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Lung Cancer in 2025: Which Strategy Delivers The Best Value? Innovation, Equity and Cost-Effetiveness

Robotic & Minimally Invasive Surgery

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Rome, 27/10/25

Gemelli
Fondazione Policlinico Universitario Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore

GART
Advanced Radiation Therapy

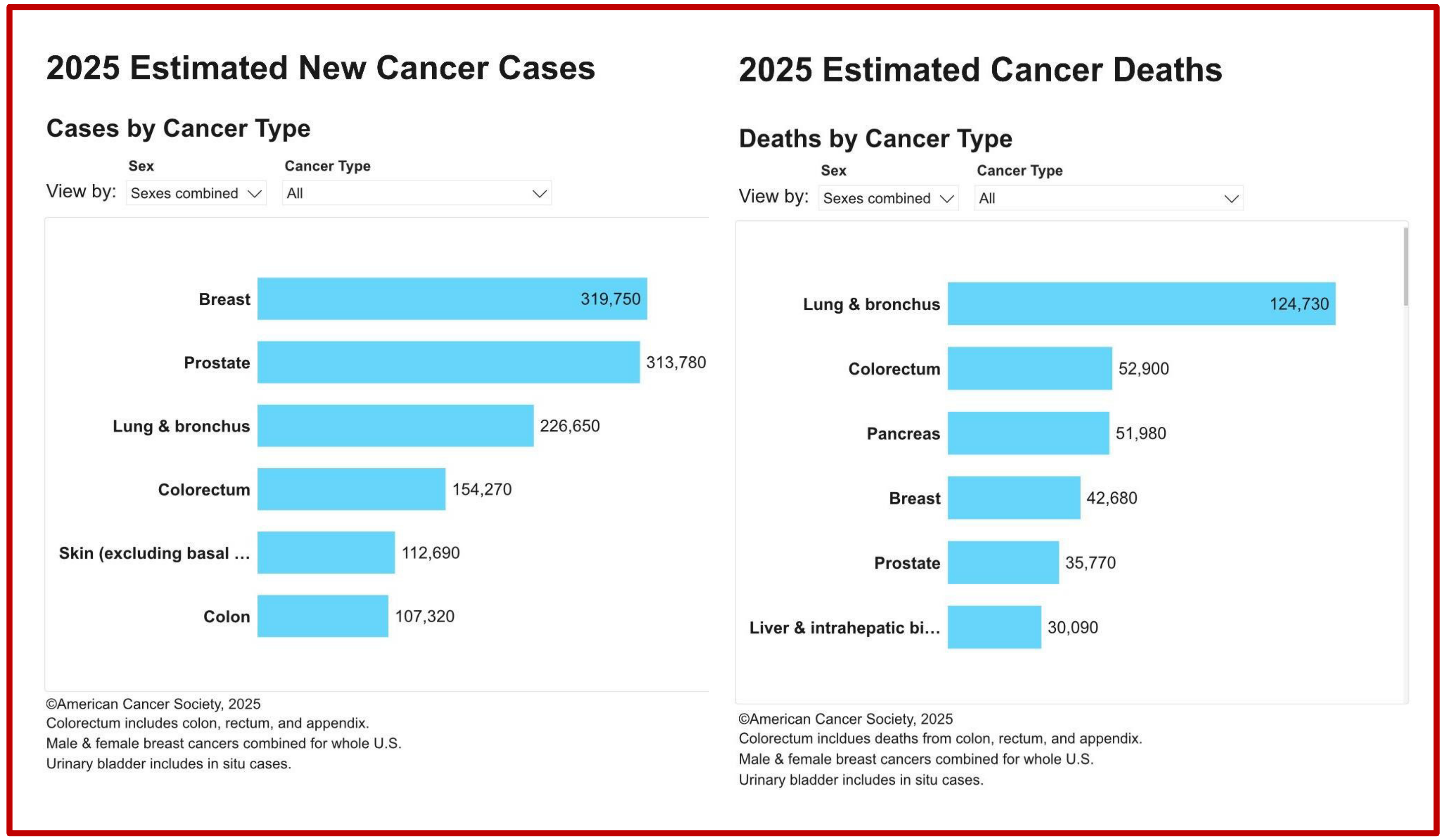
Shaping the Future

Innovation
- Advances in technology
- Expanding surgical possibilities

Equity
- Access across centers & regions
- Training and dissemination

Cost-effectiveness
- Sustainibility for healthcare systems
- Balancing outcomes and costs

Surgery in 2025: multimodal care



Lung cancer remains the leading cause of cancer death worlwide.

Surgery is the cornerstone of curative treatment for early-stage lung cancer, within an integrated multimodal approach

Adoption Trends of Minimally Invasive Thoracic Surgery

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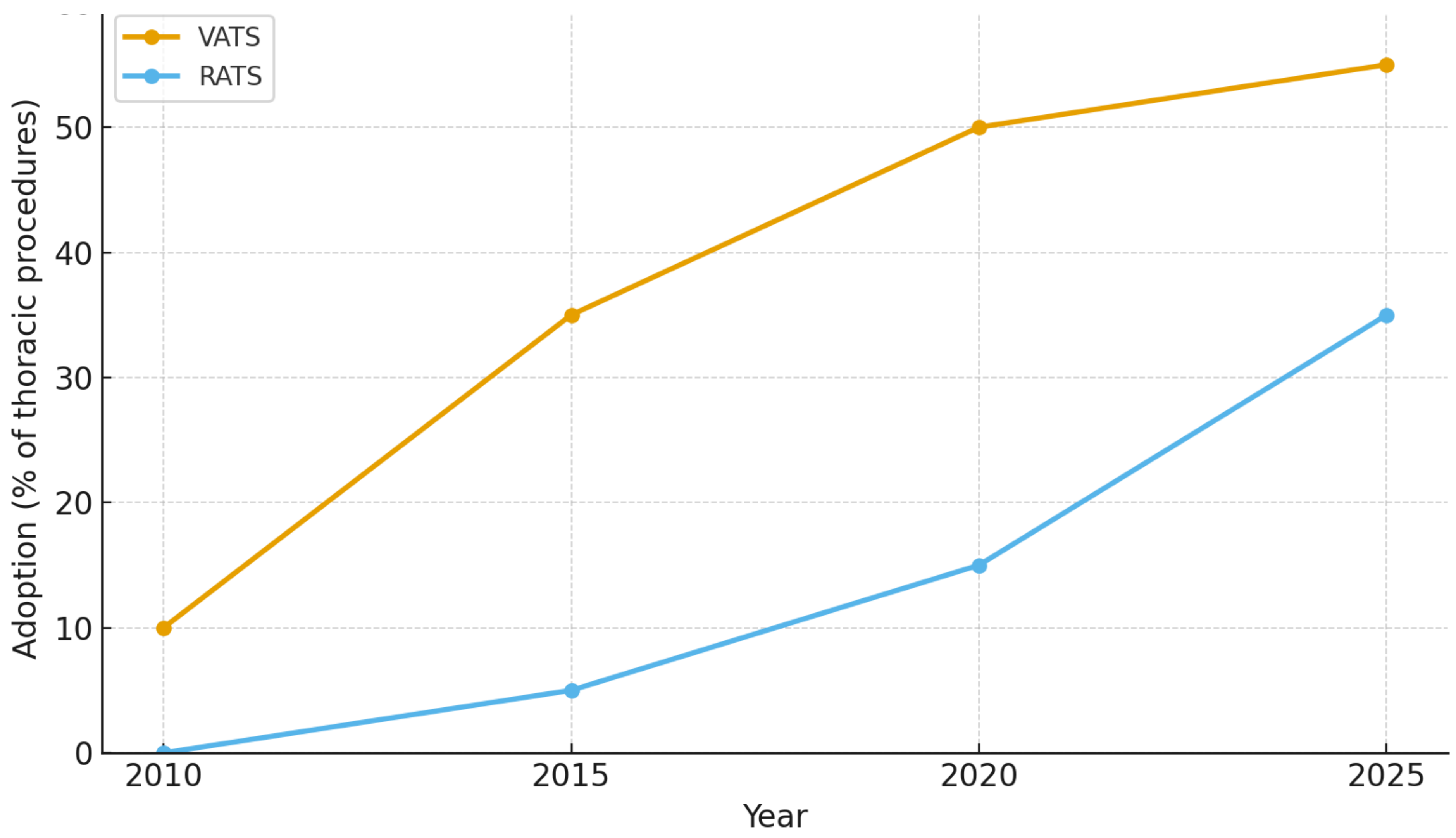
VATS: *standard of care* in many centres → reduced morbidity and shorter hospital stay compared to open surgery.

