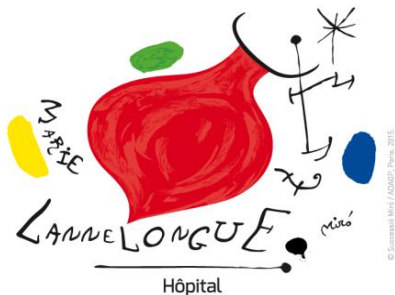




Indications of aortic endografting during pulmonary resections

**Dominique Fabre, Pichoy Danial ,Marie Corniquet ,Justine Mougin,
Philippe Brenot, Delphine Mitilian, Elie Fadel, Sacha Mussot, Olaf Mercier,
Dorian Verscheure, Elie Fadel, Stephan Haulon**



HOPITAL MARIE LANNELONGUE
UNIVERSITE PARIS-SUD SACLAY



Disclosure

Speaker name:

Dominique Fabre

I have the following potential conflicts of interest to report:

Gore medical

Cook medical

Medtronic

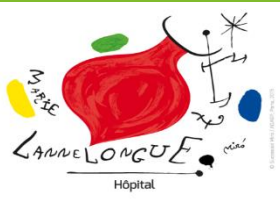
Indications / TEVAR + pulmonary resection

Aortic Disease

- TEVAR with Resection during oncological lobectomy or pneumonectomy
- TEVAR / sequestration artery resection and lobectomy
- TEVAR / extended mediastinal tumor
- Lobectomy / Aneurysm / TEVAR
- Emergencies:
 - Aorto-esophageal Fistula Occurring during Lung Cancer Treatment,
 - massive bleeding after Radiation therapy
 - Bronchopleural fistula after lower lobectomy



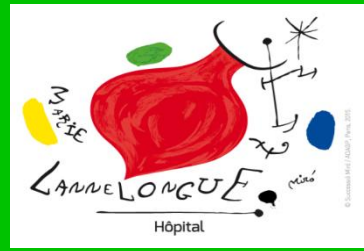
Limitations of TEVAR vs Open surgery



- **Off-label use** / endografts
- Facilitate en bloc resection of tumors invading the aortic wall or secure the aortic resection
 - Minor invasiveness / risk of Spinal Cord Ischemia (SCI)
 - Absence of requirement of cardiopulmonary or aortoaortic bypass use at the time of surgery.
 - Absence of bypass-related anticoagulation during the tumor resection in case of spine involvement
 - Facilitate resection
- Prevent and control bleeding



Optimal pre-op imaging



- Optimal pre-operative imaging is not clearly established.
- There are 3 options:
 - CT scan,
 - MRI and
 - endoscopic ultrasound (EUS),but none of them have demonstrated superiority.
- *Tsujimoto H. Distance between the esophageal tumor and the aorta measured by using the contrast-enhanced attenuation on computed tomography for predicting this tumor invading aorta. J Gastroenterol Hepatol 2013*
- *Hong YJ. Respiratory dynamic magnetic resonance imaging for determining aortic invasion of thoracic neoplasms. J Thorac Cardiovasc Surg 2014*
- *Faigel DO. Biopsy-negative malignant esophageal stricture: diagnosis by endoscopic ultrasound. Am J Gastroenterol 1998*

Optimal pre-op imaging CT scan

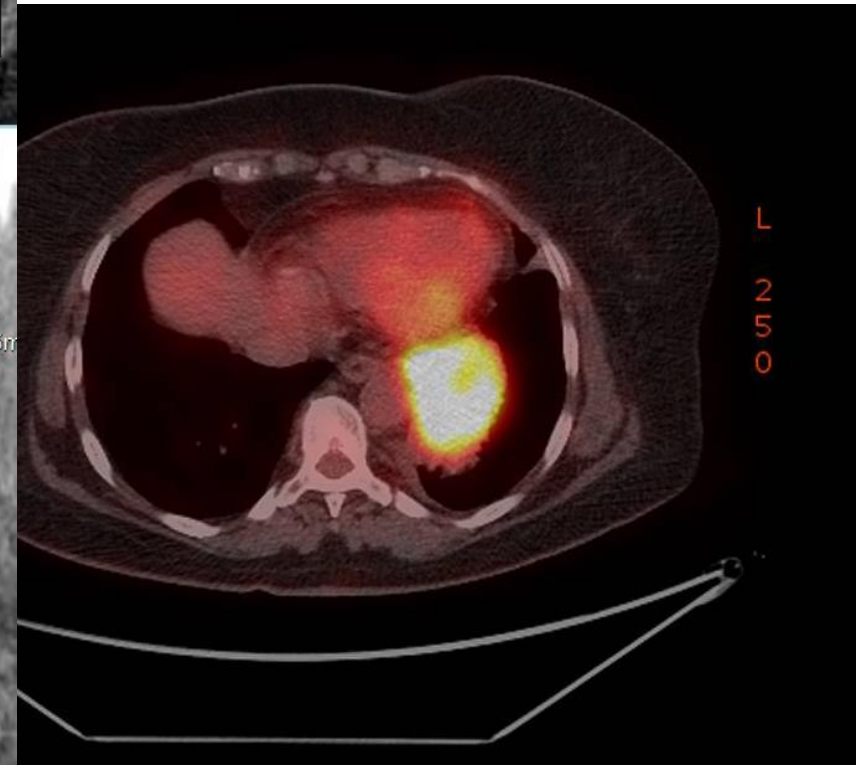
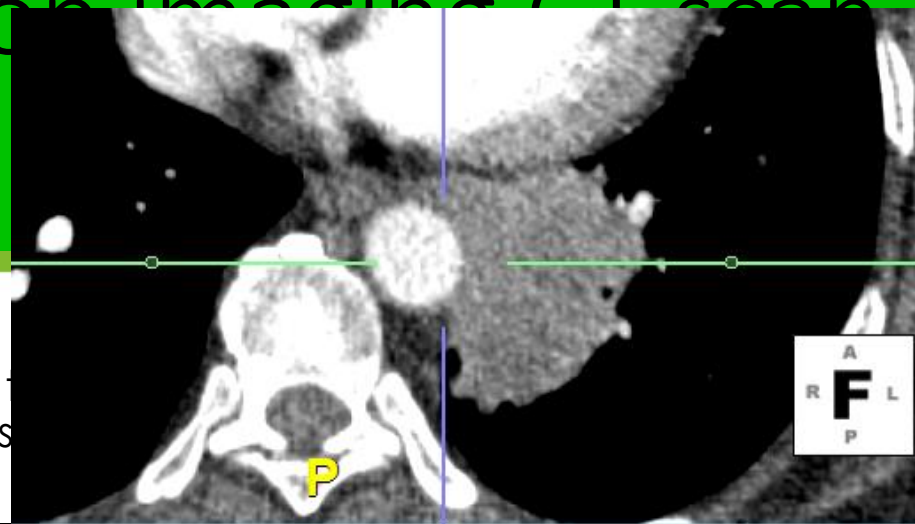
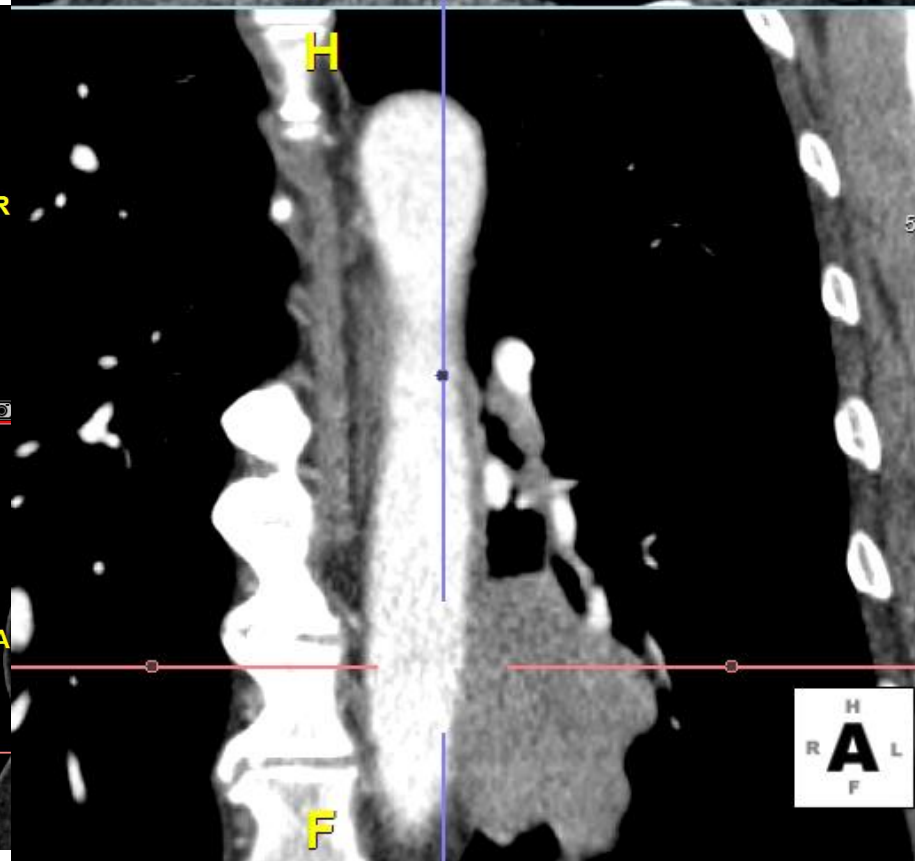
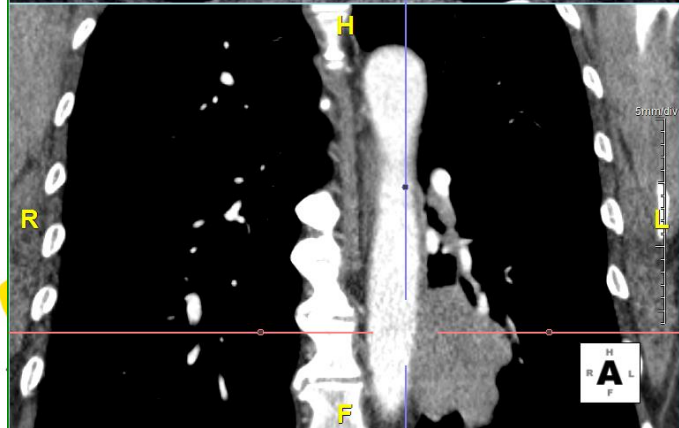
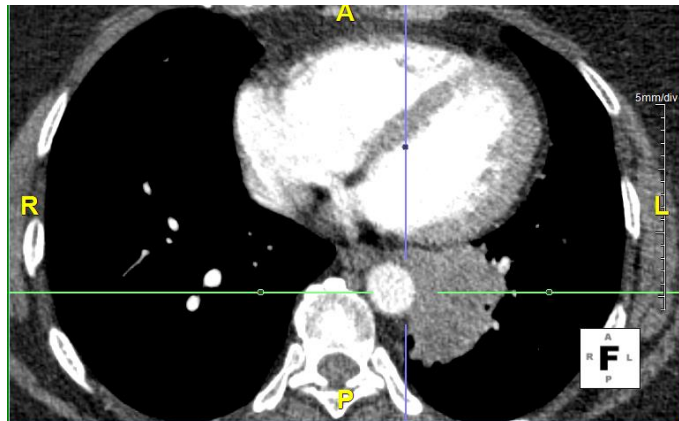
Preoperative axial CT view showing a lung metastasis from an osteosarcoma invading the aortic wall.

Need for:
ECG-gated Cardiac CT
Access (iliac and femoral view)



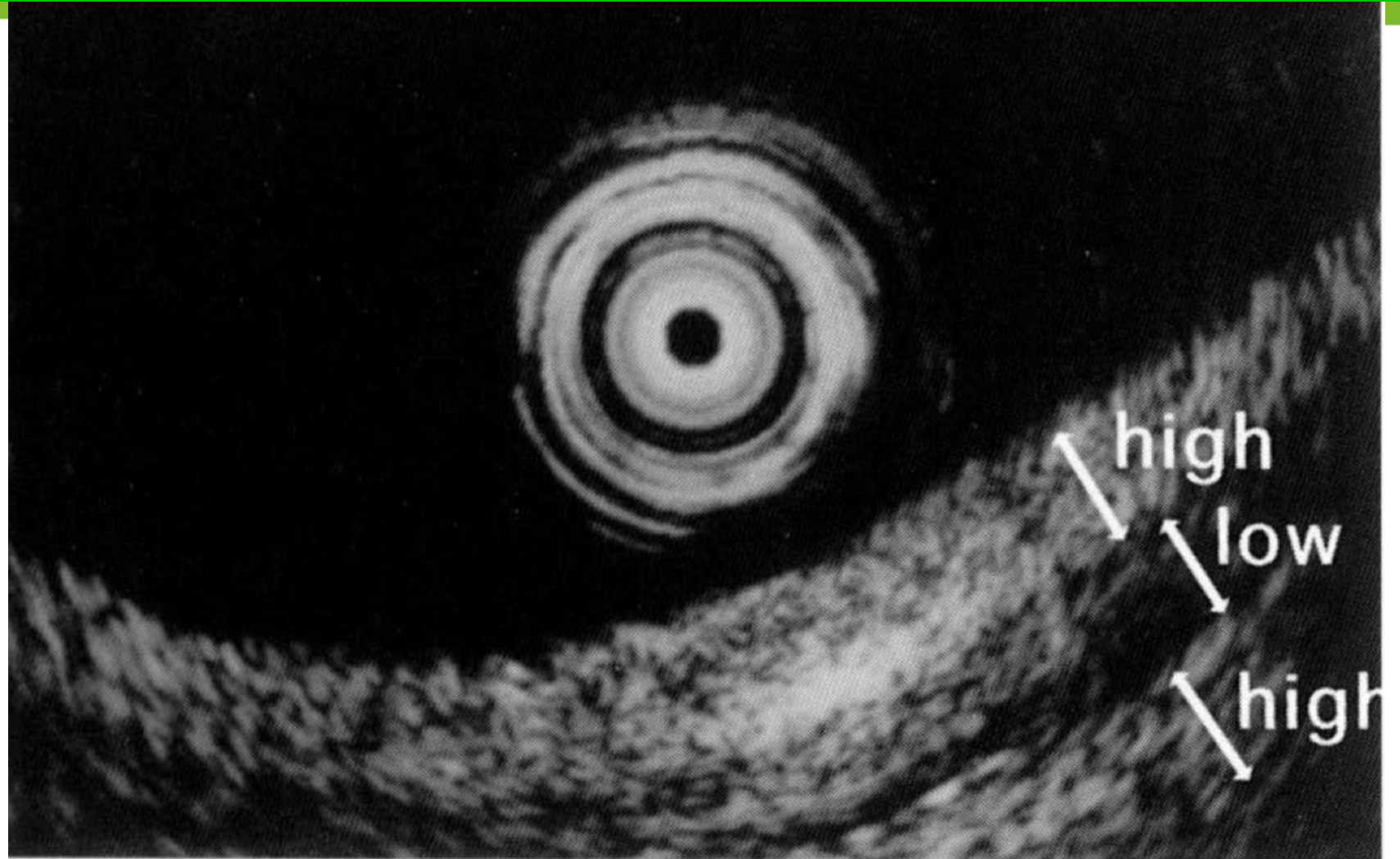
Optimal pre-operative CT scan / PET

- Preoperative CT scan showing aortic aneurysm and suspected aortic invasion



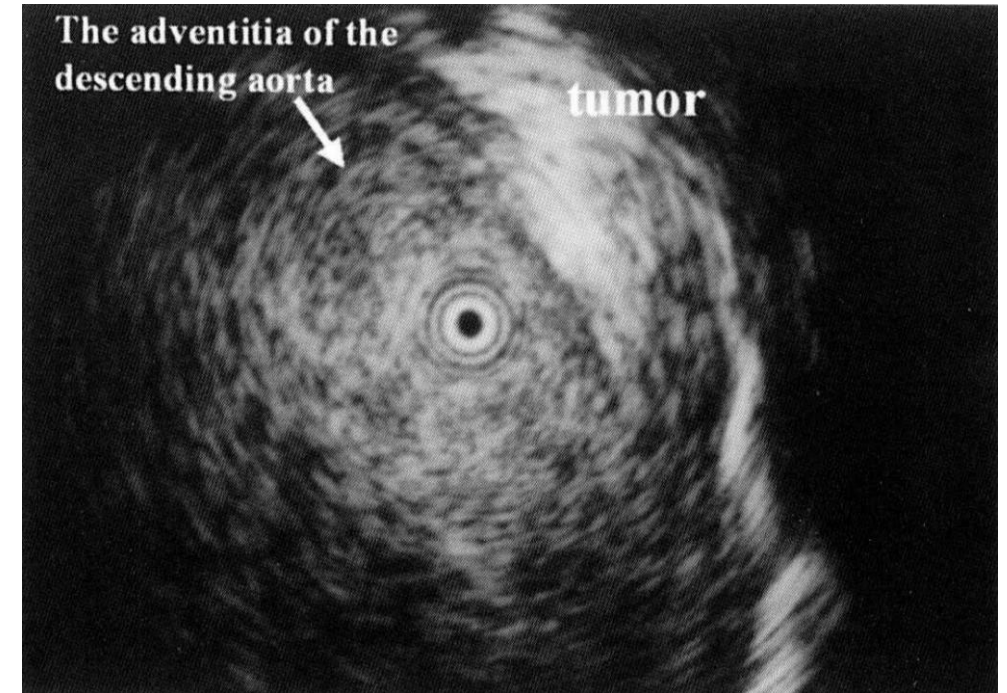
Optimal pre-op imaging IVUS

Yamada N, et al. The application of intravascular ultrasound imaging (IVUS) for diagnosis of aortic wall invasion in lung cancer patients. *Nippon Kyobu Geka Gakkai Zasshi*. 2004



Optimal pre-op imaging IVUS

No reimbursement of
IVUS
In France for those
indications

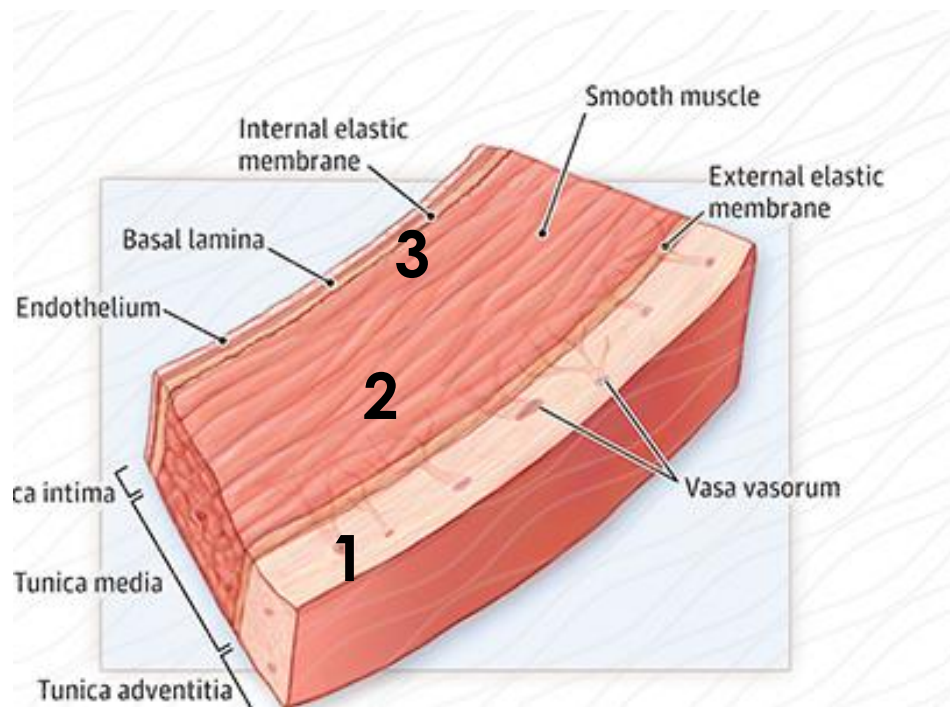


Graft choice / oversizing?



