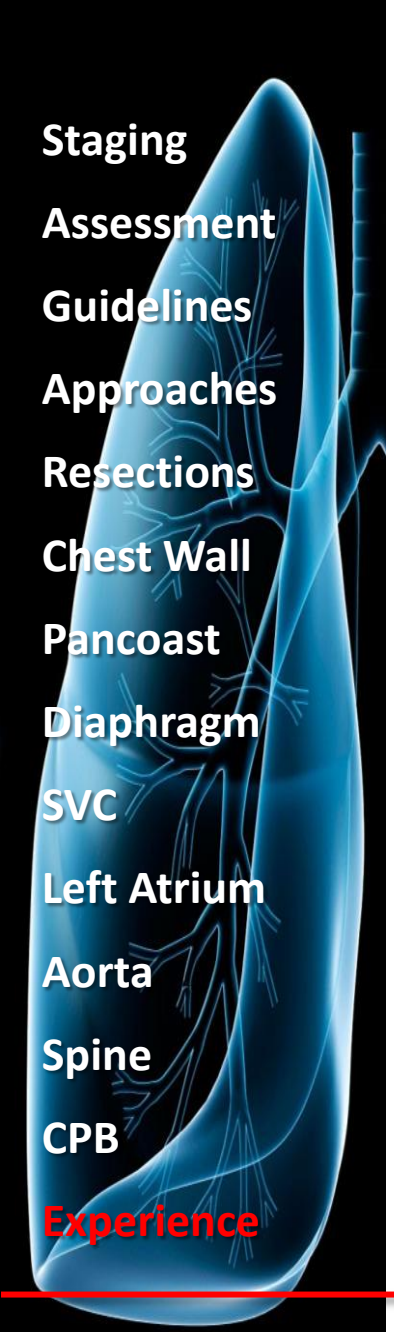

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Table 4. Review of publication for extented lung resections

Publication year	Author	Country	No patient	Period	
				From	To
1971	Charles P. Bailey	USA	2		
1991	Takayuki Shirakusa	Japan	12		
1993	Maeda	Japan	42		
1994	Ryosuke Tsuchiya	Japan	101	1962	1991
1994	Nael Martini	USA	44	1974	1984
1994	Thomas	France	15	1981	1991
1994	Roviaro		28	1983	1992
1995	Dartevelle	France	14		
1995	Jakob R. Izbicki	Germany	94	1987	1990
1995	Tatsuo Fukuse	Japan	42	1976	1993
1996	Dartevelle and Macchiarini		60		
1996	Pitz	Netherlands	70	1977	1993
1997	Fukuse	Japan	42	1976	1993
1999	Takao Takahashi	Japan	49	1980	1996
1999	Walter Klepetko	Austria	7	1991	1996
1999	Mitchell	USA	135	1962	1999
2000	Spaggiari	France	25	1983	1996
2001	Mitchell	USA	60	1973	1998
2001	Victor A. Tarasov	Russia	50		
2001	Oda	Japan	24	1981	1999
2001	Bernard A	France	77	1990	1998
2002	Mezzetti	Italy	27	1979	1999
2002	Spaggiari	France	93	1985	2000
2002	Ara A. Vaporciyan	USA	19		
2002	Porhanov	Russia	151	1979	2002
2003	Cordula C.M. Pitz	Netherlands	89		
2003	Seiki Hasegawa	Japan	11		
2003	Pitz	Netherlands	89	1977	1993
2004	Spaggiari	Italy	15	1963	2000
2004	John G. Byrne	USA	14		
2004	Ratto	Italy	19	1996	2004
2004	Bobbio	Italy	23	1982	2001
2005	Regnard	France	65	1983	2002
2005	Shargall	Canada	15	1988	2003
2005	Lorenzo Spaggiari	Italy	15		
2005	Mitsunori Ohta	Japan	16		
2006	Macchiarini	Spain	50	2000	2006
2006	Roviaro	Italy	53	1983	2004
2006	De Perrot	France	119	1981	2004
2008	Rea	Italy	49	1982	2005
2008	Francesco Petrella	Italy	21		
2008	Bedrettin Yildizeli	France	271		
2009	Wu	China	46	2000	2006
2010	Wang	China	48	1996	2008
2013	Lorenzo Spaggiari	Italy	125	1998	2010
2014	Geraud Galvaing		19	2004	2012
2016	Waldemar Schreiner1	Germany	9		
2016	Langer	France	373	1980	2013

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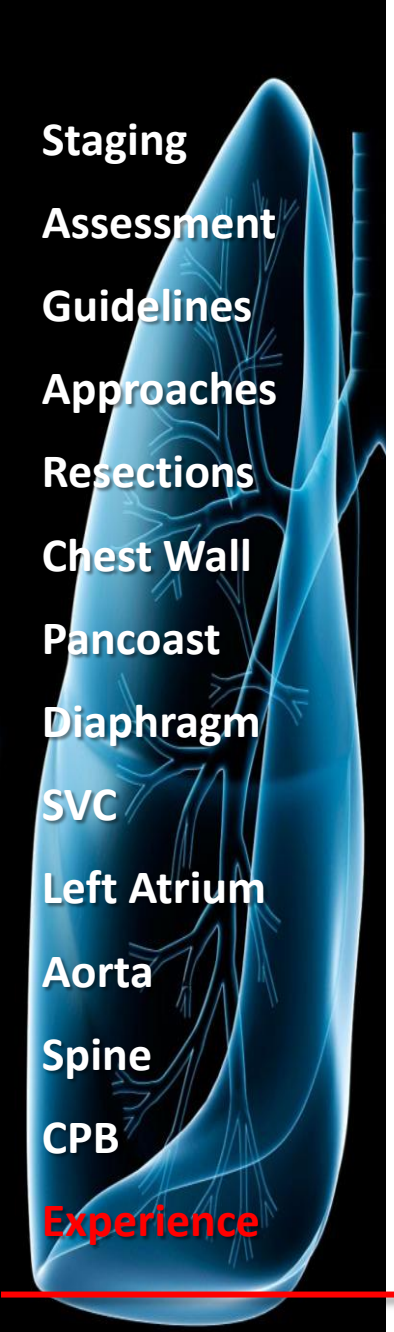

Our Experience

In conclusion,

we suggest that in patients with stage IIIA NSCLC,
the complete resection of T4 tumor
is really challenging for experienced thoracic surgeons,
while there is a true benefit for the patients
on long term survival.

More specified studies on this area of NSCLC
probably will show the same results

and will lead the guidelines
to the most personalized therapeutic procedures
of these patients.

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