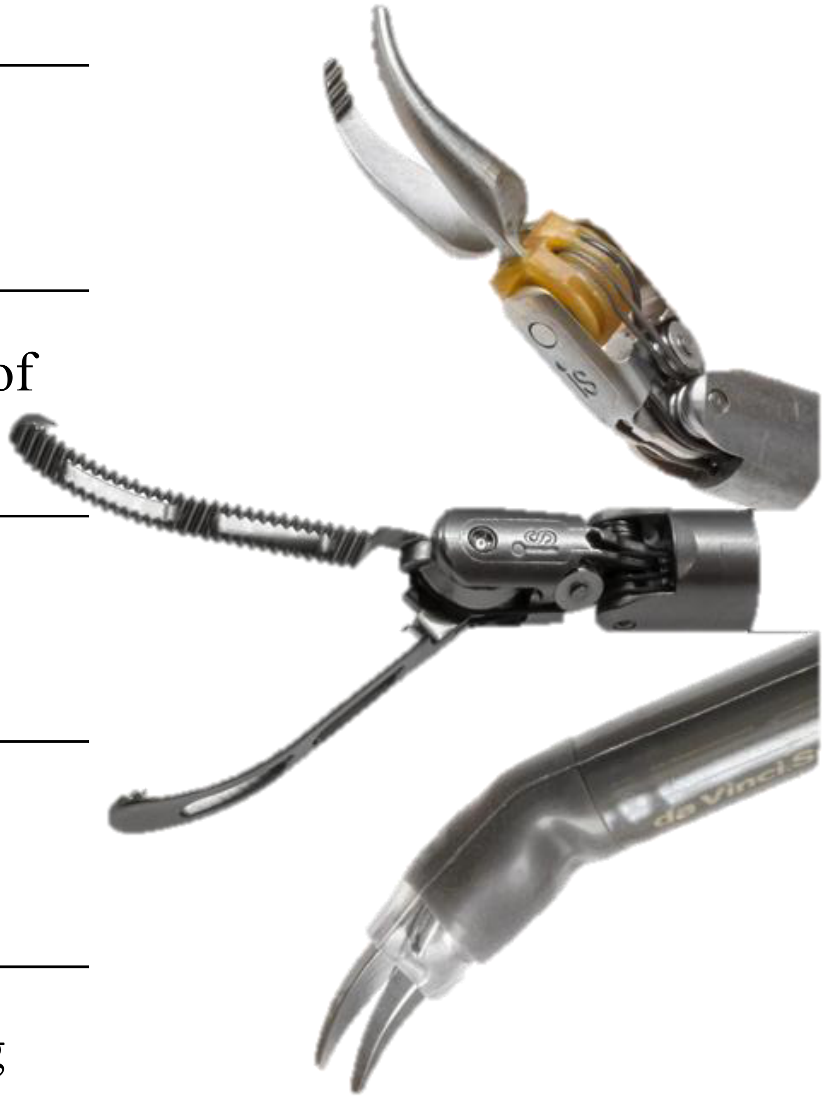
RATS: rapidly expanding, with growing use in complex anatomic resections.



Common Goal: minimize invasiveness while maintaining oncological radicality

VATS vs RATS

Feature	VATS	RATS
Learning curve	Steeper, requires advanced skills	Smoother, more intuitive
Visualization	2D, limited depth perception	3D-HD, magnified vision
Instruments	Straight instruments, limited angulation	Wristed EndoWrist®, 7 degrees of freedom, tremor filtration
Ergonomics	Less favourable	Improved
Lymph node dissection	Adequate, sometimes challenging	More precise and extensive
Clinical outcomes	Established safety and efficacy	Comparable outcomes; growing evidence***



VATS vs RATS

Robotic-assisted versus video-assisted lobectomy for resectable non-small-cell lung cancer: the RVlob randomized controlled trial

Check for updates

*Zhenyi Niu,[a,h] Yuqin Cao,[a,h] Mingyuan Du,[a,h] Siying Sun,[a] Yan Yan,[a] Yuyan Zheng,[a] Yichao Han,[a] Xianfei Zhang,[a] Zhengyuan Zhang,[b] Ye Yuan,[c] Jian Li,[d] Yajie Zhang,[a] Chengqiang Li,[a] Dingpei Han,[a] Hailei Du,[a] Wei Guo,[a] Kai Chen,[a] Jie Xiang,[a] Lianggang Zhu,[a] Jiaming Che,[a] Junbiao Hang,[a] Jian Ren,[a] Toni Lerut,[e] Abbas E. Abbas,[f] Jules Lin,[g] Runsen Jin,[a,**] and Hecheng Li[a,*]*

oa OPEN ACCESS

- 5-year follow-up of 246 patients
- 5-y OS: 94.1% (RATS) vs 91.4% (VATS), p = 0.48
- 3-y DFS: HR 0.87 (95% Cl 0.50-1.52), p = 0.62

* **Long-term outcomes of robotic versus video-assisted pulmonary lobectomy for non-small cell lung cancer: systematic review and meta-analysis of reconstructed patient data**

Panagiotis T. Tasoudis^, J. Nathaniel Diehl, Aurelie Merlo, Jason M. Long

Division of Cardiothoracic Surgery, Department of Surgery, School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

- Systematic review + reconstruction patient data
- HR for OS ~ 1.0 (95% Cl 0.88-1.27, p = 0.53)