- Prefer the use of endograft without hooks at the level of the resection zone:
 - Medtronic Navion
 - Gore CTAG
 - Zenith Alpha thoracic
 - Terumo Relay
- Median oversizing was 15 to 20%
- Percutaneous approach / fusion imaging / low profile stentgraft
- Sealing zone compromise between 2 to 4 cm (SCI)
- Ballooning on the proximal and distal sealing zones is recommended

Full-thickness aortic wall resection?



- The level of resection of the aortic wall is classified in 3 levels:
- 1/ Limited to the adventitia
- 2/Extended to the media
- 3 /Extended to the intima= full thickness resection
- Reinforcement with a Patch (Pericardium) could be performed

Associated resections?

- 3 levels of hemivertebrectomies
- Associated with Right lower lobne resection
 - After TEVAR



TEVAR and NSCLC / T4 resection

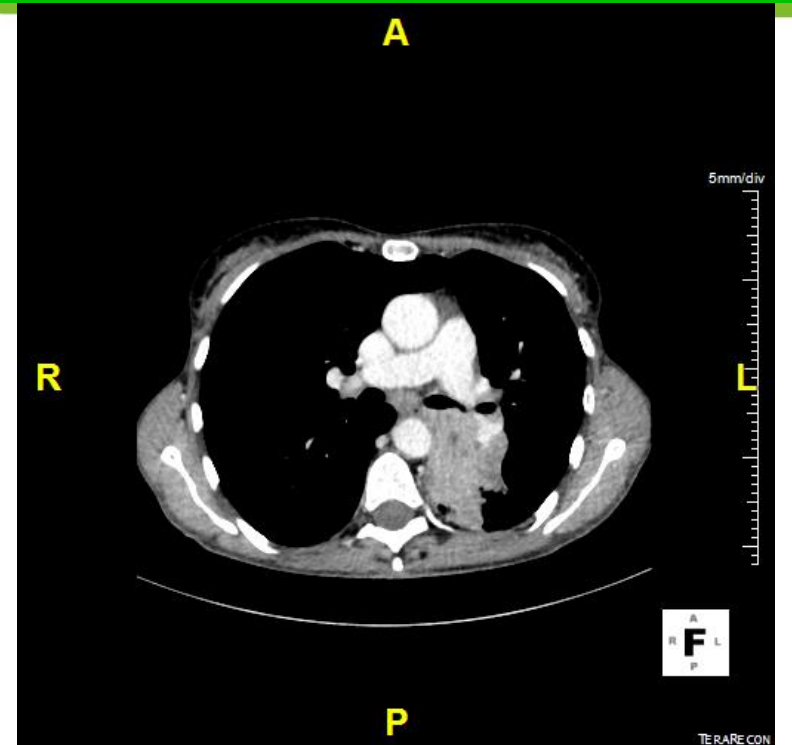
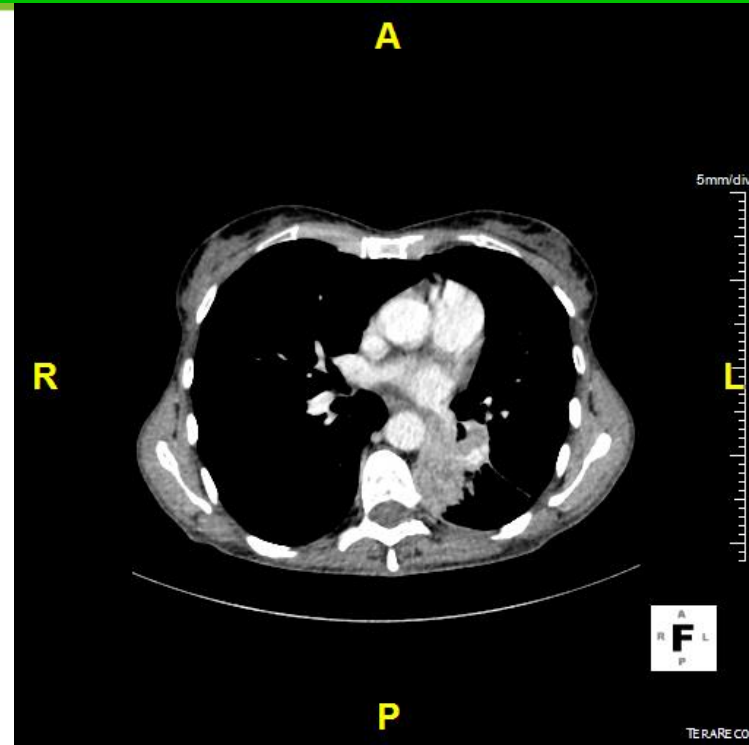
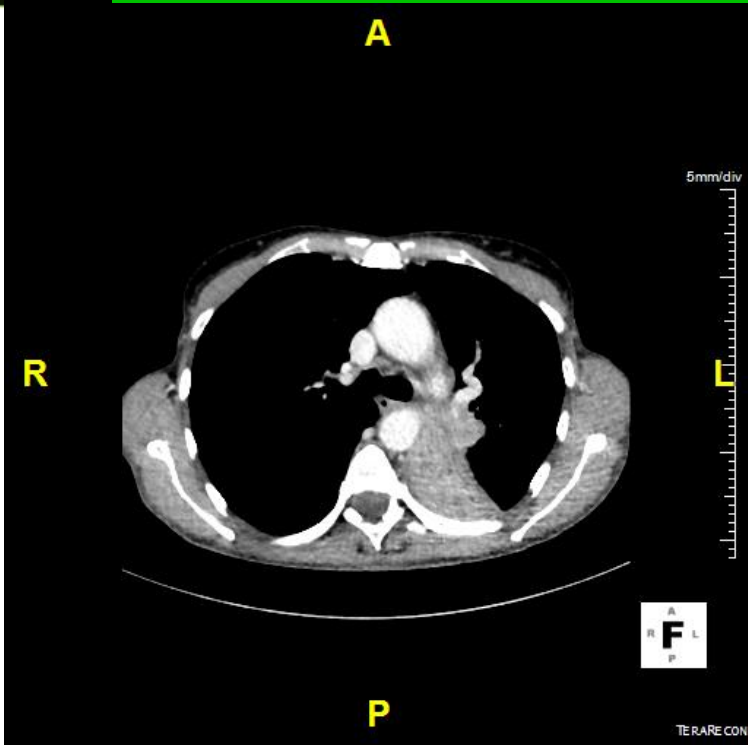
Case 1

- 61 years old w
- Left lower lobe epidermoid carcinoma
- Left recurrent nerve palsy
- FEV1 66%
- cT4N0M0



TEVAR and NSCLC / T4 resection

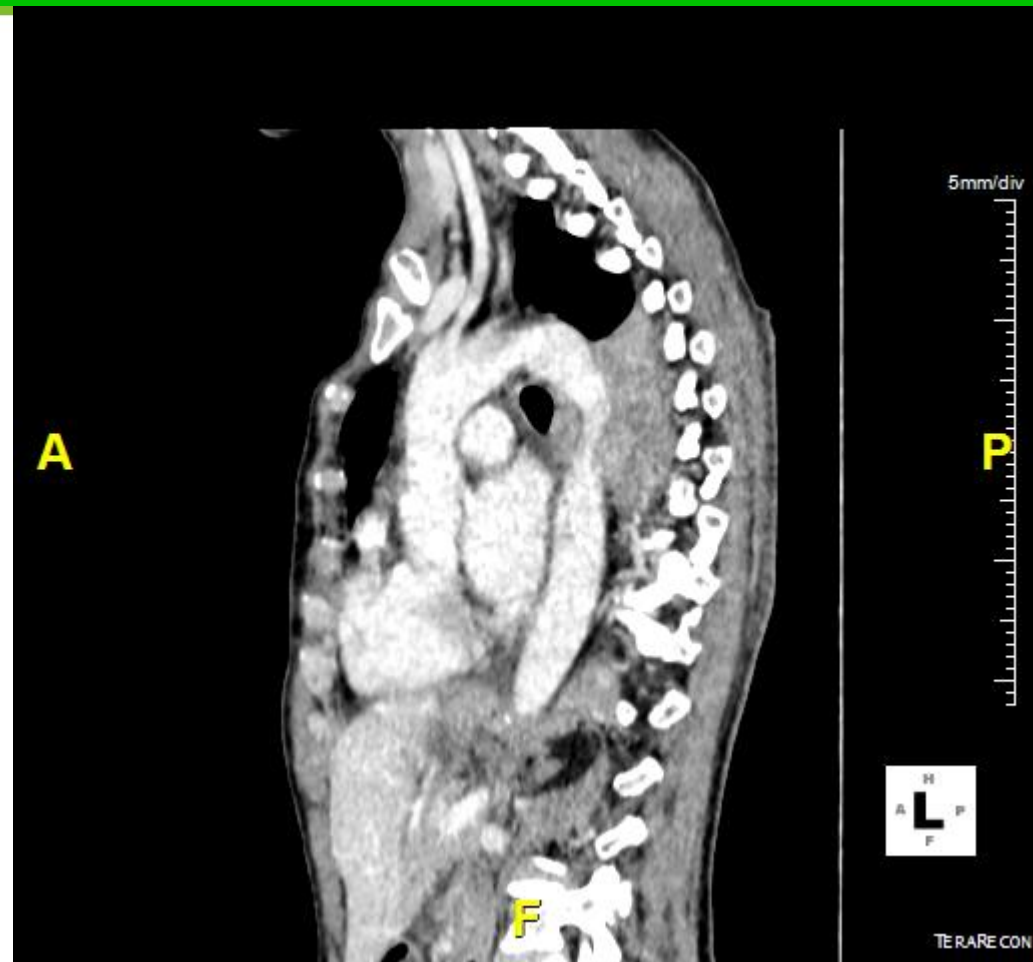
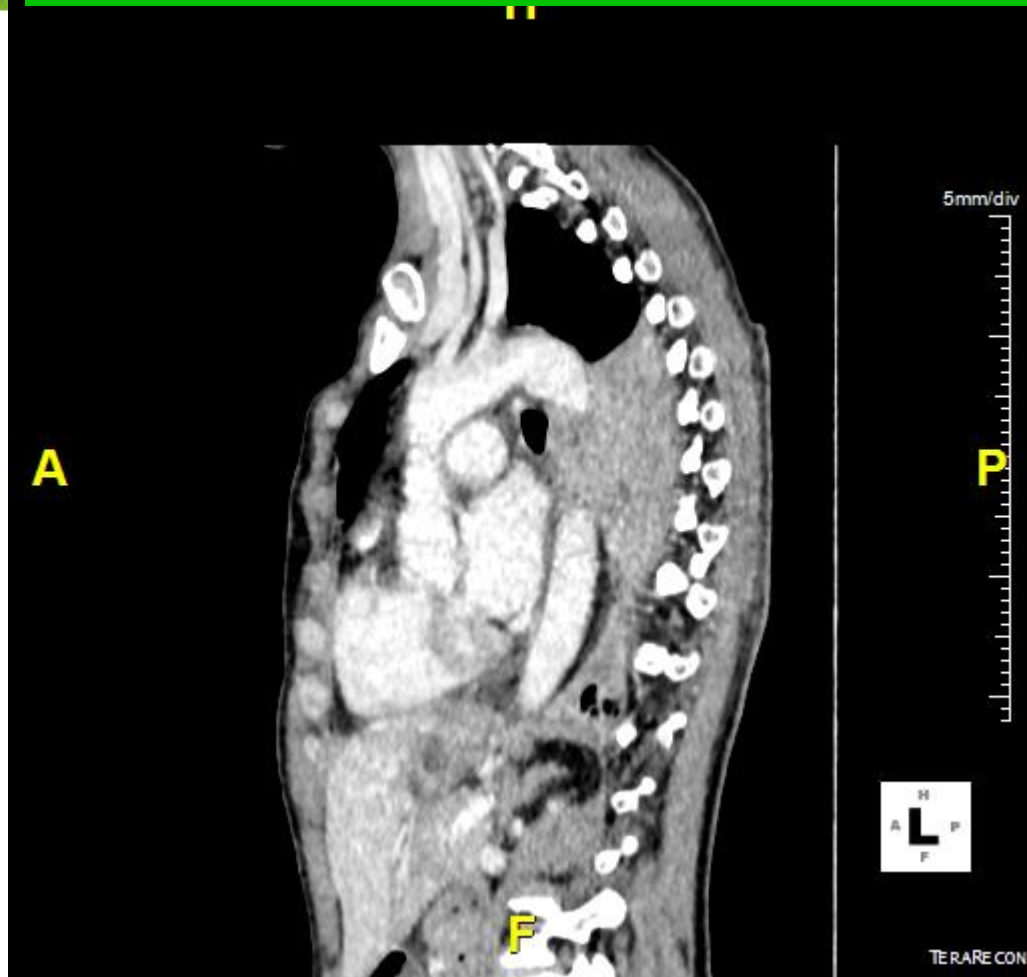
Case 1



ECG-gated Cardiac CT

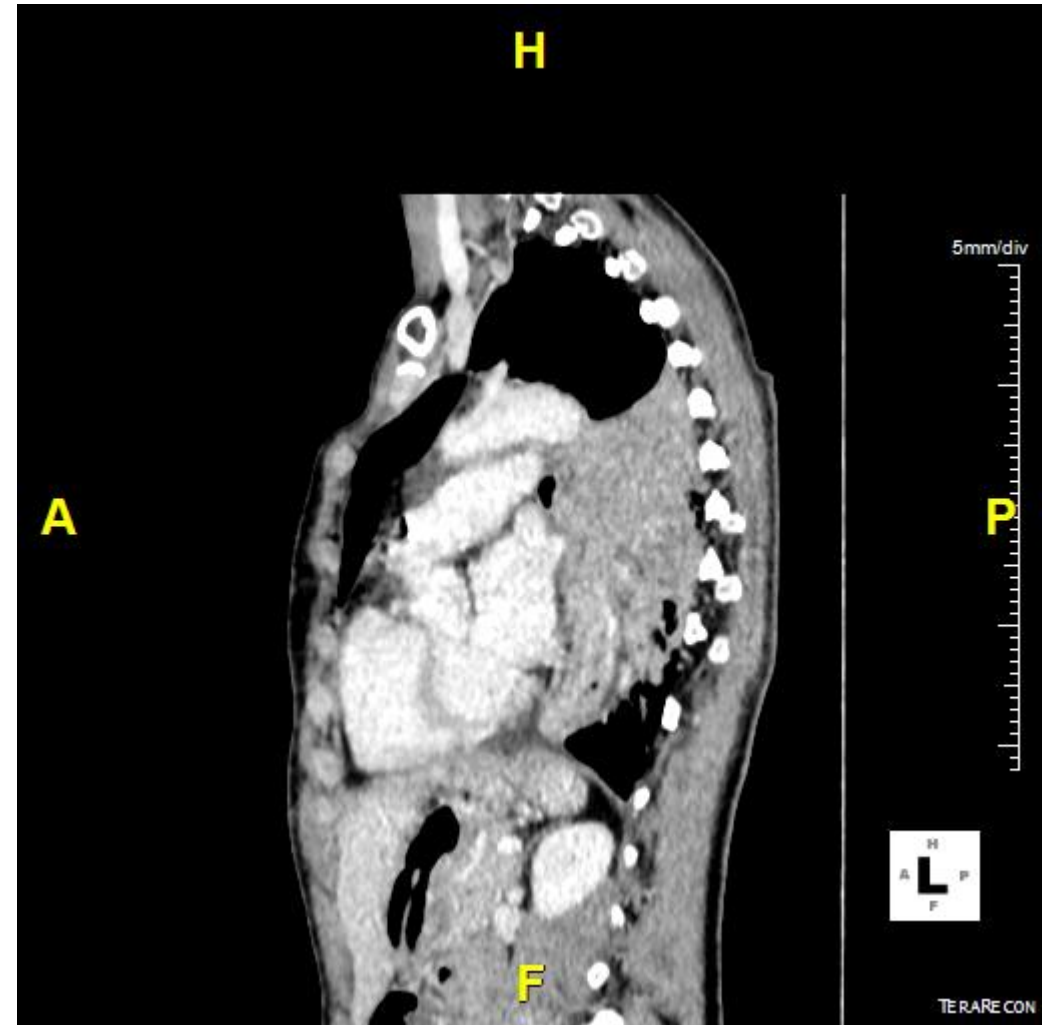
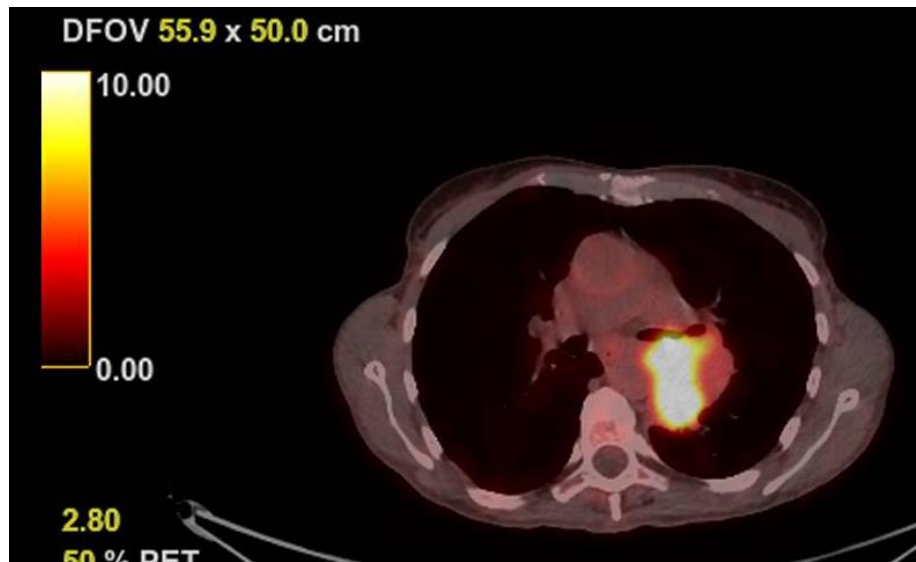
TEVAR and NSCLC / T4 resection

Case 1



TEVAR and NSCLC / T4 resection

Case 1



TEVAR and NSCLC / T4 resection

Case 1

PET CT:

Tumor intense fixation

SUV 21

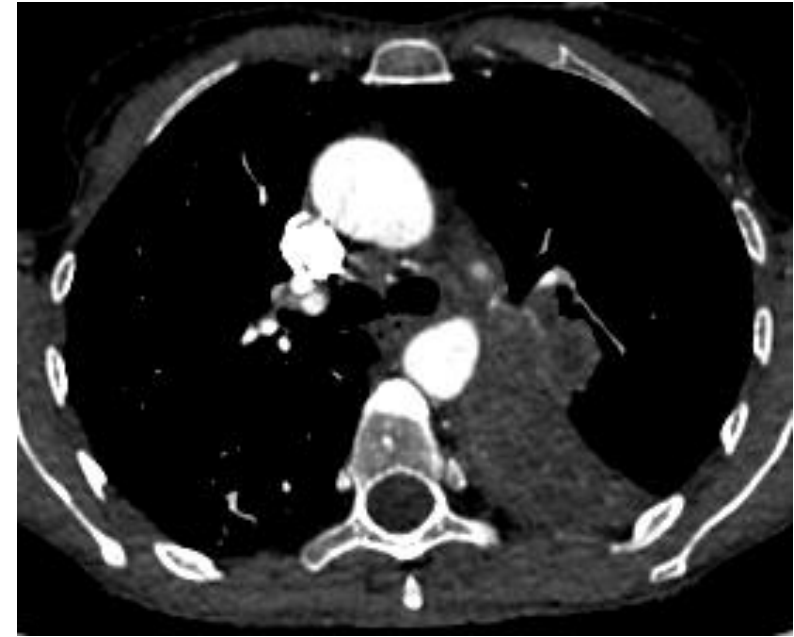
No lymph node fixation

No distant metastasis



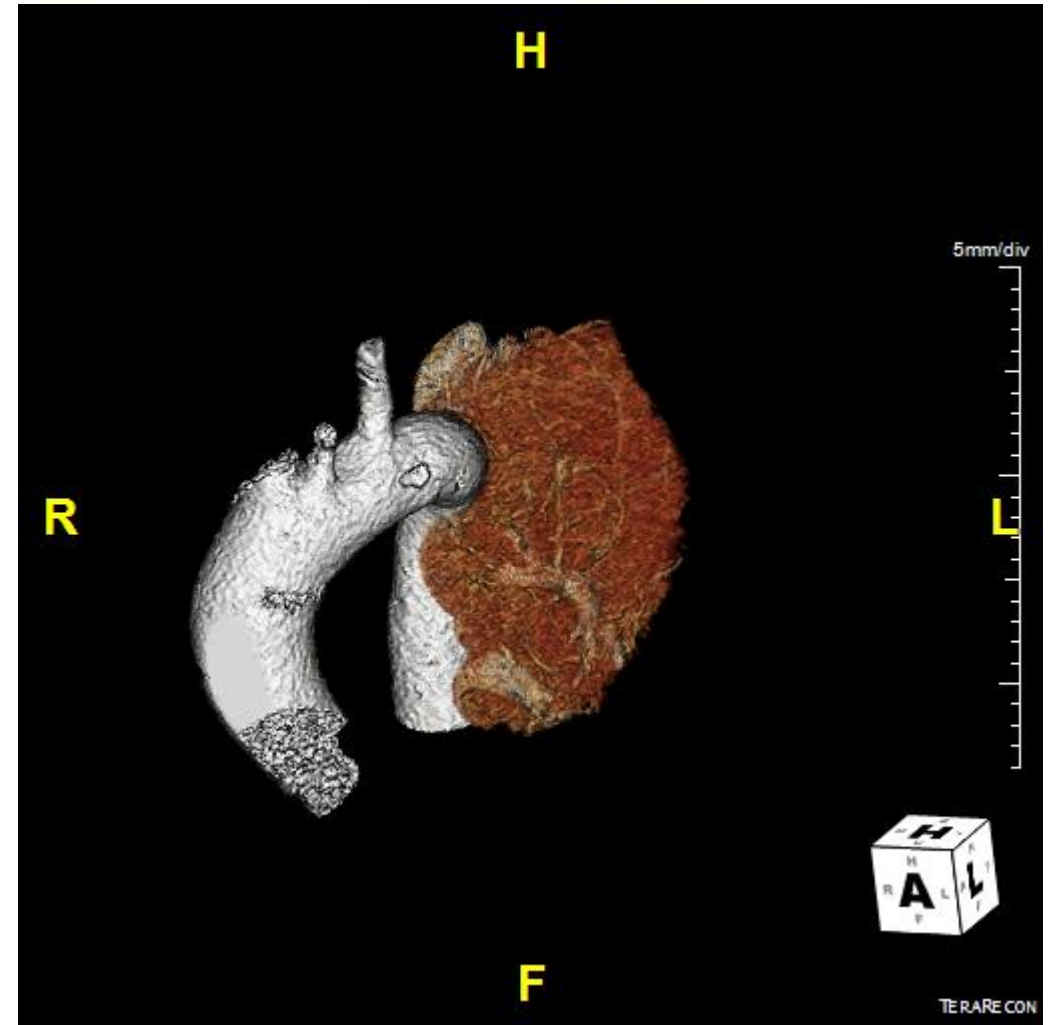
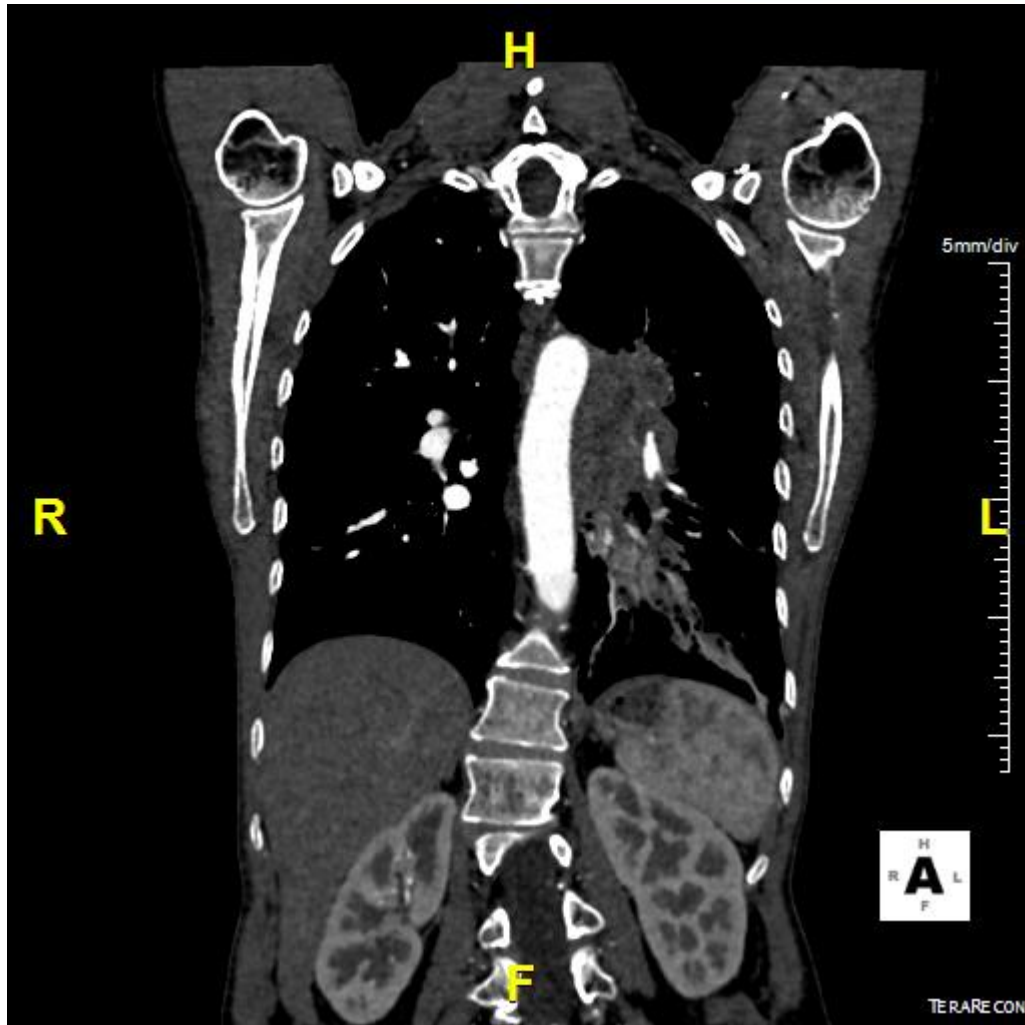
TEVAR and NSCLC / T4 resection

Case 1



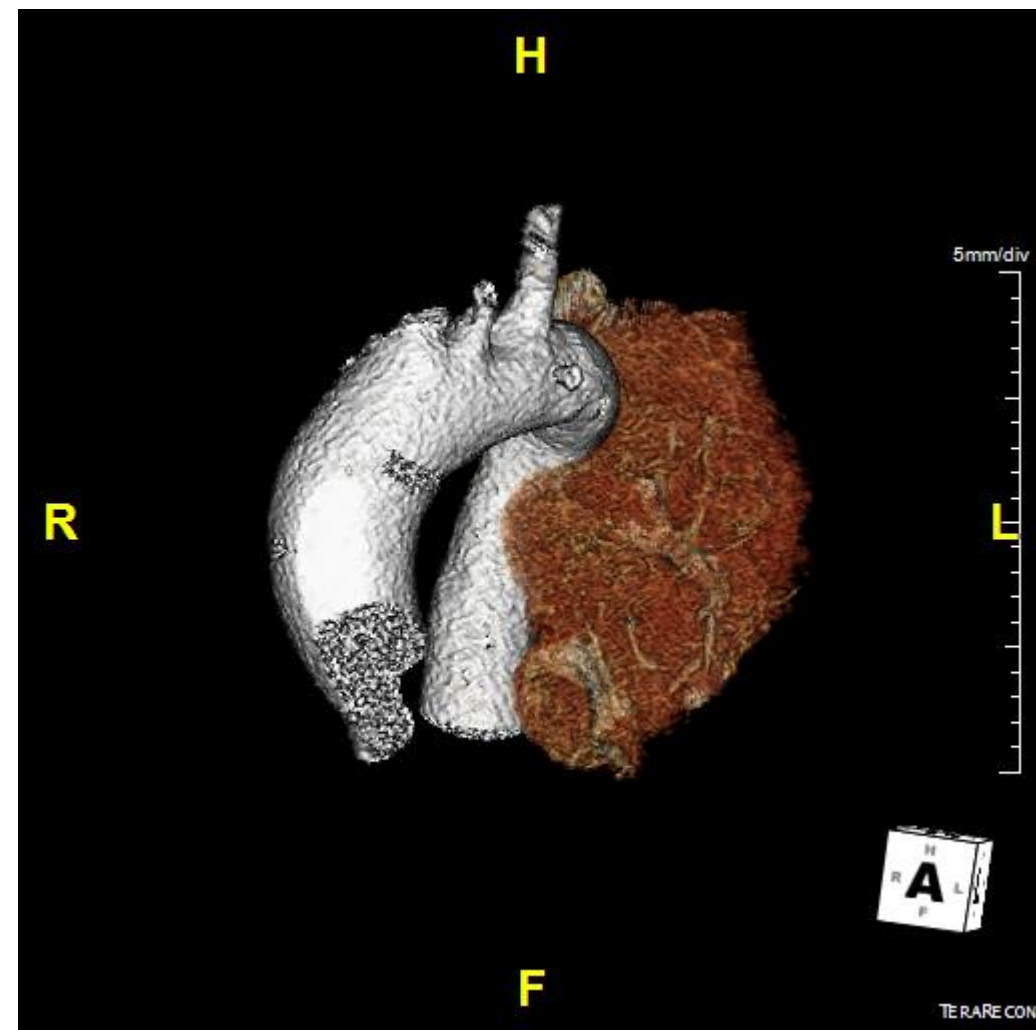
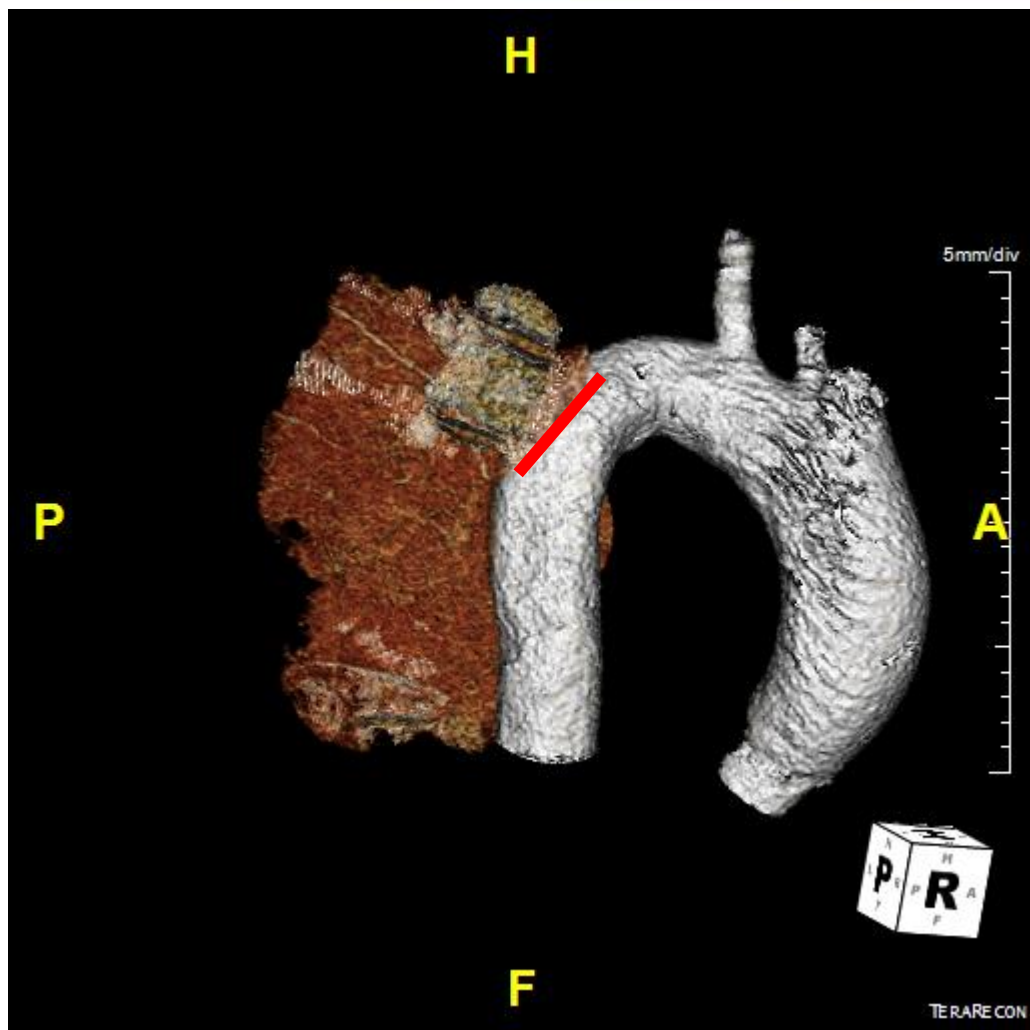
TEVAR and NSCLC / T4 resection