*

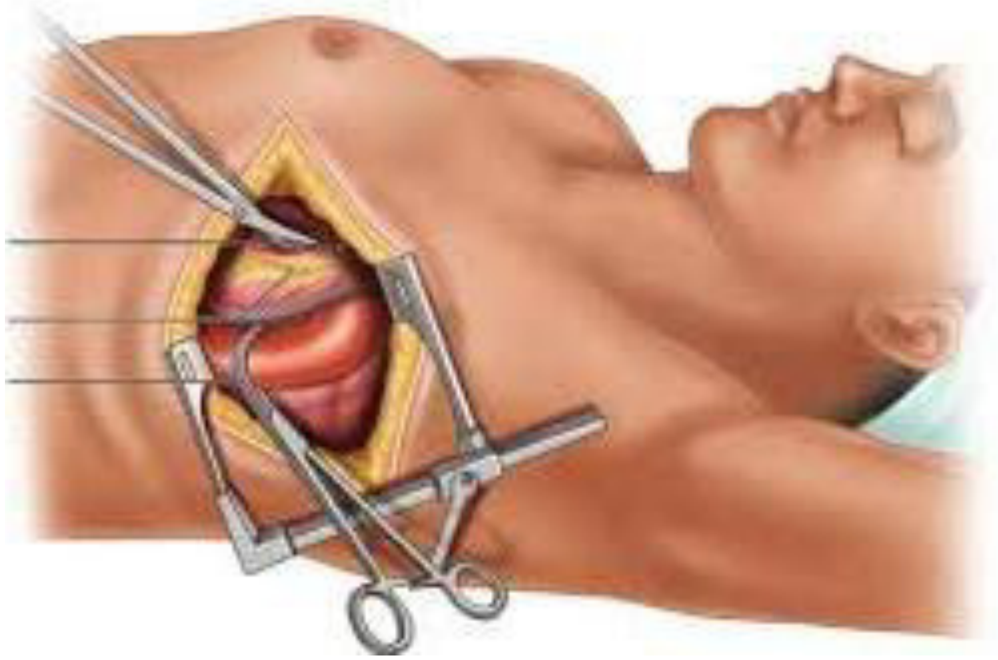
Review > Front Oncol. 2022 Apr 12:12:853530. doi: 10.3389/fonc.2022.853530. eCollection 2022.

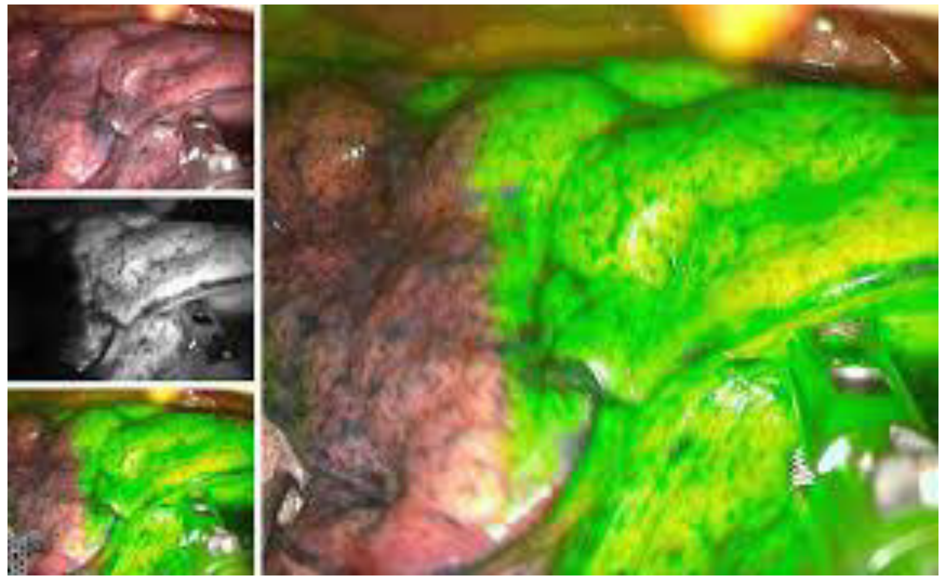
Updated Evaluation of Robotic- and Video-Assisted Thoracoscopic Lobectomy or Segmentectomy for Lung Cancer: A Systematic Review and Meta-Analysis

Jianyong Zhang [1], Qingbo Feng [2], Yanruo Huang [3], Lanwei Ouyang [4], Fengming Luo [1 5]

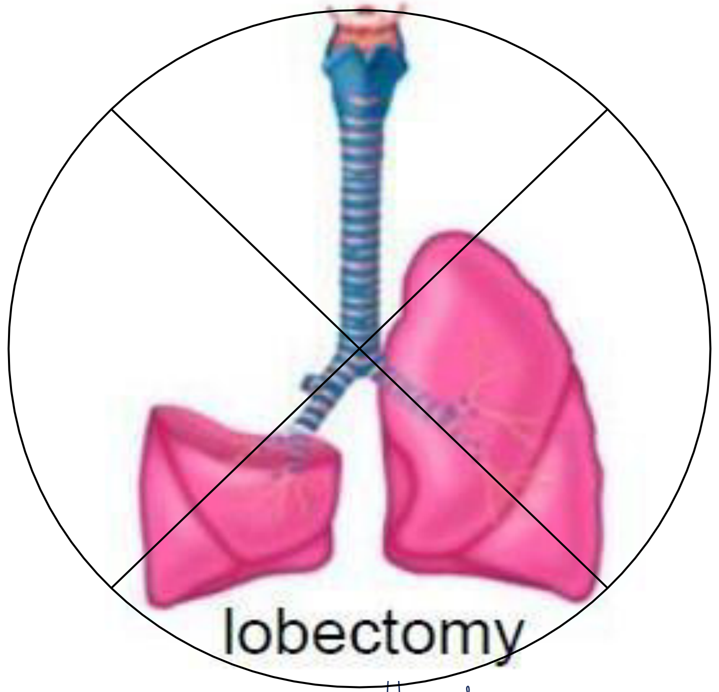
- 26 studies, > 45,000 pts
- Comparable OS and recurrence for VATS & RATS

Mini-invasivness in the treatment of early-stage NSCLC





ICG-guided segmentectomy



segmentectomy

Two recent trials

1. Japanese Clinical Oncology Group/West Japan Oncology Group (**JCOG0802/WJOG4607L**)
2. Cancer and Leukemia Group B (**CALGB140503**)

- They compare survival between sublobar resections and lobectomies.
- Effectiveness of sublobar resections for nodules smaller than 2 cm.

ARTICLES | VOLUME 399, ISSUE 10335, P1607-1617, APRIL 23, 2022

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Segmentectomy versus lobectomy in small-sized peripheral non-small-cell lung cancer (JCOG0802/WJOG4607L): a multicentre, open-label, phase 3, randomised, controlled, non-inferiority trial

Prof Hisashi Saji, MD • Morihito Okada, MD • Masahiro Tsuboi, MD • Ryu Nakajima, MD • Kenji Suzuki, MD • Keiju Aokage, MD • et al. Show all authors • Show footnotes

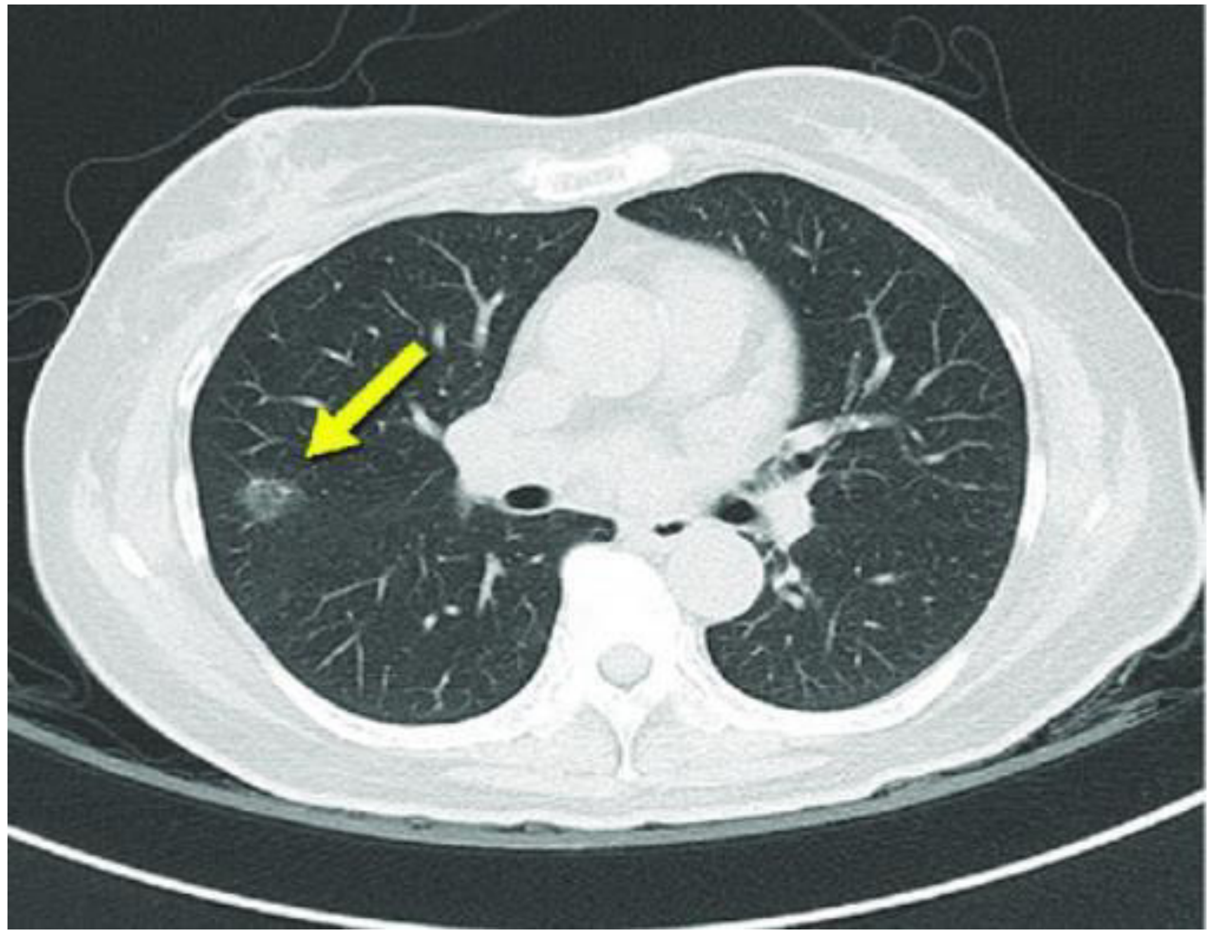
Published: April 23, 2022 • DOI: https://doi.org/10.1016/S0140-6736(21)02333-3 • Check for updates

JCOG0802/WJOG4607L

Stage IA NSCLC

(diameter <2 cm; consolidation-to-tumor ratio >0.5)

Randomly assigned in a 1:1 ratio to undergo either lobectomy or segmentectomy.



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JCOG0802/WJOG4607L

	Lobectomy group (n=554)	Segmentectomy group (n=552)*
Age, years	67 (35–85)	67 (32–83)
Sex		
Female	261 (47·1%)	262 (47·5%)
Male	293 (52·9%)	290 (52·5%)
ECOG performance status		
0	541 (97·7%)	542 (98·2%)
1	13 (2·3%)	10 (1·8%)
Smoking history		
Yes	308 (55·6%)	308 (55·8%)
No	246 (44·4%)	244 (44·2%)
Pack years		
≥20	239 (77·6%)	251 (81·5%)
<20	67 (21·8%)	55 (17·9%)
Unknown	2 (0·6%)	2 (0·6%)
Comorbidities		
Presence/absence	275 (49·6%)/ 279 (50·4%)	270 (48·9%)/ 282 (51·1%)
1/2/3/more comorbidities	173 (31·2%)/ 77 (13·9%)/25 (4·5%)	164 (29·7%)/ 77 (13·9%)/29 (5·3%)
Respiratory disease	25 (4·5%)	31 (5·6%)
Cerebrovascular disease	6 (1·1%)	9 (1·6%)
Cardiovascular disease	23 (4·2%)	30 (5·4%)
Liver dysfunction	12 (2·2%)	11 (2·0%)
Renal dysfunction	1 (0·2%)	2 (0·4%)
Hypertension	169 (30·5%)	156 (28·3%)
Diabetes	49 (8·8%)	56 (10·1%)
Other disease	115 (20·8%)	125 (22·6%)
Whole-tumour diameter, cm	1·6 (0·6–2·0)	1·6 (0·6–2·0)

	Lobectomy group (n=554)	Segmentectomy group (n=552)*
(Continued from previous column)		
TNM classification (7th edition)		
pT1a/pT1b	427 (77·1%)/ 51 (9·2%)	453 (82·1%)/ 35 (6·3%)
pT2a/pT2b/pT3	71 (12·8%)/ 0 (0%)/4 (0·7%)	59 (10·7%)/ 1 (0·2%)/2 (0·4%)
Unknown pT status	1 (0·2%)	2 (0·4%)
pN0/pN1/pN2	522 (94·2%)/ 16 (2·9%)/15 (2·7%)	516 (93·5%)/ 17 (3·1%)/17 (3·1%)
Unknown pN status	1 (0·2%)	2 (0·4%)
pM0/pM1a/pM1b	553 (99·8%)/ 0 (0%)/0 (0%)	549 (99·5%)/ 0 (0%)/1 (0·2%)
Unknown pM status	1 (0·2%)	2 (0·4%)
pIA/pIB	455 (82·1%)/ 64 (9·2%)	468 (84·8%)/ 46 (8·3%)
pIIA/pIIB	15 (2·7%)/ 3 (0·5%)	18 (3·3%)/ 1 (0·2%)
pIIIA/pIV	16 (2·9%)/0 (0%)	18 (3·1%)/1 (0·2%)
Unknown p stage	1 (0·2%)	2 (0·4%)
Nodal dissection		
No dissection	0 (0%)	1 (0·2%)
Hilar	9 (1·6%)	17 (3·1%)
Mediastinal, systematic	221 (39·9%)	182 (33·0%)
Mediastinal, selective	324 (58·5%)	352 (63·8%)
Video-assisted thoracic surgery		
Yes	491 (88·7%)	495 (89·7%)
No	63 (21·3%)	57 (20·3%)
Complete resection		
R0/R1/R2	554 (100%)/ 0 (0%)/0 (0%)	550 (99·6%)/ 0 (0%)/2 (0·4%)
Operation time, min	174 (68–567)	201 (90–462)
Blood loss, mL	45 (0–900)	50 (0–800)