Case 1



TEVAR and NSCLC / T4 resection

Case 1

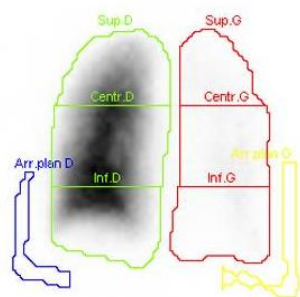


TEVAR and NSCLC / T4 resection

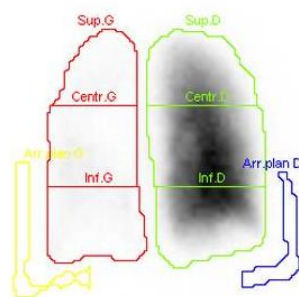
Case 1 V/Q scan + EUS

	G %	D%
1/3 SUPERIEUR	1,72	19,19
1/3 MOYEN	3,12	49,88
1/3 INFERIEUR	2,17	23,94
TOTAL	7,00	93,00

PERFUSION



FACE ANT



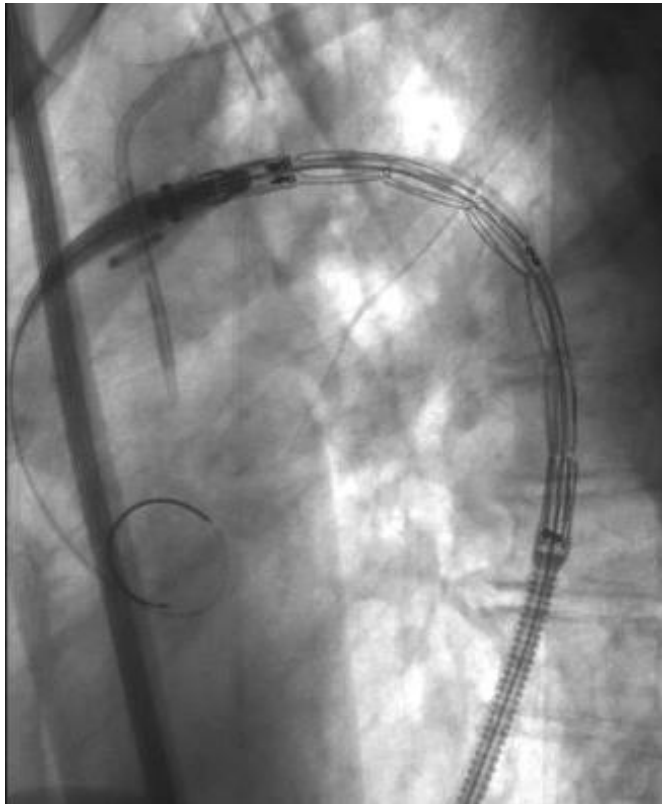
FACE POST

EUS:
oesophageal
involvement 15 mm

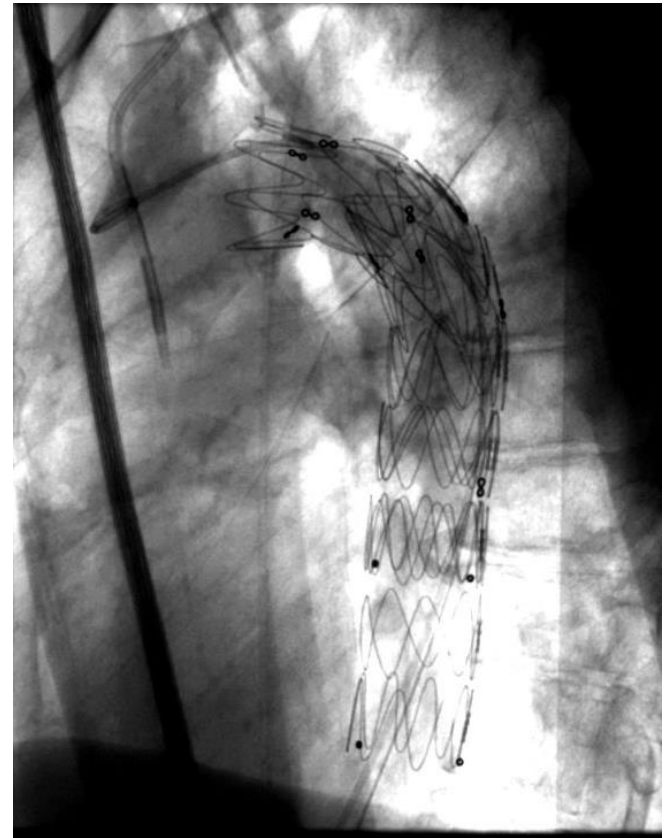
Adventitial aortic
involvement 25 mm

TEVAR and NSCLC / T4 resection

Case 1 / TEVAR

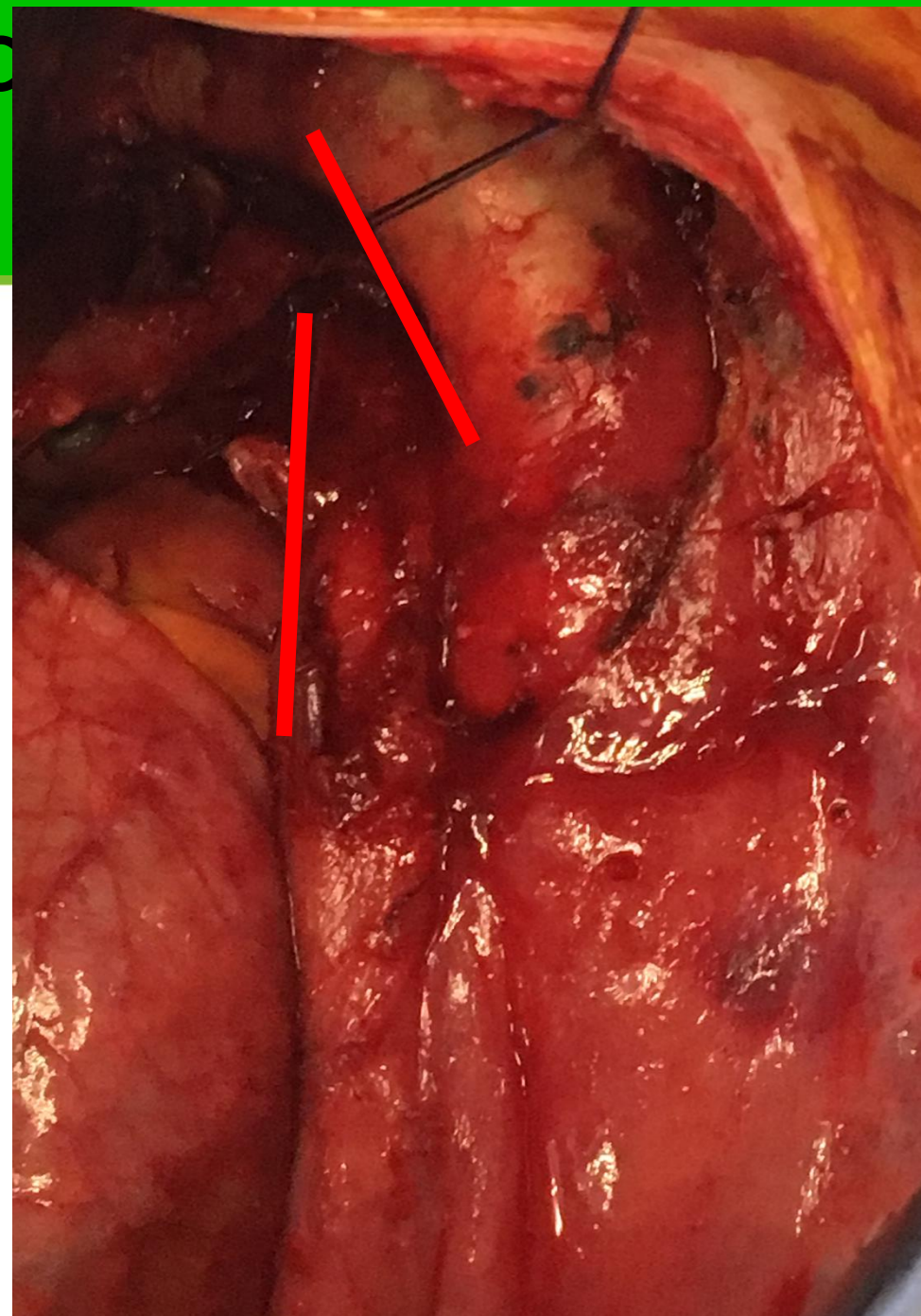
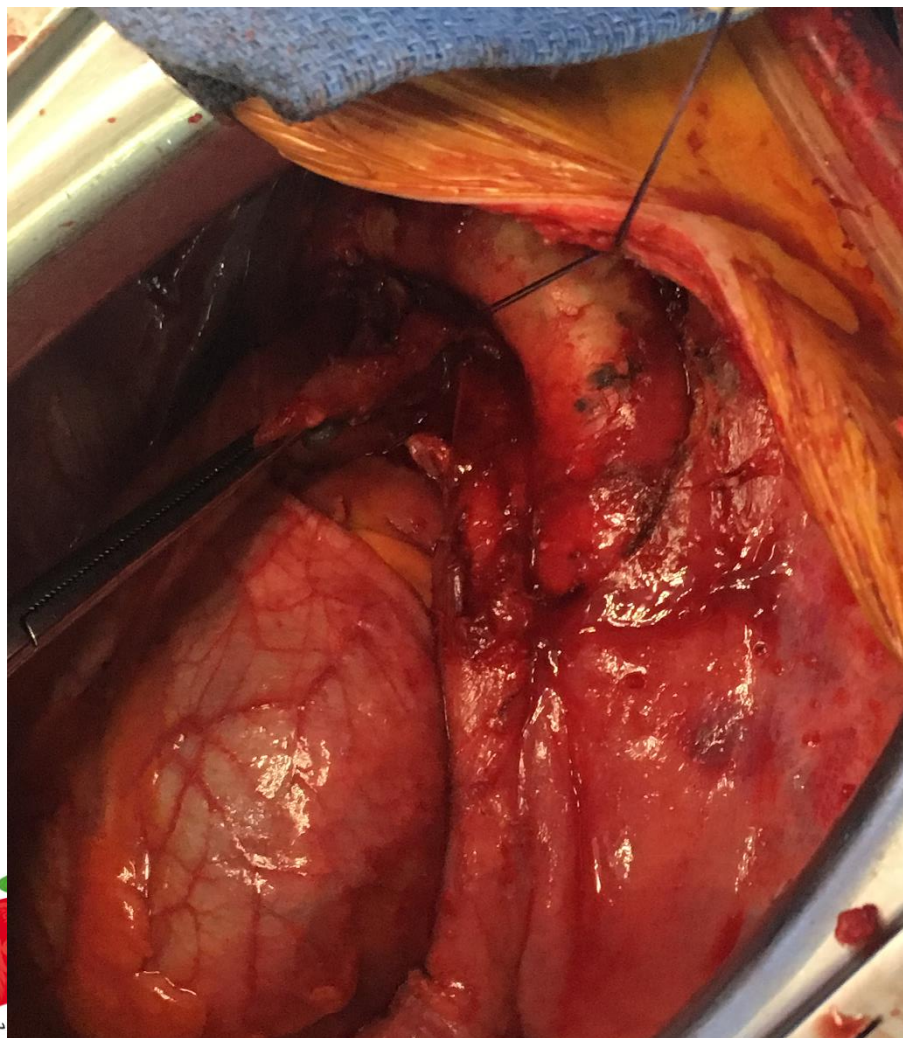


TEVAR
Percutaneous
Under fusion imaging
Medtronic Valiant
15% Oversizing





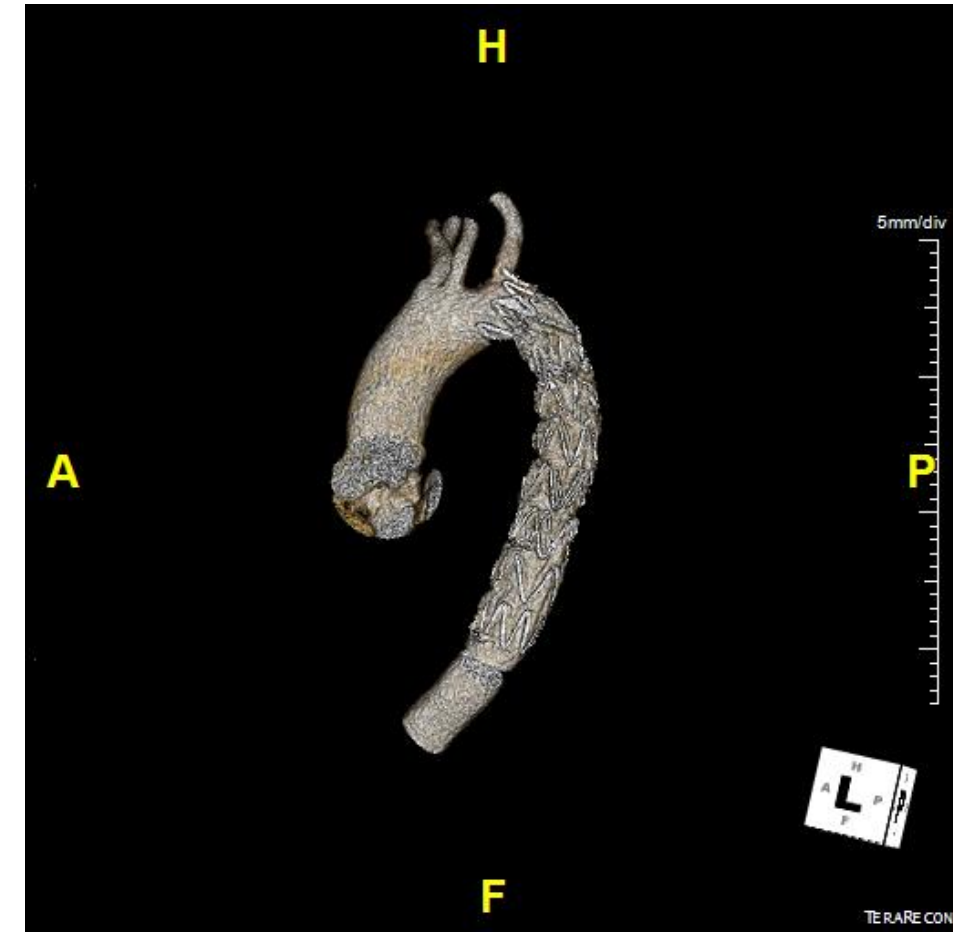
TEVAR and NSCLC / T4 resection Case 1



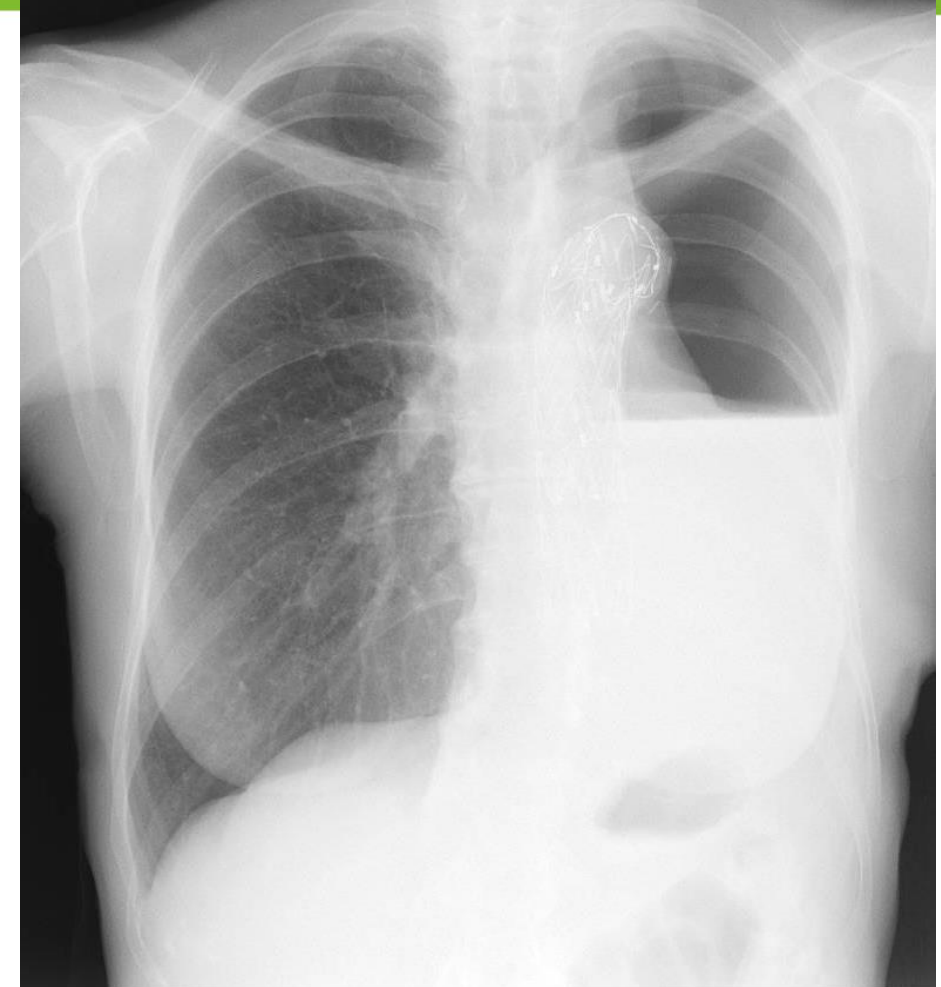
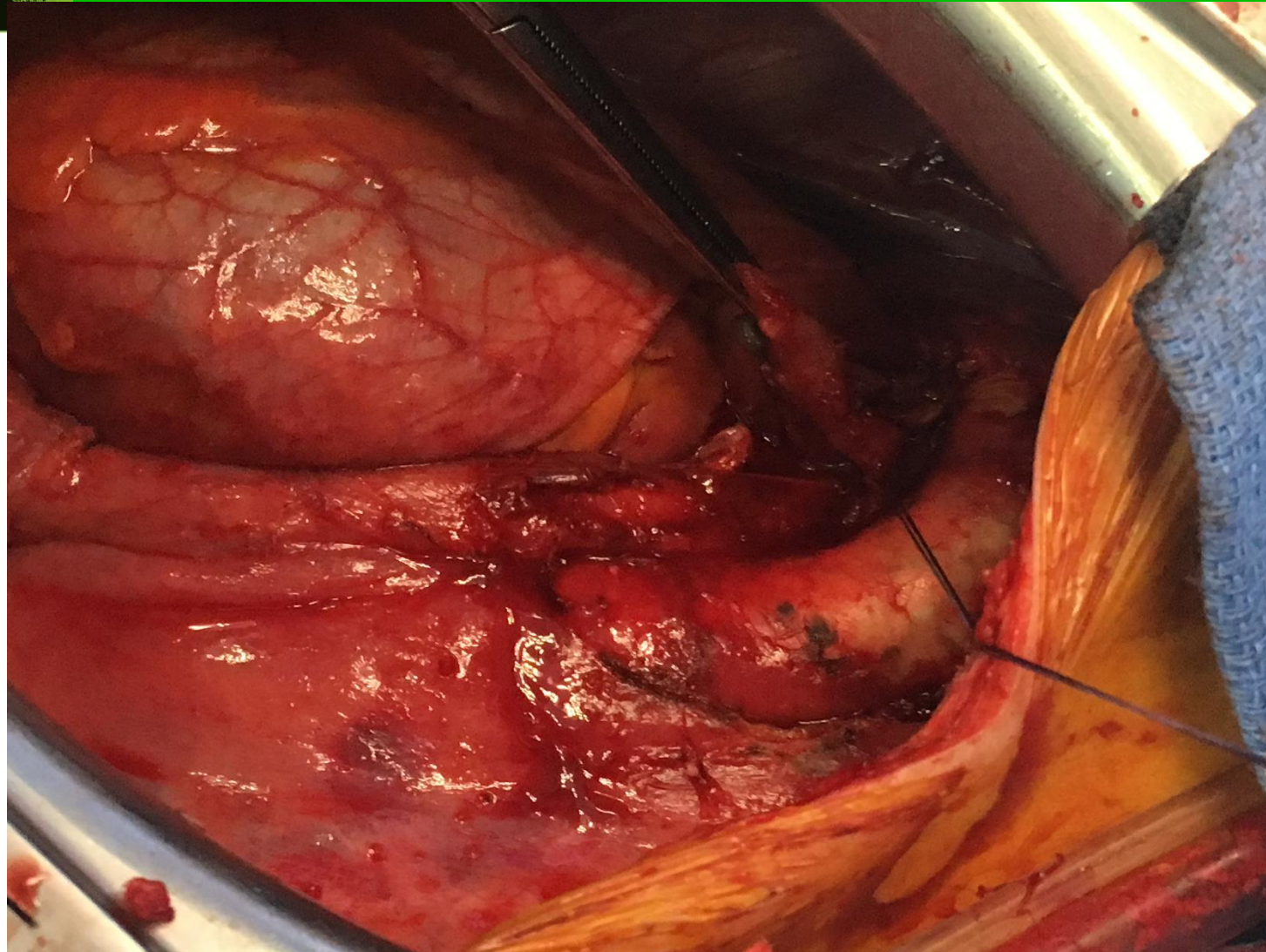
TEVAR and NSCLC / T4 resection

Case 1

- Intrapericardial Left pneumonectomy extended to the oesophagus 15 mm, aortic adventitia 25 mm,
- Radioopaque metallic clip marking for adjuvant radiation therapy
- pT4N1MO / RO resection / PDL-1:80%
- Oncologic multidisciplinary meeting:
 - Adjuvant RT and 4 cycles of chemotherapy (Cisplatin / Navelbine) Pearls protocol inclusion (Immunotherapy vs placebo)