CTR		
0 to ≤0·25	1 (0·2%)	0 (0%)
0·25 to ≤0·5	62 (11·2%)	73 (13·2%)
0·5 to <1	208 (37·6%)	194 (35·1%)
1	283 (51·1%)	285 (51·6%)
FEV1, mL	2260 (1110–4760)	2280 (1010–4900)
FVC, mL	3050 (1370–5990)	3095 (1590–5940)
Pathological type		
Adenocarcinoma	501 (90·4%)	502 (90·9%)
Squamous cell carcinoma	38 (6·9%)	37 (6·7%)
Others	15 (2·7%)	13 (2·4%)

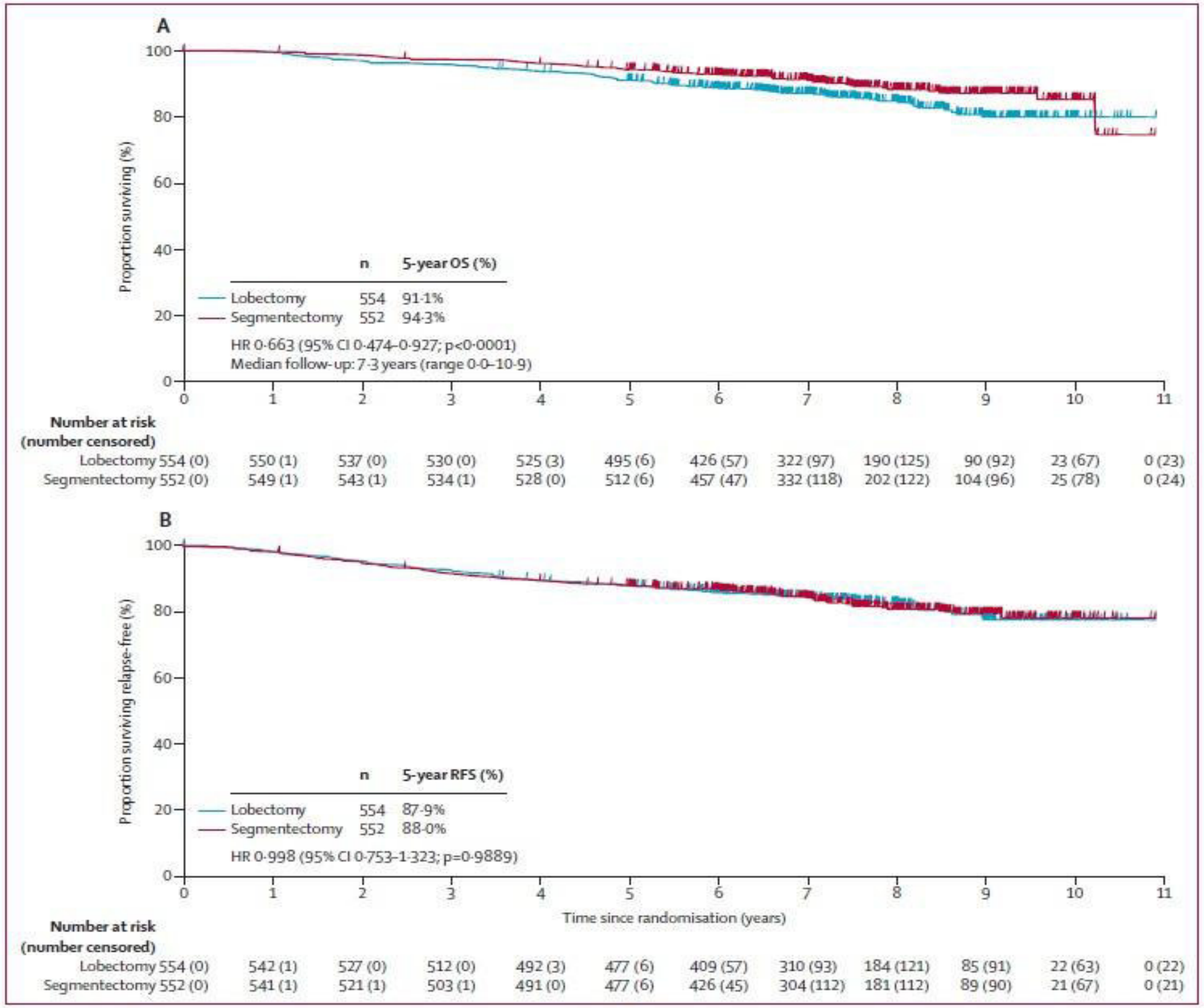

Figure 2: **Kaplan–Meier estimates of overall survival (A) and relapse-free survival (B)**
HR=hazard ratio. OS=overall survival. RFS=relapse-free survival.

Median follow-up: 7.3 years

5-year overall survival:
94.3% for segmentectomies and
91.1% for lobectomies

5-year relapse free survival 87,9% per le lobectomie 88% per le segmentectomie

JCOG0802/WJOG4607L

JCOG0802/WJOG4607L

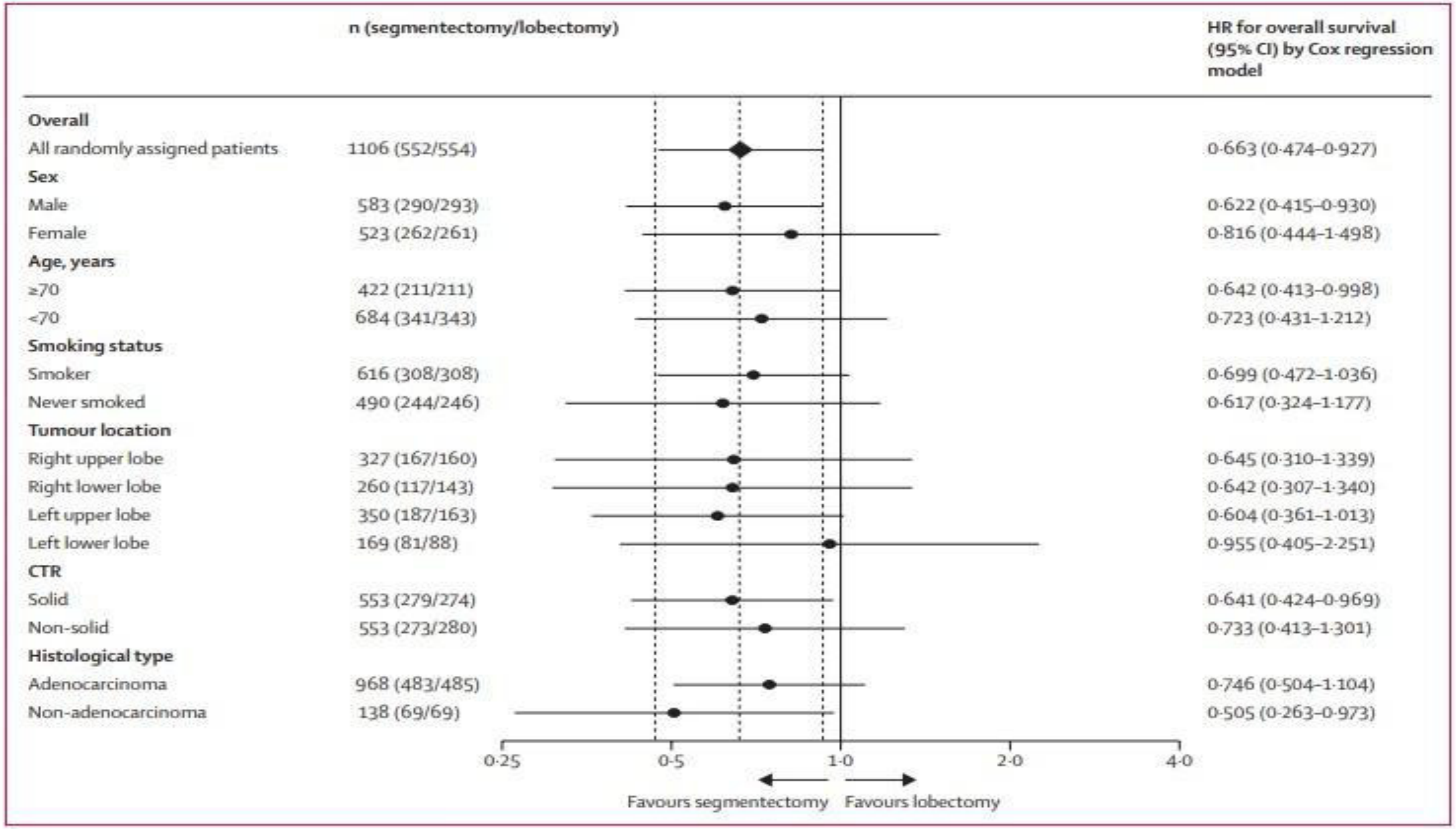

Figure 3: **Subgroup analyses of overall survival**

First phase 3 trial showing noninferiority of segmentectomies vs. lobectomies for small, peripheral NSCLC

Segmentectomy should be the standard approach for this population.

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CALGB140503

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 FEBRUARY 9, 2023 VOL. 388 NO. 6

Lobar or Sublobar Resection for Peripheral Stage IA Non–Small-Cell Lung Cancer

Nasser Altorki, M.D., Xiaofei Wang, Ph.D, David Kozono, M.D., Ph.D., Colleen Watt, B.S., Rodney Landrenau, M.D., Dennis Wigle, M.D., Ph.D., Jeffrey Port, M.D., David R. Jones, M.D., Massimo Conti, M.D., Ahmad S. Ashrafi, M.D., Moishe Liberman, M.D., Ph.D., Kazuhiro Yasufuku, M.D., Ph.D., Stephen Yang, M.D., John D. Mitchell, M.D., Harvey Pass, M.D., Robert Keenan, M.D., Thomas Bauer, M.D., Daniel Miller, M.D., Leslie J. Kohman, M.D., Thomas E. Stinchcombe, M.D., and Everett Vokes, M.D.

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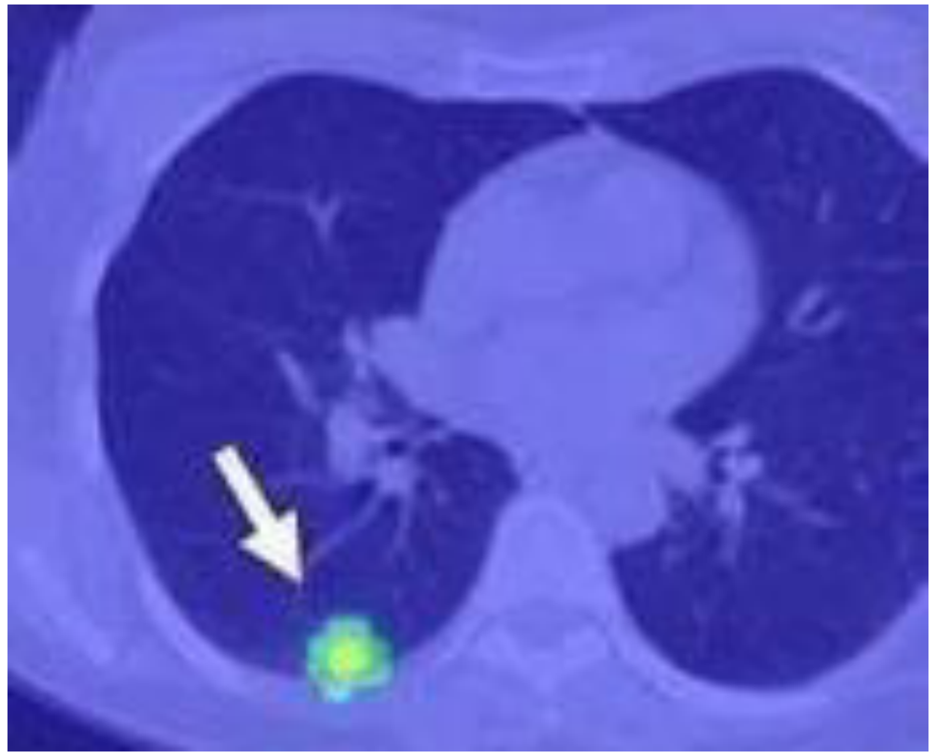

Peripheral solid nodules <2 cm

No evidence of metastatic disease
N0 NSCLC confirmed by extemporaneous testing

Primary endpoint: disease-free survival

Secondary endpoints:
Overall survival
Locoregional and systemic recurrences
Respiratory function

Table 1. Demographic and Clinical Characteristics of the Patients at Baseline.*

Characteristic	Sublobar Resection (N=340)	Lobar Resection (N=357)	Total (N=697)
Age — yr			
Median	68.3	67.6	67.9
Range	37.8–89.7	43.2–88.9	37.8–89.7
Race — no. (%)†			
White	314 (92.4)	313 (87.7)	627 (90.0)
Black	16 (4.7)	29 (8.1)	45 (6.5)
Asian	2 (0.6)	4 (1.1)	6 (0.9)
Other	8 (2.4)	11 (3.1)	19 (2.7)
Sex — no. (%)			
Male	150 (44.1)	147 (41.2)	297 (42.6)
Female	190 (55.9)	210 (58.8)	400 (57.4)
ECOG performance-status score — no. (%)‡			
0	263 (77.4)	250 (70.0)	513 (73.6)
1	72 (21.2)	102 (28.6)	174 (25.0)
2	5 (1.5)	5 (1.4)	10 (1.4)
Smoking status — no. (%)			
Never	28 (8.2)	35 (9.8)	63 (9.0)
Former	172 (50.6)	177 (49.6)	349 (50.1)
Current	140 (41.2)	145 (40.6)	285 (40.9)
Tumor size — no. (%)			
<1.0 cm	28 (8.2)	30 (8.4)	58 (8.3)
1.0–1.5 cm	174 (51.2)	180 (50.4)	354 (50.8)
>1.5–2.0 cm	138 (40.6)	147 (41.2)	285 (40.9)
Histologic type — no. (%)			
Adenocarcinoma	218 (64.1)	226 (63.3)	444 (63.7)
Squamous-cell carcinoma	45 (13.2)	53 (14.8)	98 (14.1)
Other	77 (22.6)	78 (21.8)	155 (22.2)