TEVAR and NSCLC / T4 resection Case 1





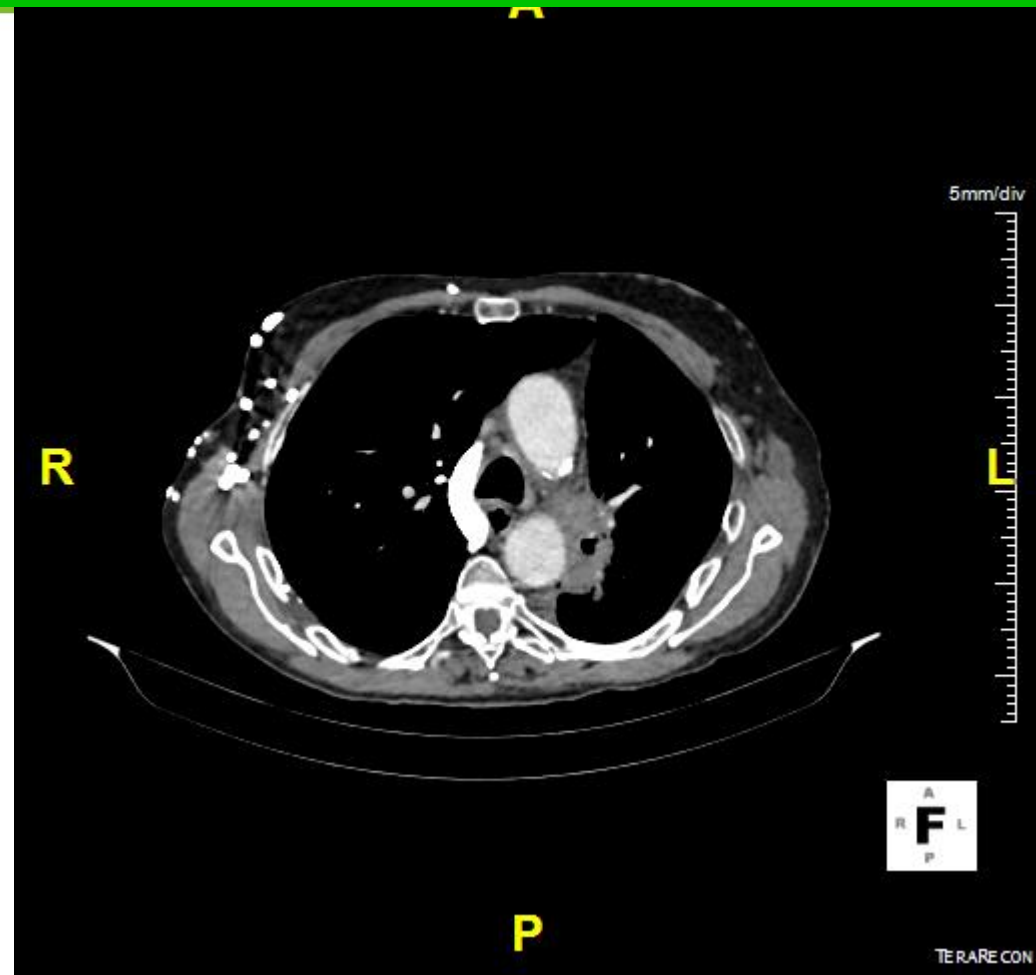
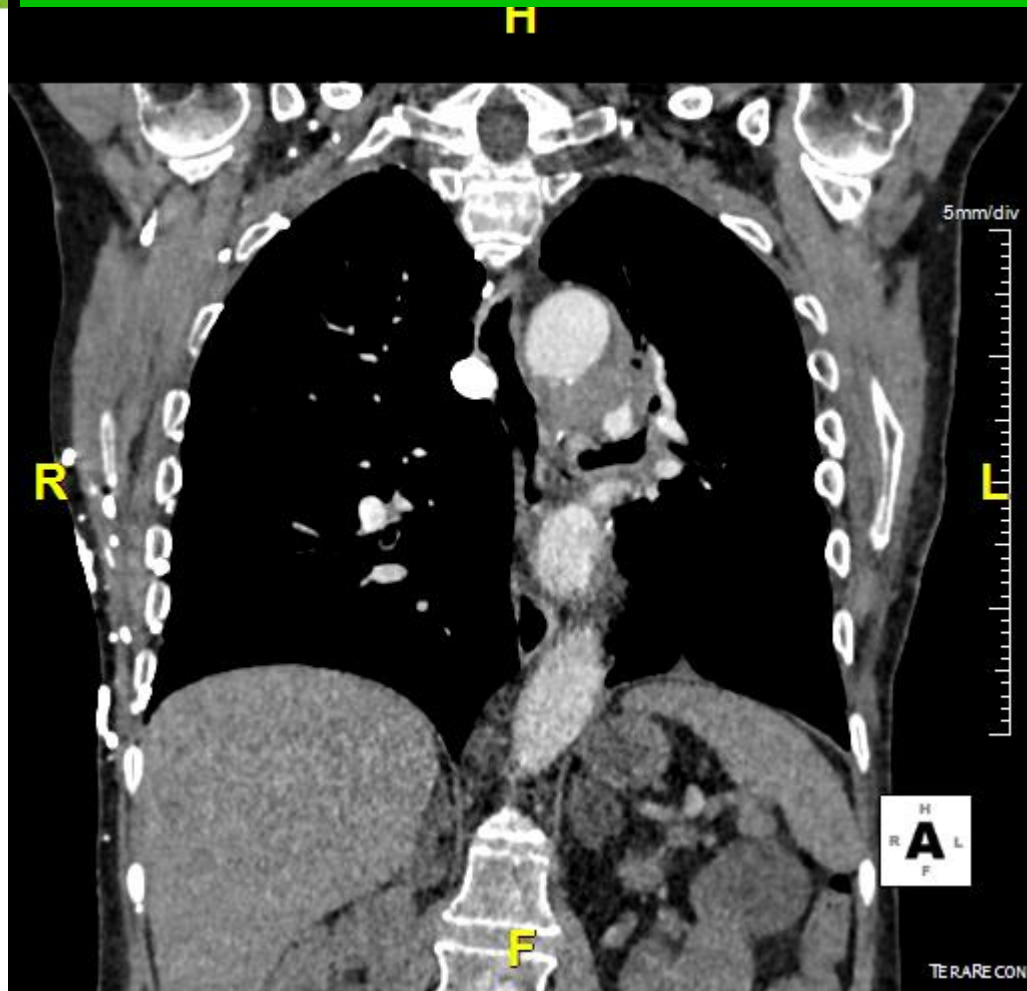
TEVAR and NSCLC / T4 resection

Case 2

- 68 years old men
- Previous Left lower lobectomy
- Left upper lobe epidermoid carcinoma
- 2016: T3N1MO
- Adjuvant Chemo and radiation therapy
- 2018 total Laryngectomy / T3NOMO epidermoid
- CT4NOMO
- EUS: oesophagal and adventitial involvement of the aorta

TEVAR and NSCLC / T4 resection

Case 2



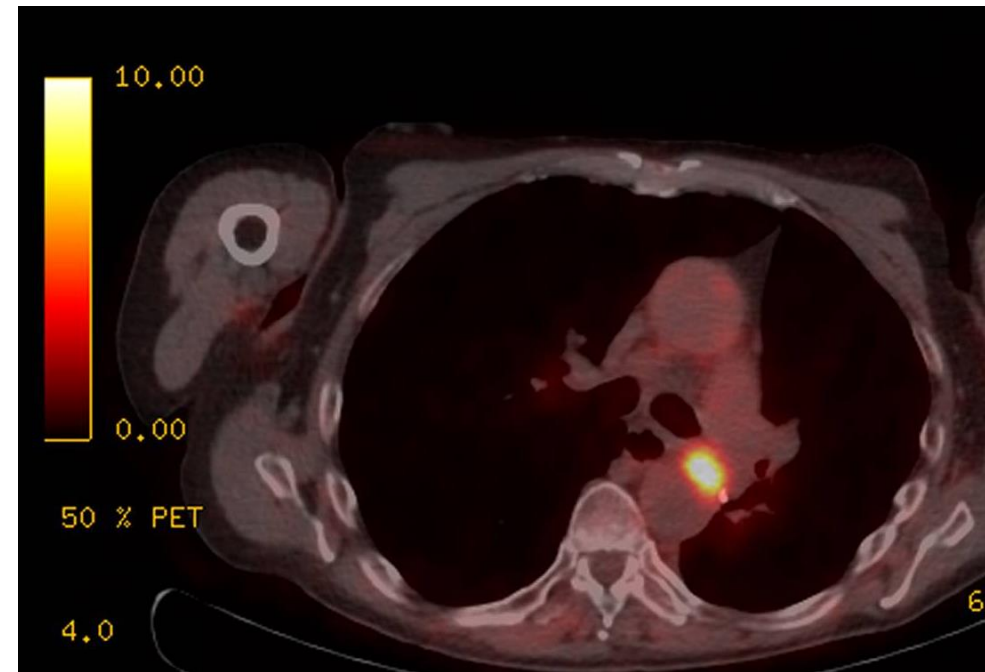
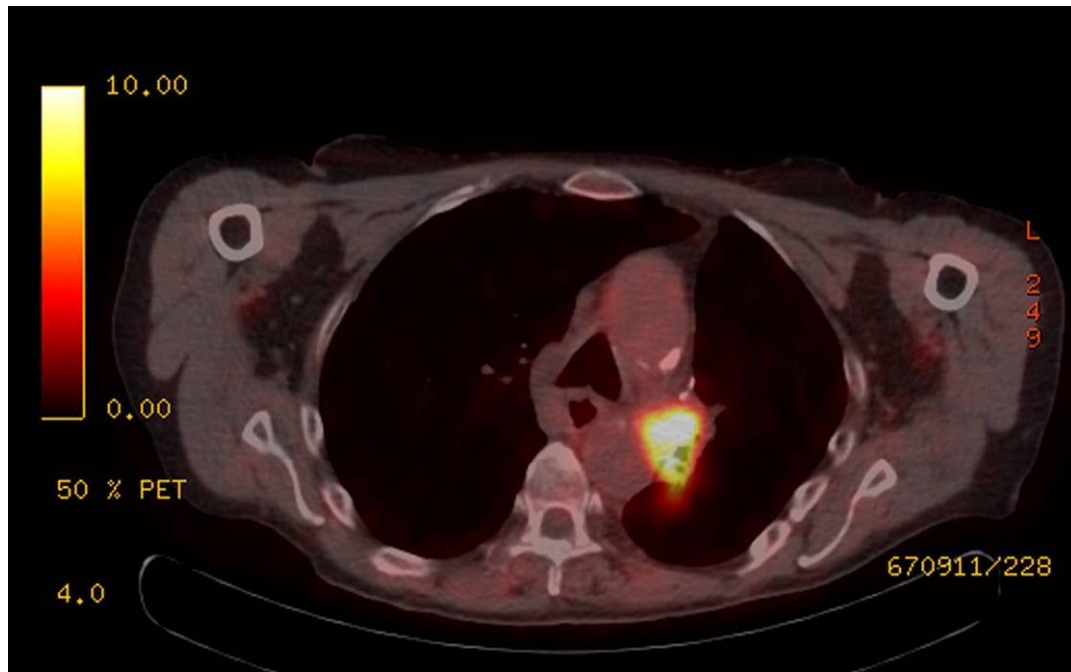
TEVAR and NSCLC / T4 resection

Case 2



TEVAR and NSCLC / T4 resection

Case 2



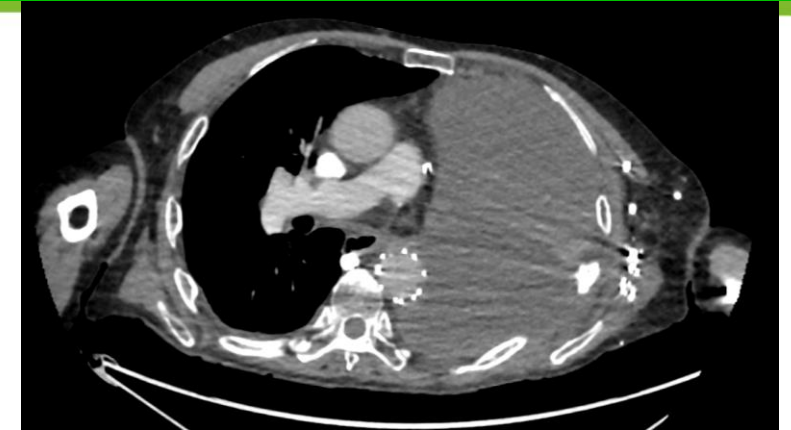
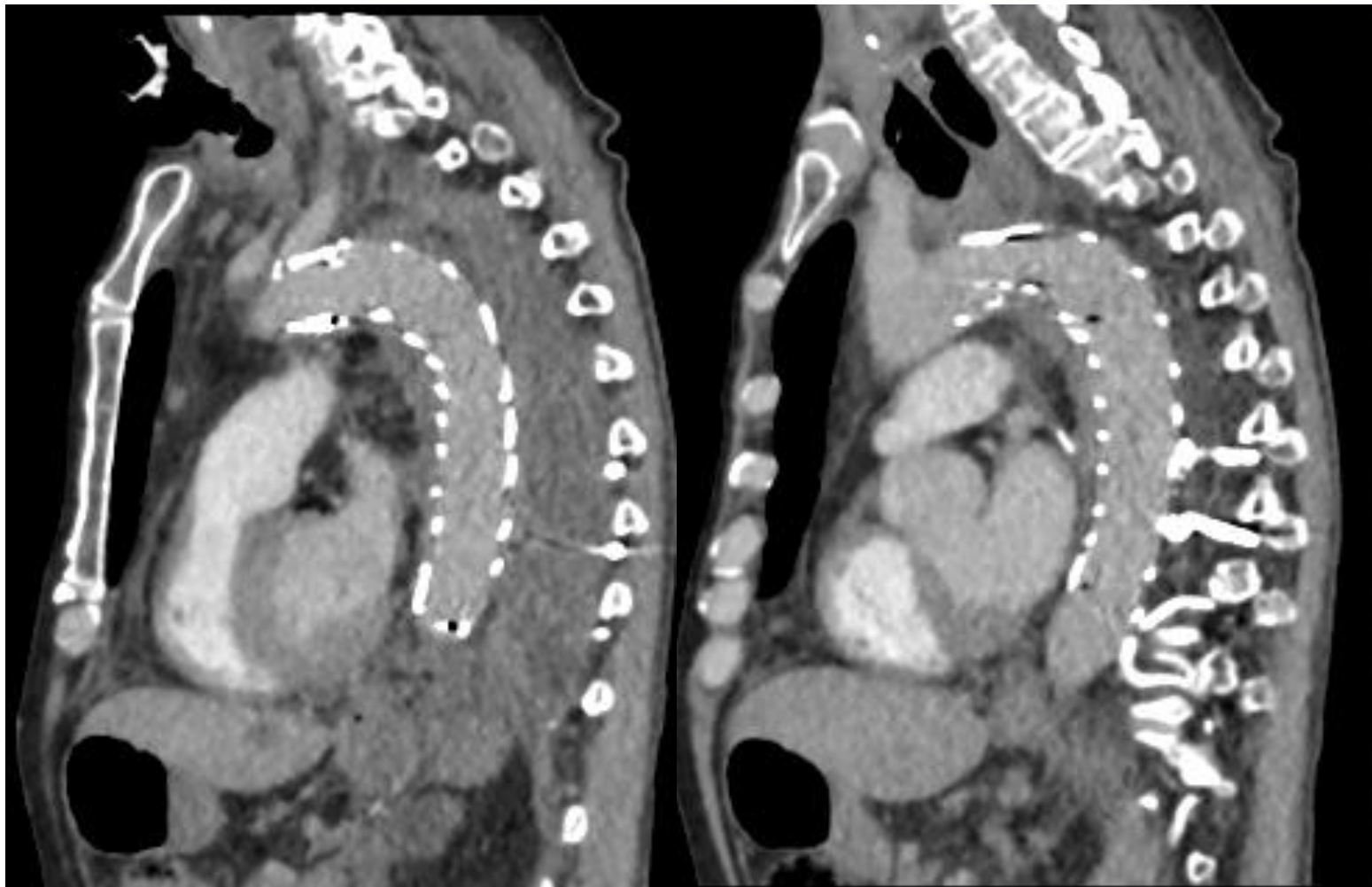
TEVAR and NSCLC / T4 resection Case 2



TEVAR
Percutaneous
Under fusion imaging
Cook alpha
15% Oversizing



TEVAR and NSCLC / T4 resection Case 2



pT4N1M0
No adjuvant therapy
1 year FU
No recurrence

Patients characteristics / Lung cancer and TEVAR 2012 /2019

Patient number	Age (years)	Sex	Histology	<u>cTNM</u>
1	61	Female	pulmonary epidermoid carcinoid	cT4N0M0
2	68	Male	pulmonary epidermoid carcinoid	cT4N0M0
3	41	Male	Pulmonary <u>undifferentiated</u> carcinoma	cT4N0M0
4	71	Female	pulmonary epidermoid carcinoid	cT4N0M0
5	69	Male	pulmonary epidermoid carcinoid	cT3N1M0
6	64	Male	Aorto-enteric fistula after Lewis-Santi for esophageal adenocarcinoma	cT3N1M0
7	54	Male	Aorto-enteric fistula after Lewis-Santi	cT4N0M0

- 7 pts.
 - 5 Lung Cancer
 - 2 Oesophagectomy / lung resection
- Median follow up was 14 months.
- 6 RO / 1 R1
- 6 still alive
- One death 7 months after initial surgery because of metastatic progression.
- In the five patients treated for lung tumor, all were alive and free from recurrence at follow up.

Resection procedures

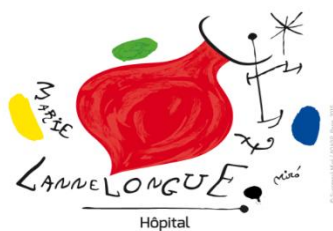
Patient number	Endograft type	Endograft length (cm)	Landing zone*	<u>Resection margins</u>
1	Medtronic Valiant	229	3	R0
2	Medtronic Valiant	207	3	R1
3	Cook Zenith Alpha	209	1	R0
4	Cook Zenith Alpha	105	3	R0
5	Medtronic Valiant	107	2	R0
6	Medtronic Valiant	200	3	R0
7	Medtronic Valiant	100	3	R0

There was no endograft related complication during follow up: no spinal cord ischemia, no retrograde aortic dissection and no septic complications.

Intra-hospital postoperative outcomes and long-term results

Patient number	Endograft related complications	Resection related complications	Adjuvant therapy	Recurrence	Survival at last follow-up	Follow-up (months)
1	none	none	CT	no	yes	1
2	none	surgical hemostasis revision	-	no	yes	4
3	none	none	-	no	yes	14
4	none	none	CT	no	yes	18
5	none	none	CT	no	yes	62
6	none	none	-	no	no	5
7	Persistent bleeding of an intercostal artery	none	CT + RT	systemic	yes	45

CT: Chemotherapy; RT: radiotherapy





Optimal delay between TEVAR and aortic wall resection

- not known.
- was performed during the same hospitalization in 3 cases (during the same day in 1 case) and was delayed in 2 cases.
- Median aortic coverage length was 140 [106 – 203] cm.
- We had never performed aortic endografting and resection during the same anesthesia.
- This lapse of time allowed us to assess the patient both clinically and radiologically for potential complications of stent-grafting, such as **paraplegia** or access issues

Level of complication after CPB / TEVAR?