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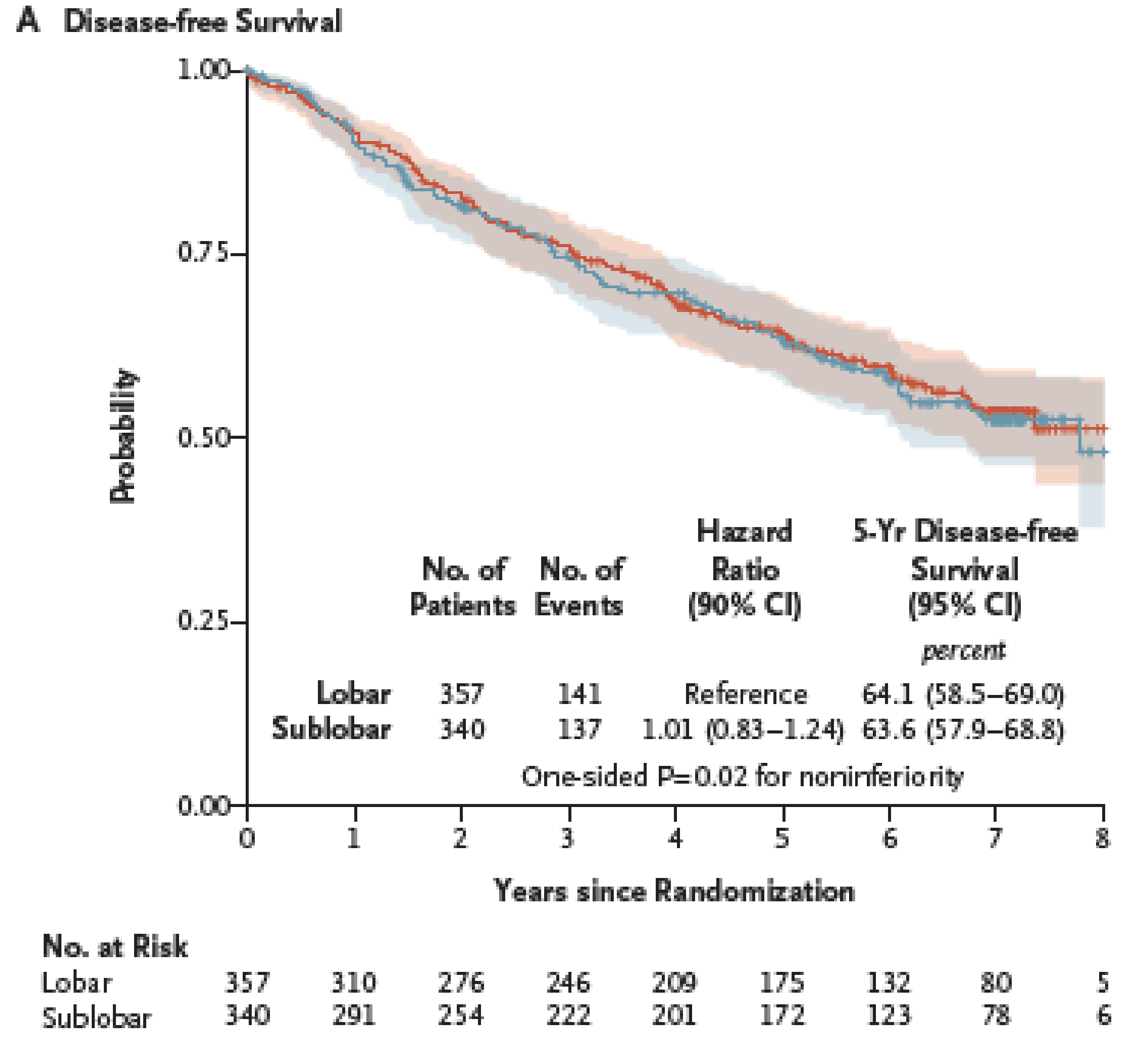
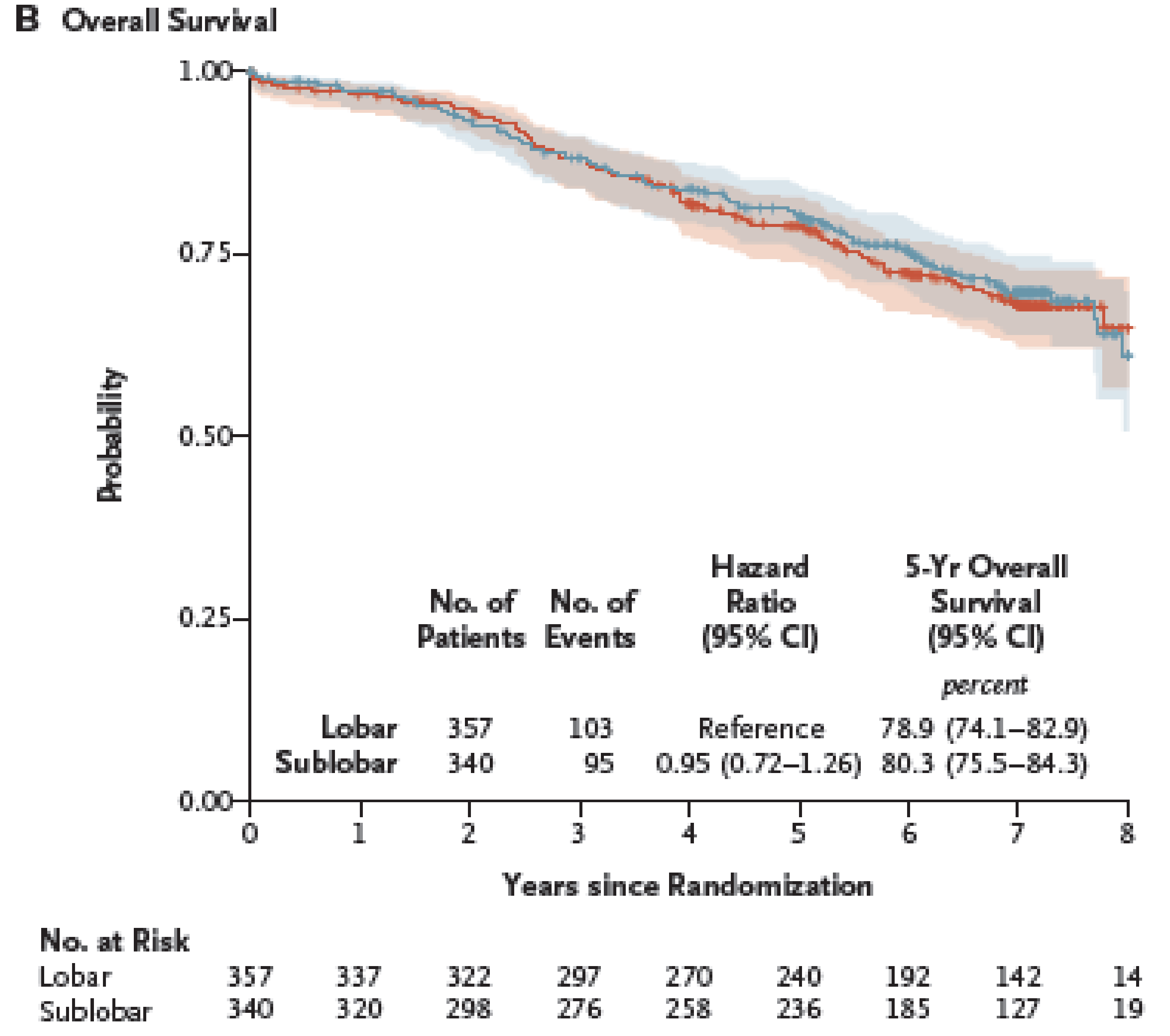