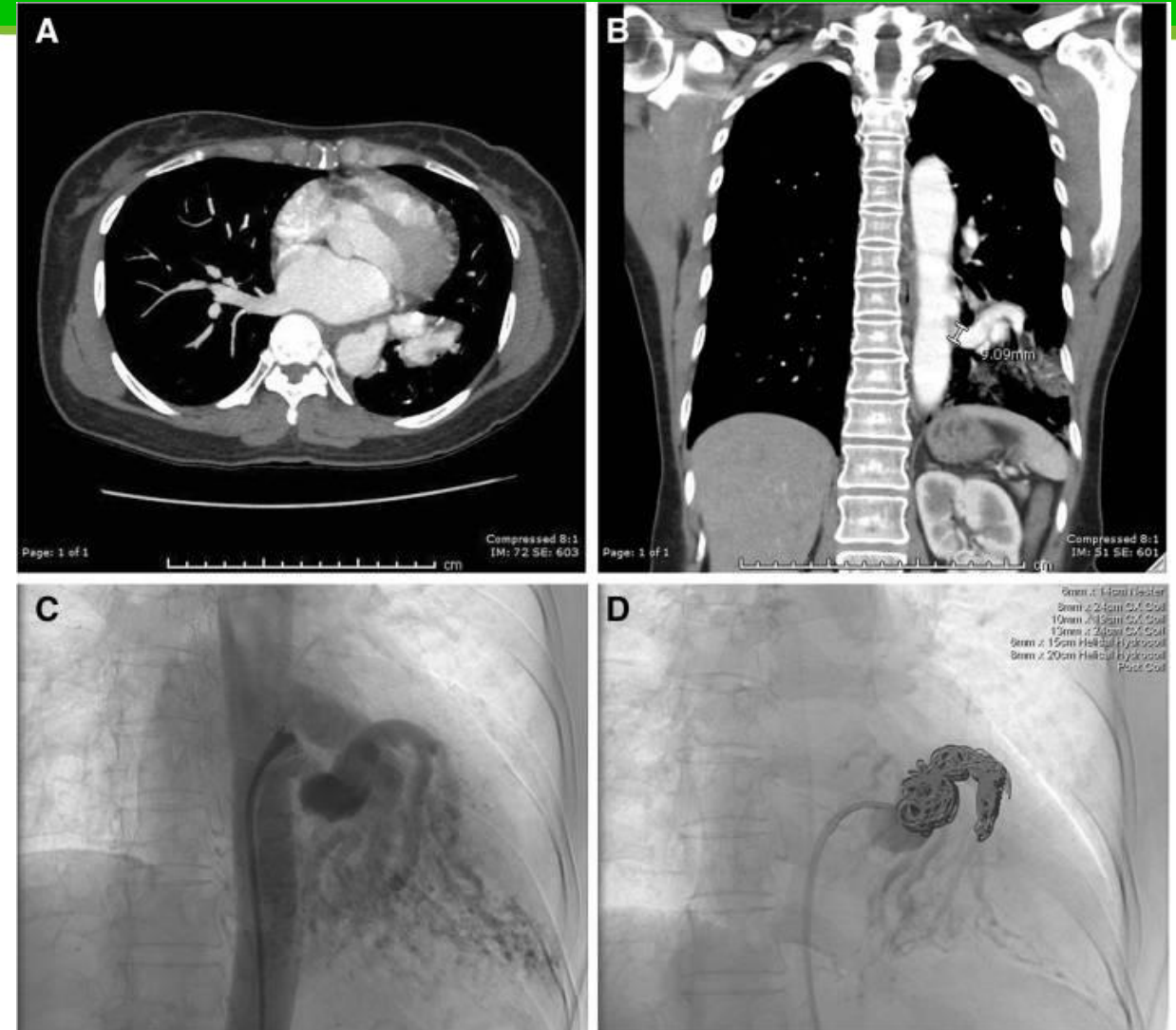
- The complication rate was 37.1% in the study by Marulli et al. in the total surgical resection group under cardiopulmonary bypass
- Marulli G, Rendina EA, Klepetko W, et al. Surgery for T4 lung cancer invading the thoracic aorta: Do we push the limits? J Thorac cardiovasc Surg 2017

Length of aortic coverage?

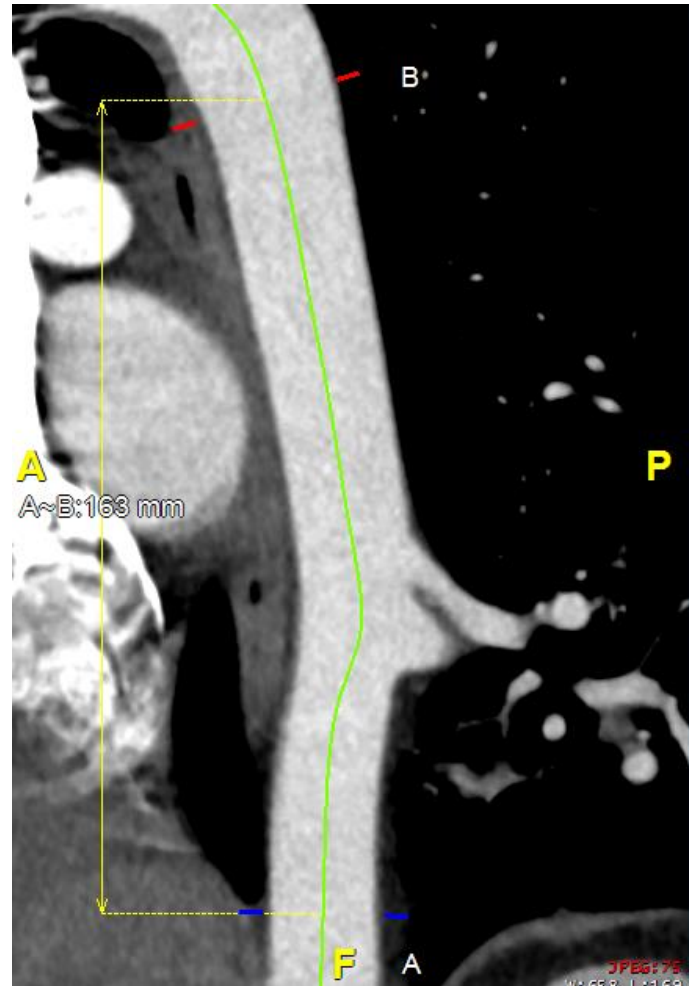
- A coverage zone of 2 cm seems to be sufficient to exclude the tumor*
 - with a safe proximal and distal margin of 4 cm of uninvolved aorta**
-
- Moeller P. *Instabilities in Aortic Length after TEVAR and Reoperation: 12 Years of Follow-up Imaging.* Ann Thorac Surg. 2019
 - Collaud S. *Thoracic aortic endografting facilitates the resection of tumors infiltrating the aorta.* J Thorac Cardiovasc Surg 2014

Sequestration / embolization or TEVAR

- Arterial embolization of PS could be considered when pulmonary lesion is small-sized.
- Endovascular stent-graft exclusion could be used to treat combined arterial aneurysm and dissection of PS.

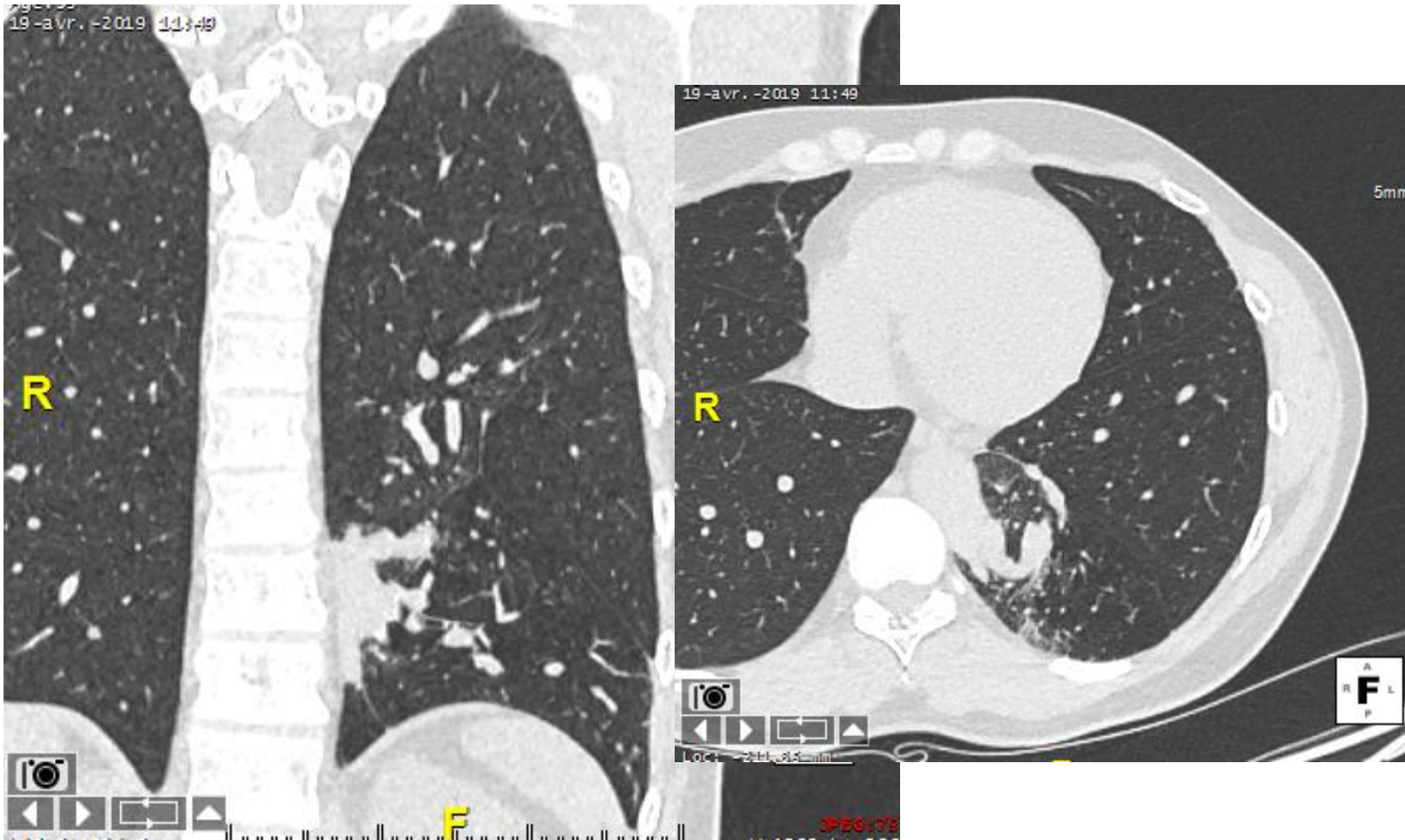


Minimally invasive treatment of Extralobar Sequestration / TEVAR+ VATS lobectomy



- 34 yrs old men
- Extralobar bronchopulmonary sequestration (BPS)
- 2 aneurysmal systemic arteries of 16 and 20 mm

Minimally invasive treatment of Extralobar Sequestration / TEVAR+ VATS lobectomy



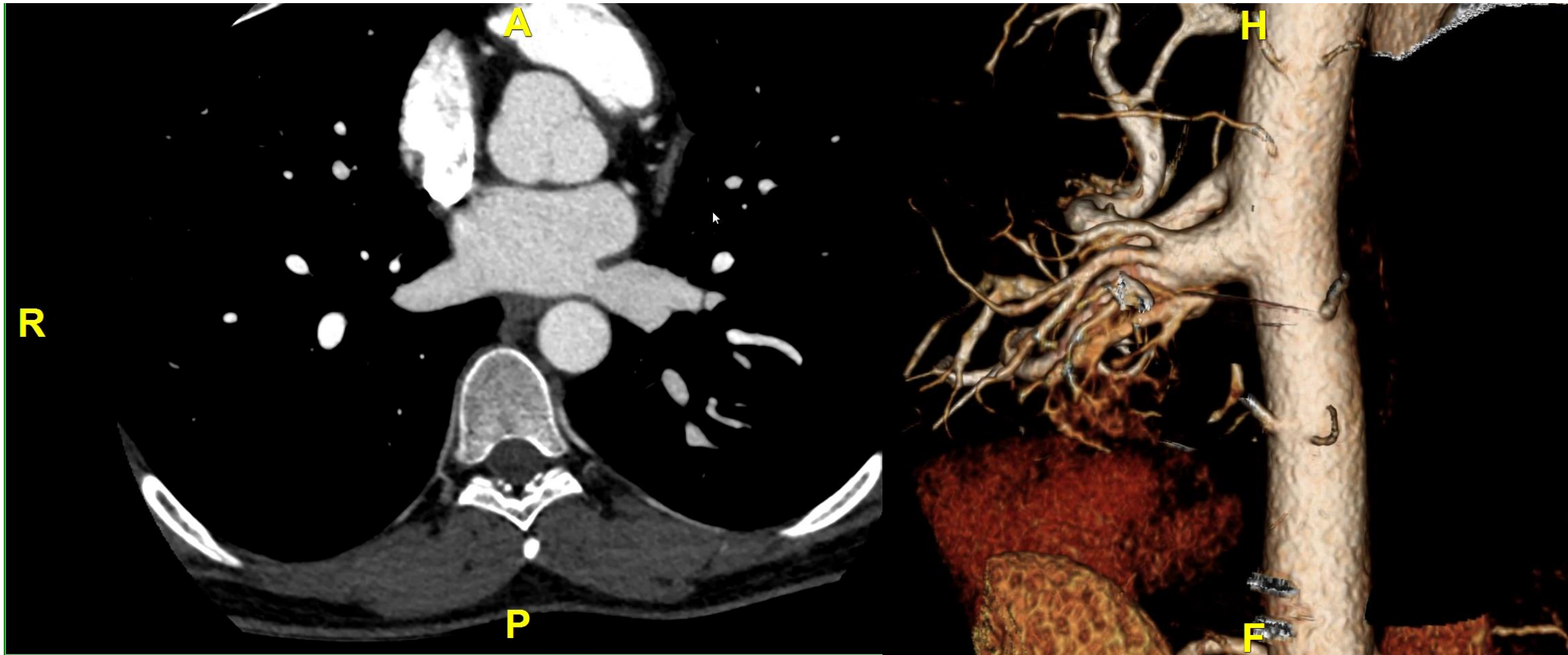
Congenital malformation of the lower respiratory tract
Rare (0,15 – 6,4% of all congenital pulmonary malformations)

Extralobar or Intra lobar (75%)

Extra lobar : separate pleural lining

Combined with aneurysmal feeding vessel even less common

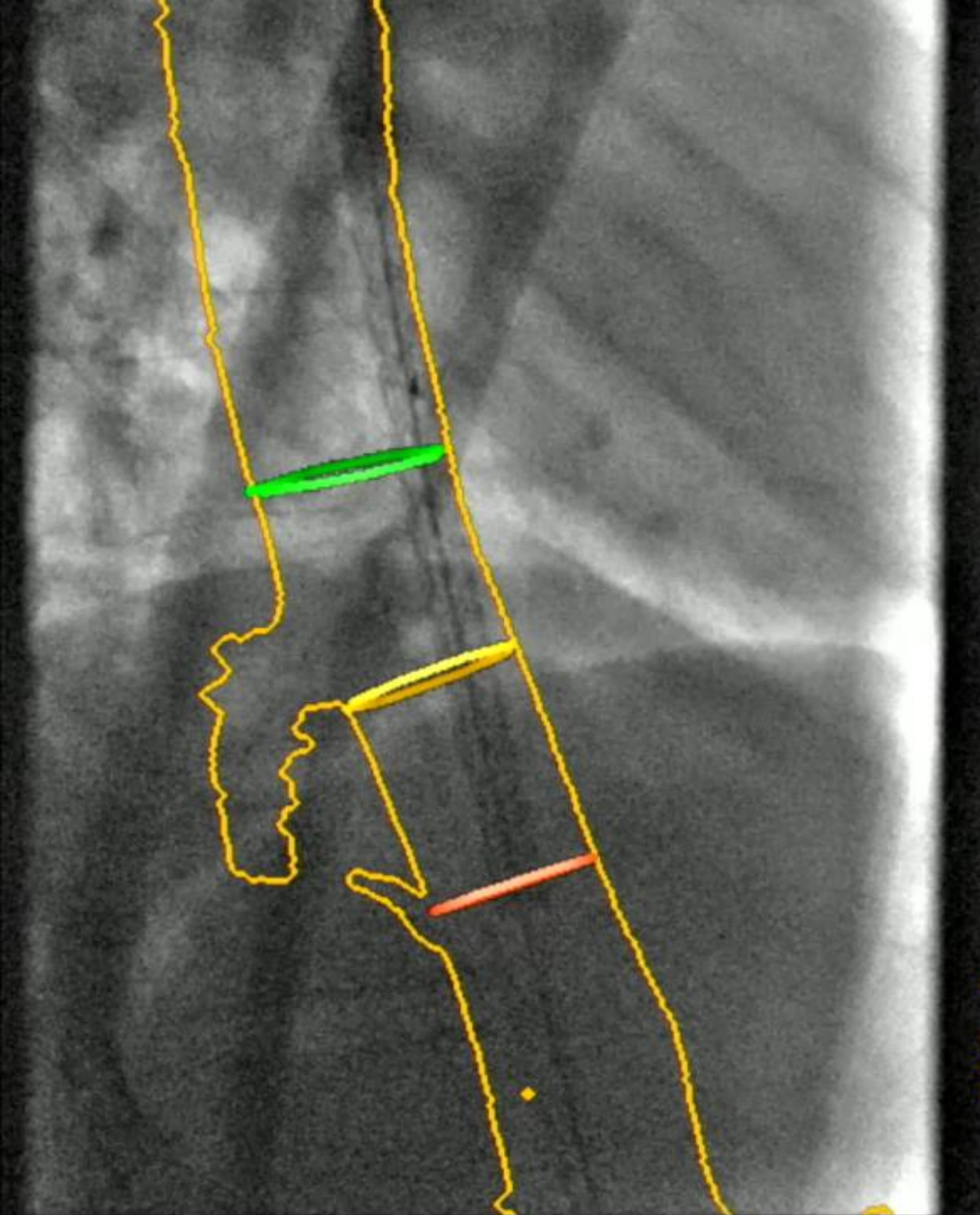
Minimally invasive treatment of Extralobar Sequestration / TEVAR+ VATS lobectomy





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FOV 4
RAO 6
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4% de 3 Gy
mGy/min 31.8
--BPM
40 cm
117 cm
↓17 cm
0 deg
RAO 63 deg
CRA 9 deg



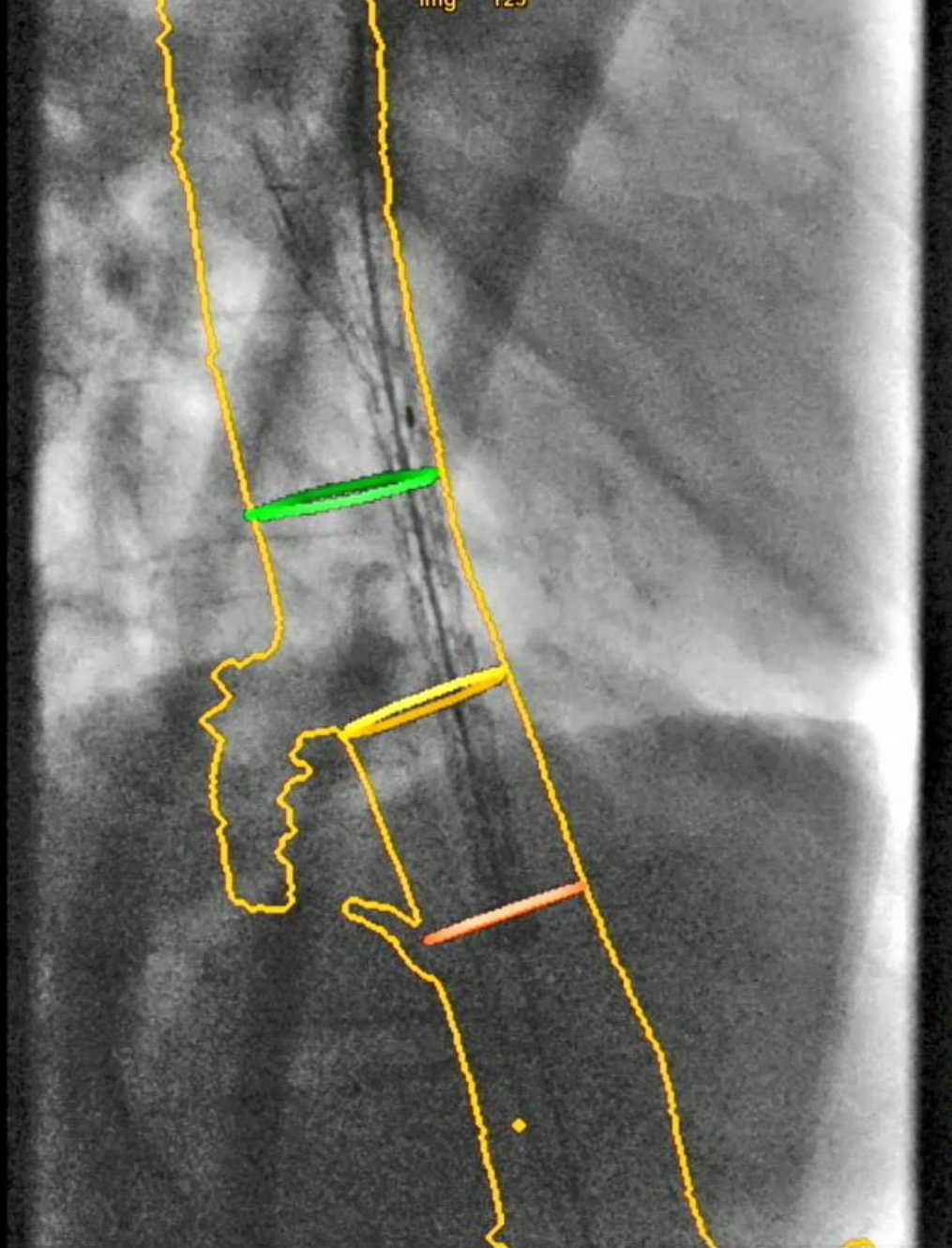
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université
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Zoom=1.3

CEDRIC



7% de 3 Gy
mGy/min 0

--BPM

40 cm
117 cm
↓17 cm

0 deg

RAO 63 deg
CRA 9 deg



FOV 4
RAO 6
CRA
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EVARVision

Dans l'examen Vision

Sélectionner 3D

Revue  Film

Verrouiller la revue   

Image 1 / 19

Sous-volume **Mini aorte**

Rendu **Contour**

Seuil : 0  1156 2939

Opacité 100 % 

Lancer 2 vues Rappel 2 vues

Outils avancés

 Annuler  Répéter

Trace artériel Réinit.

Zoom=1.3



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PIERRE-LOUIS
CEDRIC

695212
01-Jul-2019
PIERRE-LOUIS
CEDRIC



-- BPM

40 cm

117 cm

↓ 17 cm



0 deg

RAO 63 deg

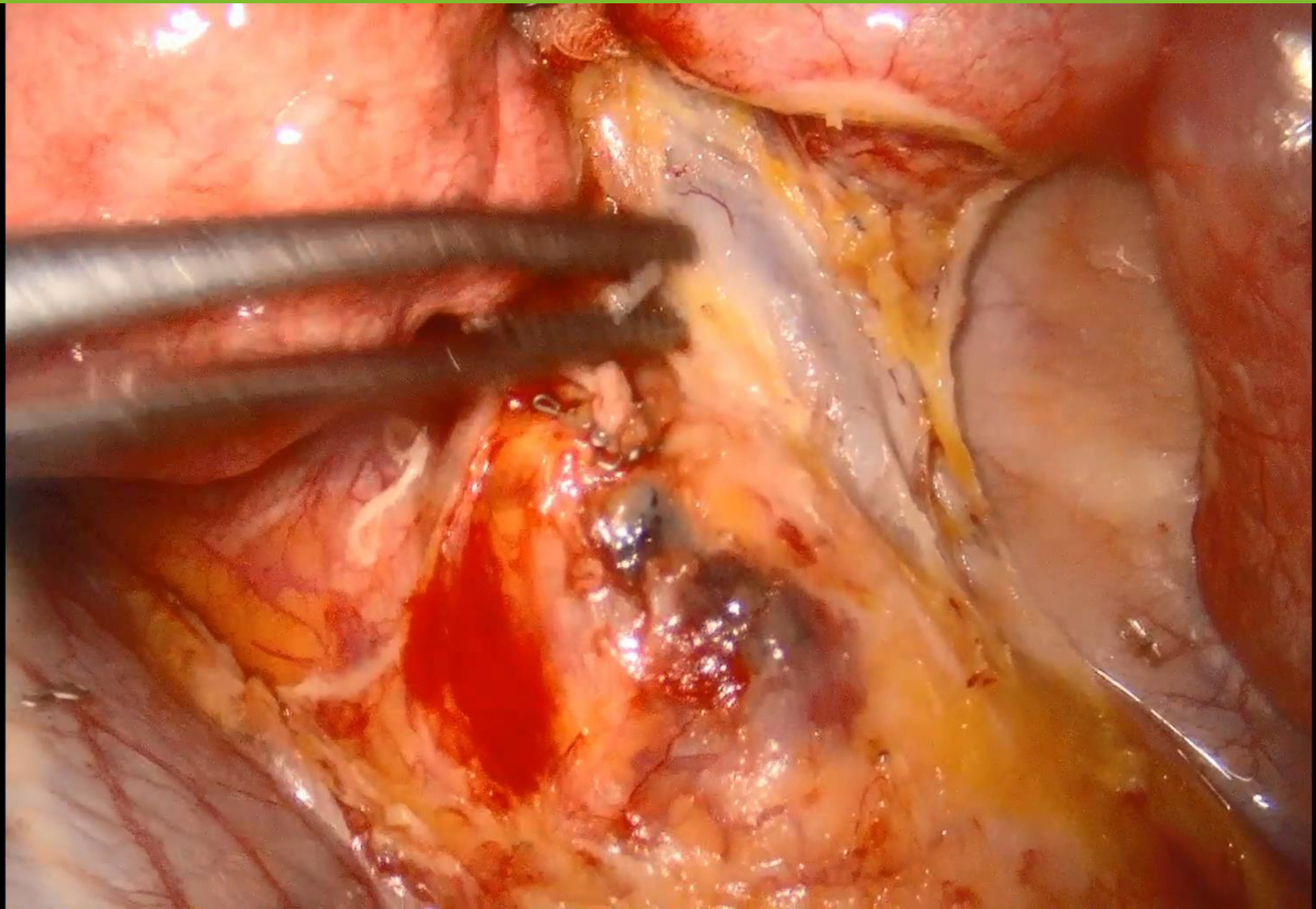
CRA 9 deg

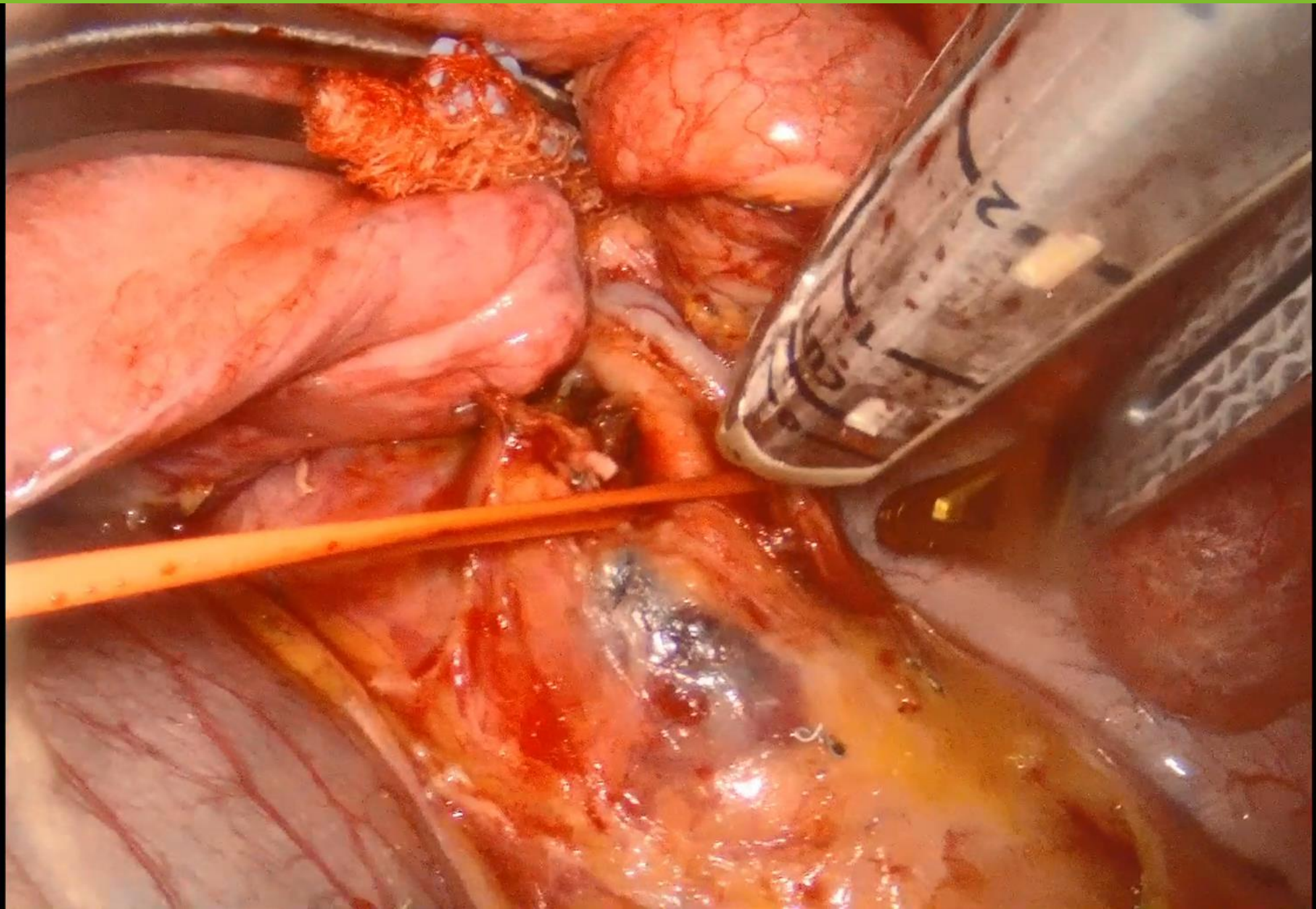


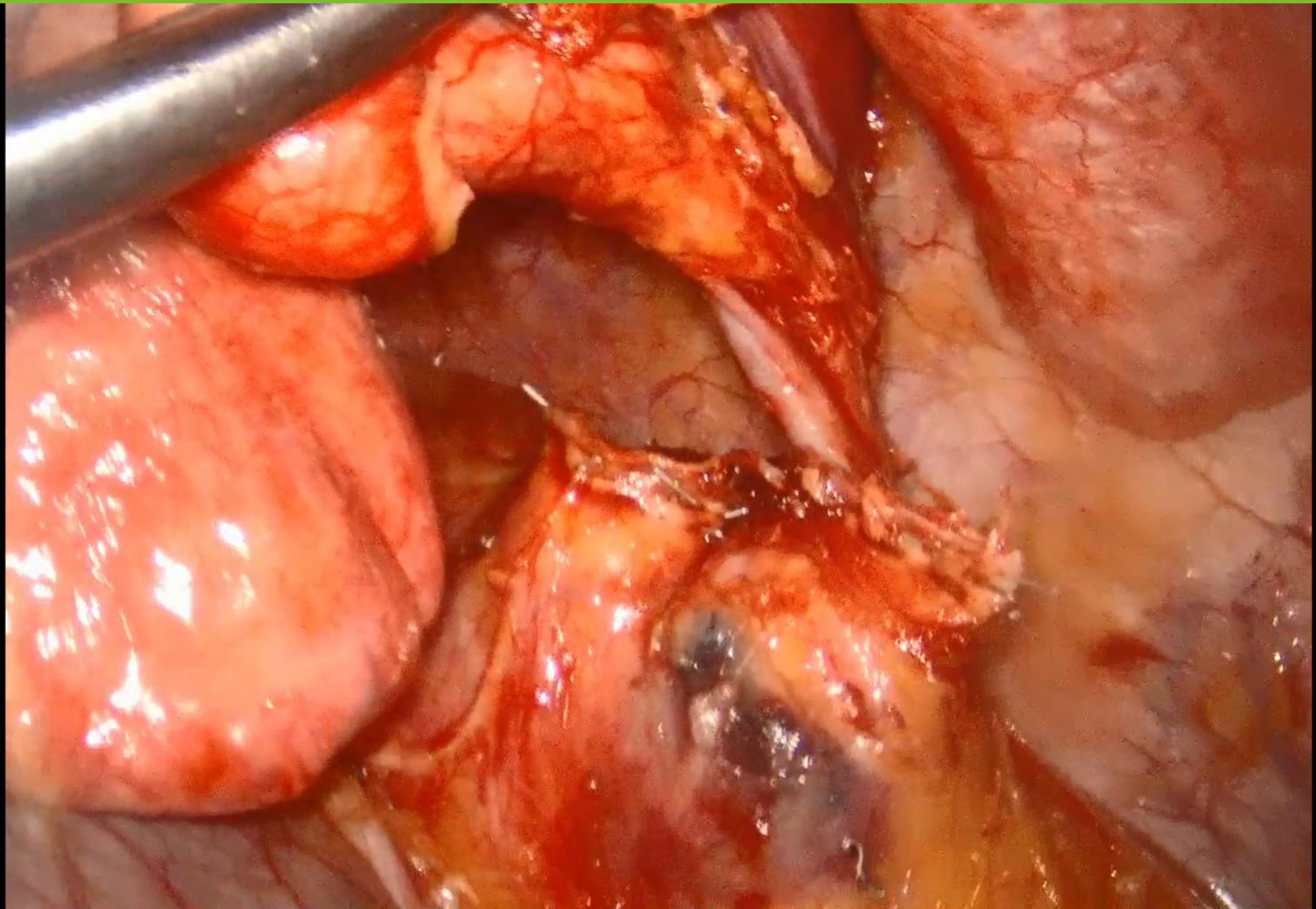
695212
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CRA L



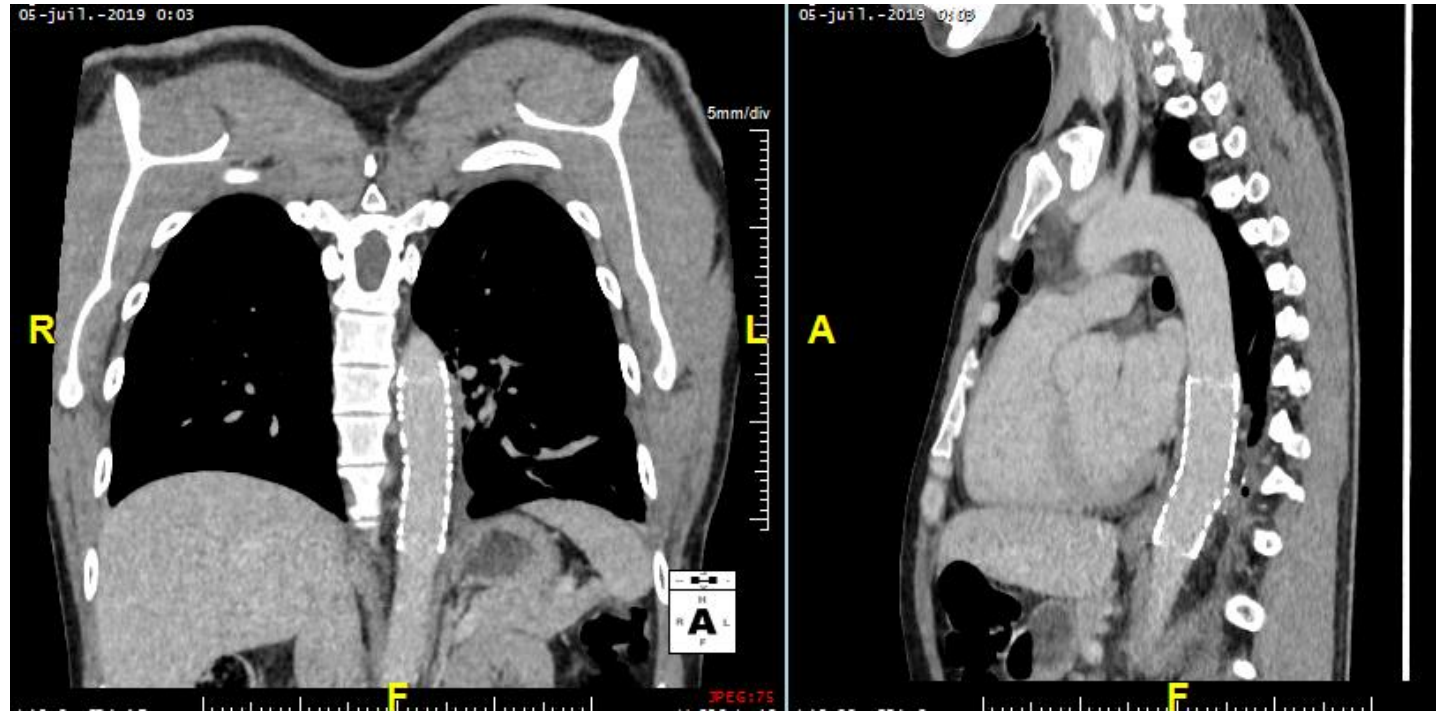




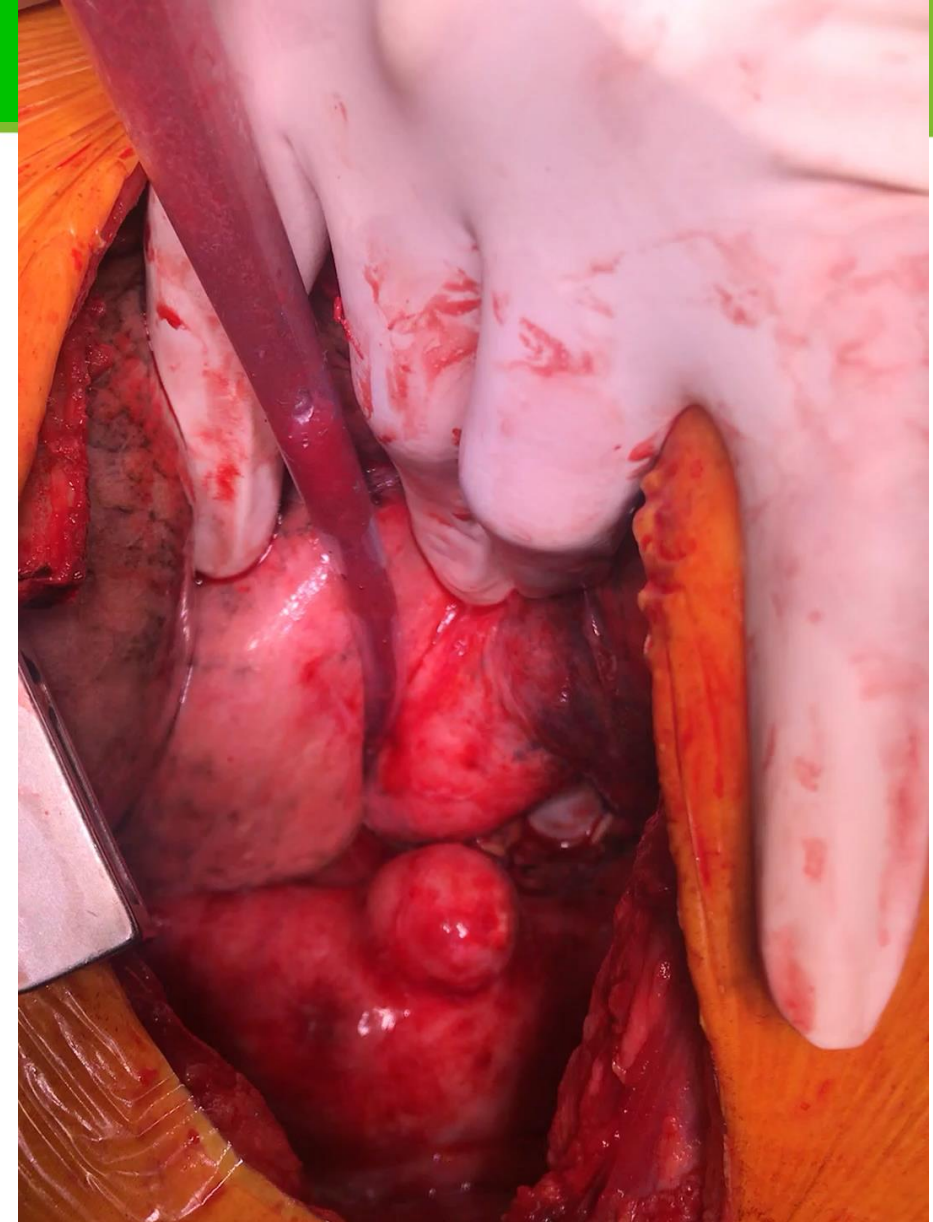
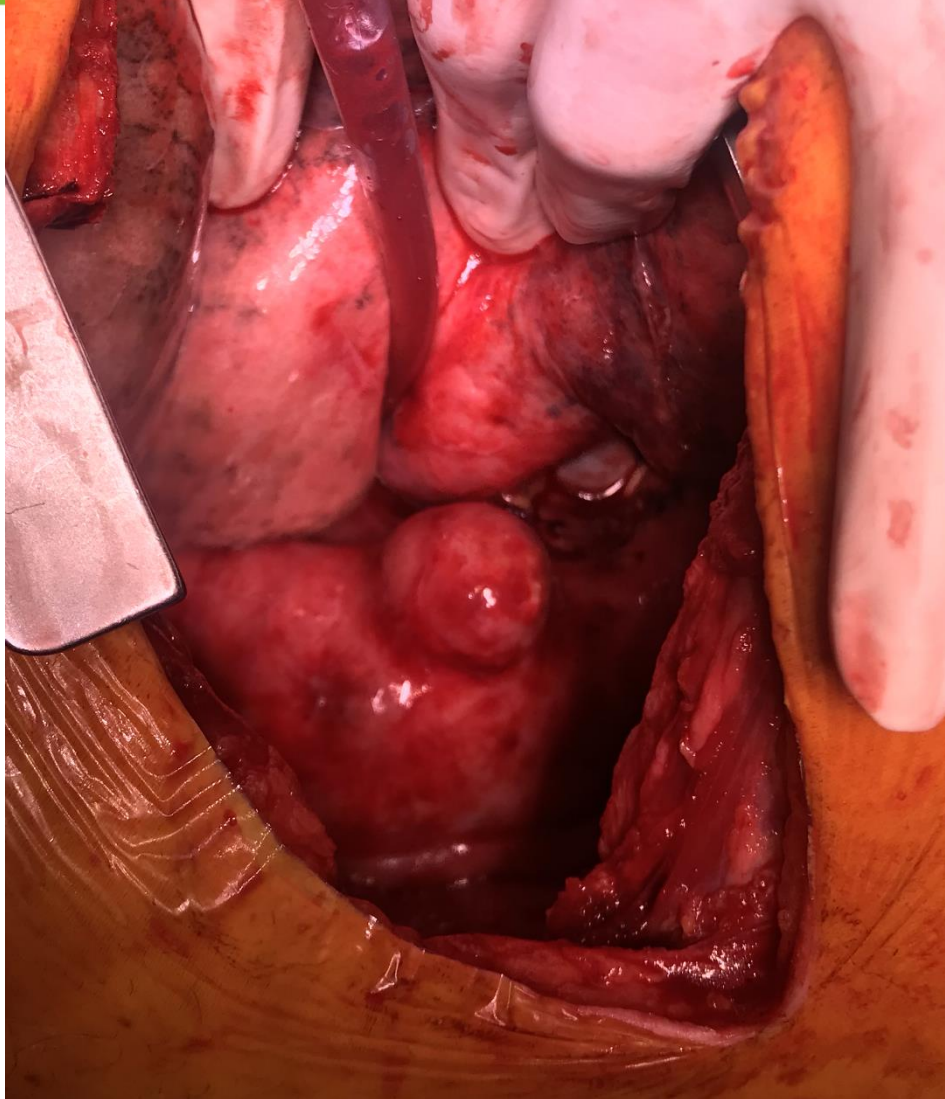


Minimally invasive treatment of Extralobar Sequestration / TEVAR+ VATS lobectomy

- No complications
- Control CT
- Discharged on day 5



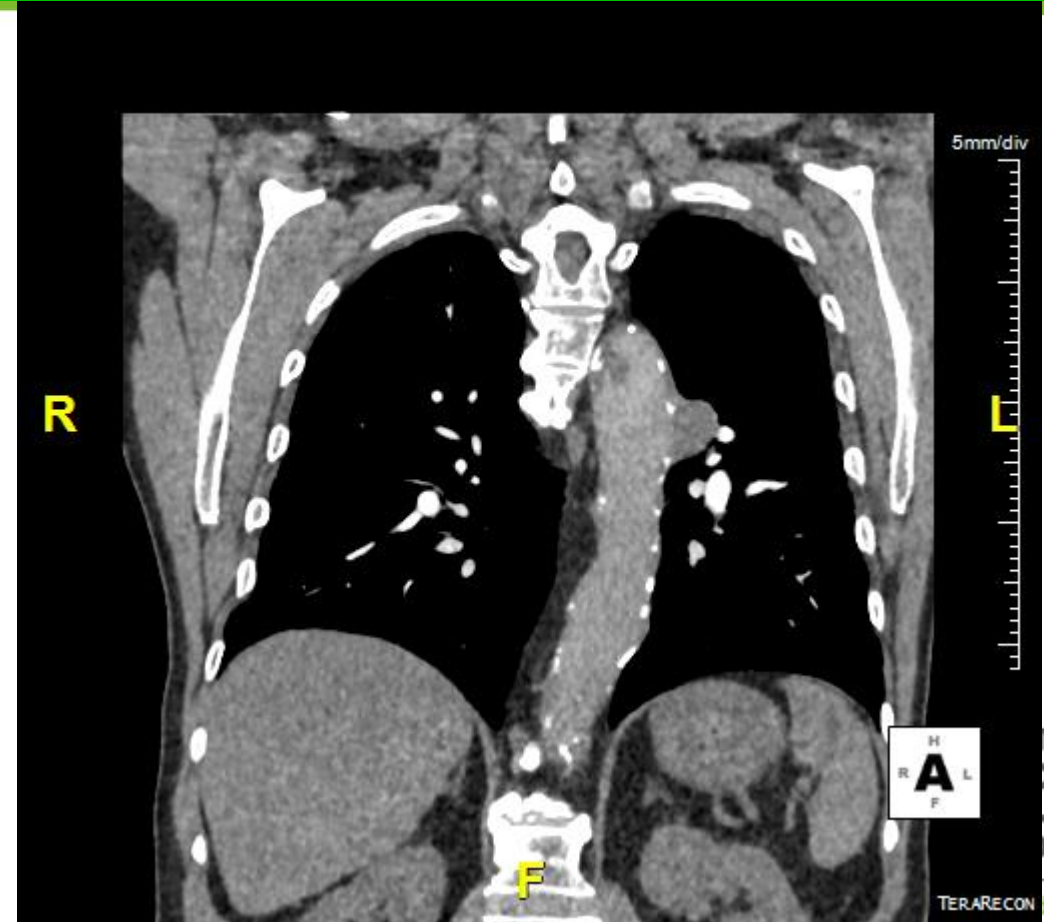
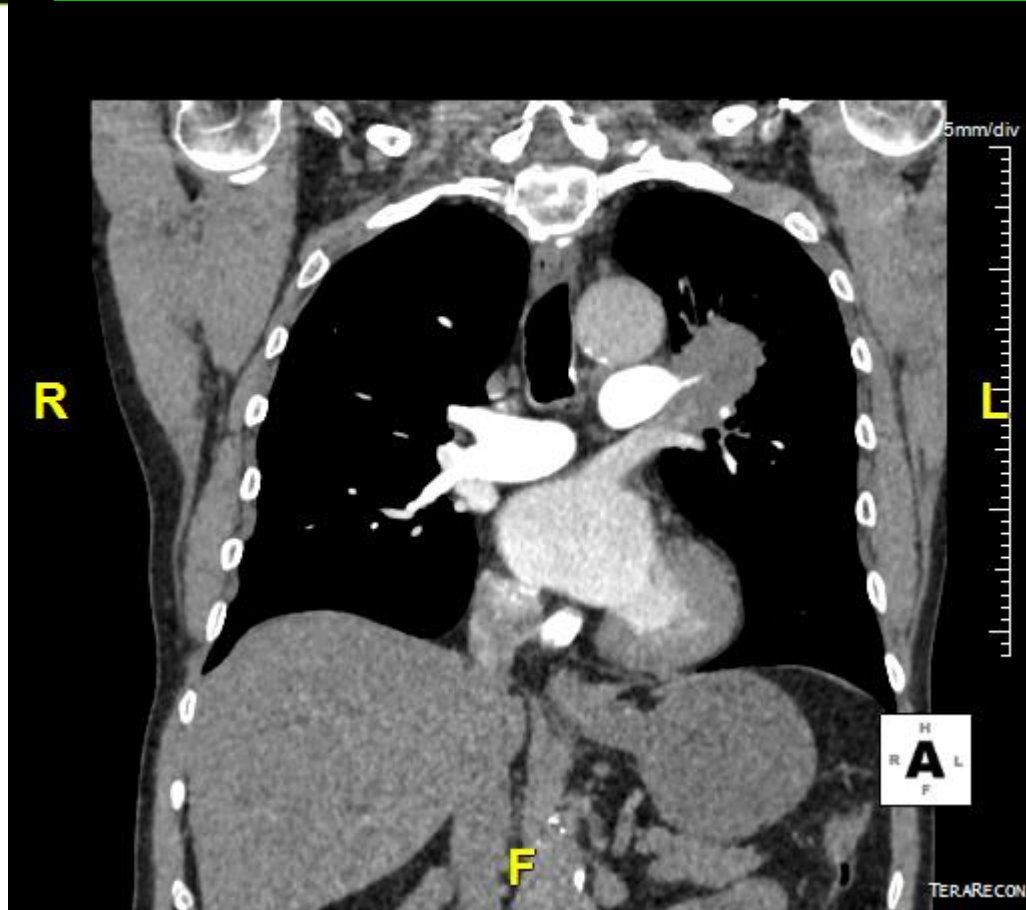
Double sleeve Lobectomy + Thoracic aneurysm =TEVAR



Double sleeve Lobectomy + Thoracic aneurysm =TEVAR

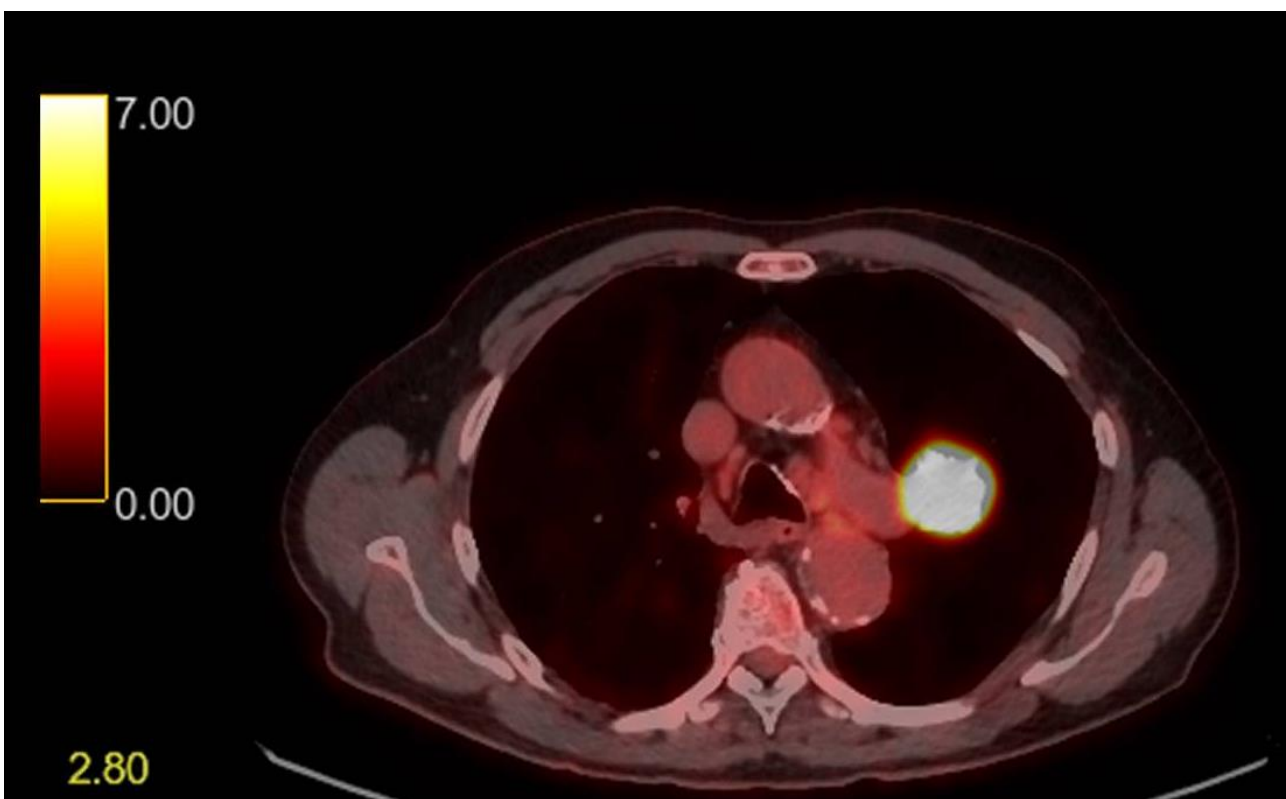


Double sleeve Lobectomy + Thoracic aneurysm =TEVAR

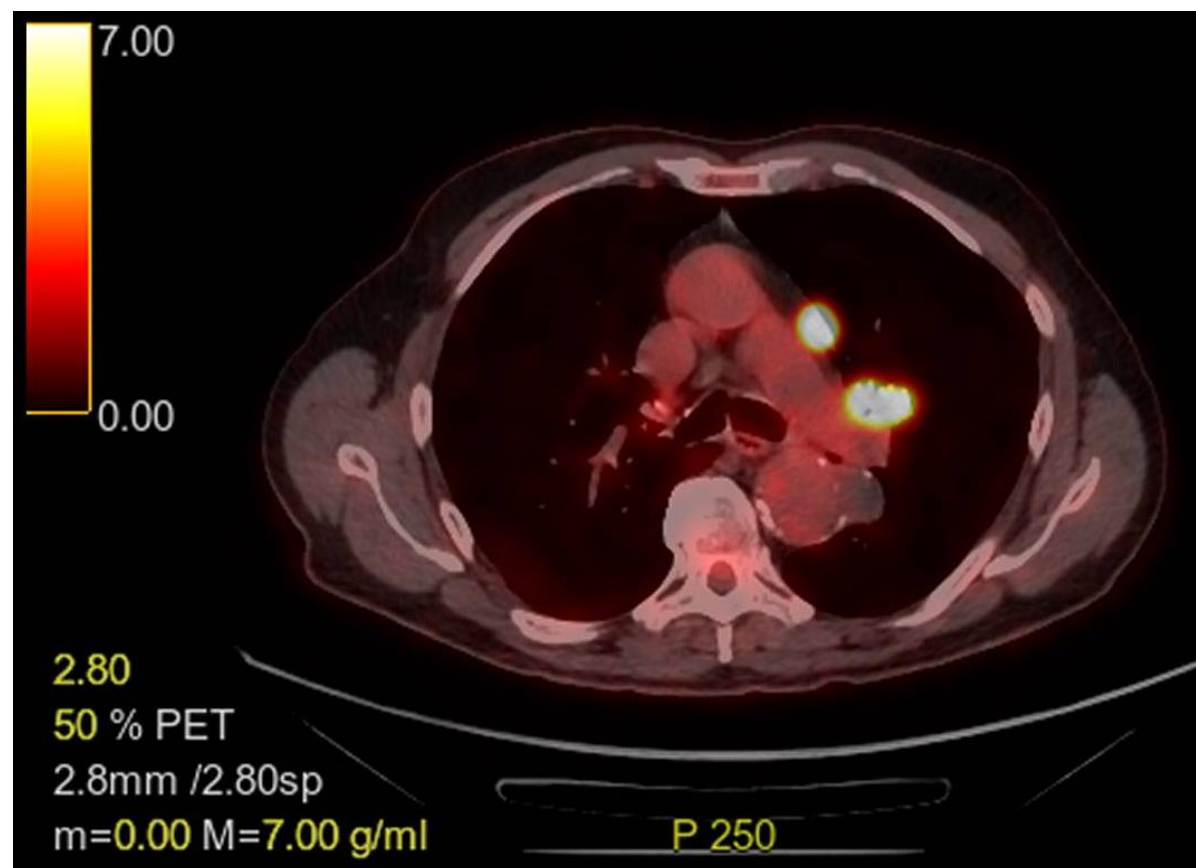




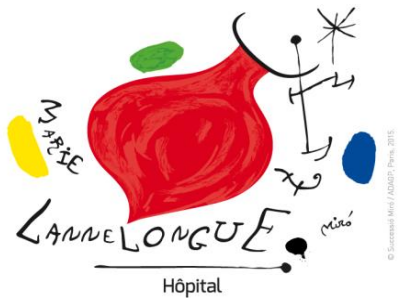
Double sleeve Lobectomy + Thoracic aneurysm =TEVAR



Hopital



Double sleeve Lobectomy + Thoracic aneurysm =TEVAR



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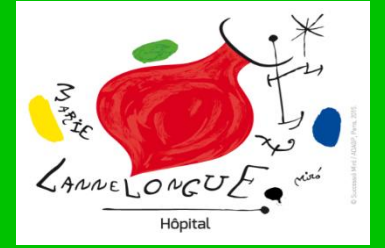


Indications / TEVAR + pulmonary resection

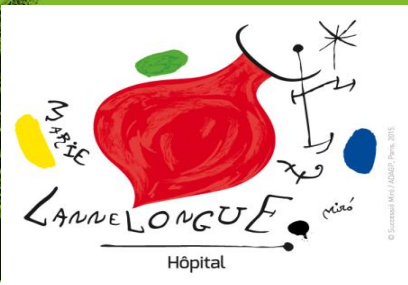
- TEVAR with Resection during oncological lobectomy or pneumonectomy / oesophagectomy: 7
- TEVAR / sequestration artery resection and lobectomy: 2
- TEVAR / extended mediastinal tumor: 1
- TEVAR / lobectomy / Aneurysm: 2
- Emergencies:
 - Aortoesophageal Fistula Occurring during Lung Cancer Treatment: 1
 - massive bleeding after Radiation therapy: 2



Conclusions



- In our experience, TEVAR and lung resection have been performed in 15 cases
- For T4 resection it allows a safe en bloc resection of tumors invading the aortic wall with a very low morbidity and mortality.
- This option was particularly helpful for tumors extending into the aortic wall and the spine.
- TEVAR is a minimally invasive approach than can ensure a safety surgical resection



JANUARY 20

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