5-year disease-free survival 63.6% after sublobar resection and 64.1% after lobectomy



5-year disease-free survival 63.6% after sublobar resection and 64.1% after lobectomy

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Subgroup	Sublobar Resection	Lobar Resection	Hazard Ratio for Disease Recurrence or Death (95% CI)
	no. of patients		
Overall	340	357	1.03 (0.81–1.30)
Age			
≤65 yr	123	131	0.96 (0.64–1.45)
>65 yr	217	226	1.07 (0.80–1.42)
Age			
≤70 yr	206	211	1.10 (0.80–1.52)
>70 yr	134	146	0.94 (0.67–1.33)
Sex			
Male	150	147	1.12 (0.78–1.59)
Female	190	210	0.97 (0.71–1.33)
Tumor location			
Right upper lobe	120	128	1.00 (0.68–1.47)
Right middle lobe	19	16	2.27 (0.71–7.26)
Right lower lobe	55	43	0.83 (0.44–1.56)
Left upper lobe	86	104	0.91 (0.59–1.41)
Left lower lobe	56	63	1.35 (0.69–2.64)
Lingula	4	3	0.93 (0.15–5.71)
Histologic type			
Squamous-cell carcinoma	45	53	0.99 (0.54–1.79)
Adenocarcinoma	218	226	1.09 (0.80–1.50)
Other	77	78	0.93 (0.60–1.46)
Smoking status			
Never	28	35	1.75 (0.65–4.71)
Former	172	177	0.91 (0.65–1.27)
Current	140	145	1.07 (0.75–1.52)
Tumor size			
<1.0 cm	28	30	0.83 (0.29–2.40)
1.0–1.5 cm	174	180	0.90 (0.65–1.25)
>1.5–2.0 cm	138	147	1.24 (0.87–1.77)
ECOG performance-status score			
0	263	250	0.96 (0.72–1.26)
1 or 2	77	107	1.31 (0.84–2.04)

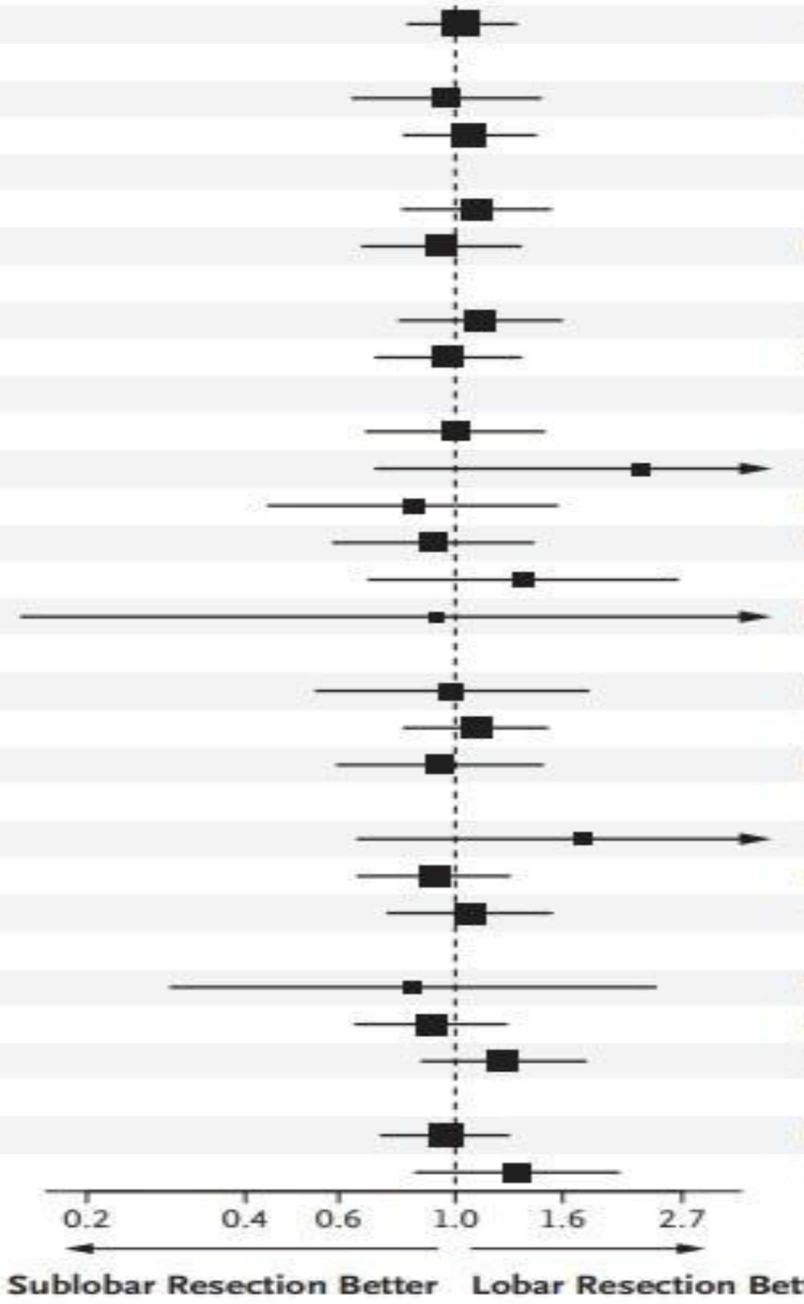

Figure 2. Exploratory Subgroup Analysis of Disease-free Survival.
Hazard ratios and 95% confidence intervals were estimated with the use of unstratified Cox proportional-hazards models. The size of the squares indicating the hazard ratios is proportional to the number of patients included in the analysis. Eastern Cooperative Oncology Group (ECOG) performance-status scores range from 0 to 5, with higher scores indicating greater disability.

Sublobar resections
(segmentectomies or atypical resections)
for peripheral nodules, smaller than 2 cm, are an appropriate approach for this type of patients.

In summary

JCOG0802/WJOG4607L

- ✓ First phase 3 Trial that showed the non-inferiority of segmentectomy vs lobectomy for the treatment of small and peripheral NSCLC
- ✓ Segmentectomy should be the approach of choice for this subset of patients

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- ✓ Sublobar resections (segmentectomies or wedge resections) for peripheral nodules, smaller than 2 cm, are the adequate resection for this type of patients

Challenges in Minimally Invasive, Parenchyma-Sparing Thoracic Surgery

What are the main difficulties for the surgeon?

- Precise identification of the intersegmental plane (especially with two or more planes)
- Accurate localization of the pulmonary nodule

Our Solutions Based on Experience

- Use of **ICG (Indocyanine Green)** to highlight intersegmental planes during surgery
- Employment of **radiological coils (spirals)** for precise nodule markin
- **Advanced surgical planning** using 3D imaging to visualize complex anatomy

ICG in the Study of the Intersegmental Plane

> JTCVS Tech. 2021 Jan 6:6:151-158. doi: 10.1016/j.xjtc.2020.12.005. eCollection 2021 Apr.

Indocyanine green imaging for pulmonary segmentectomy

Masaya Yotsukura [1], Yu Okubo [1], Yukihiro Yoshida [1], Kazuo Nakagawa [1], Shun-Ichi Watanabe [1]

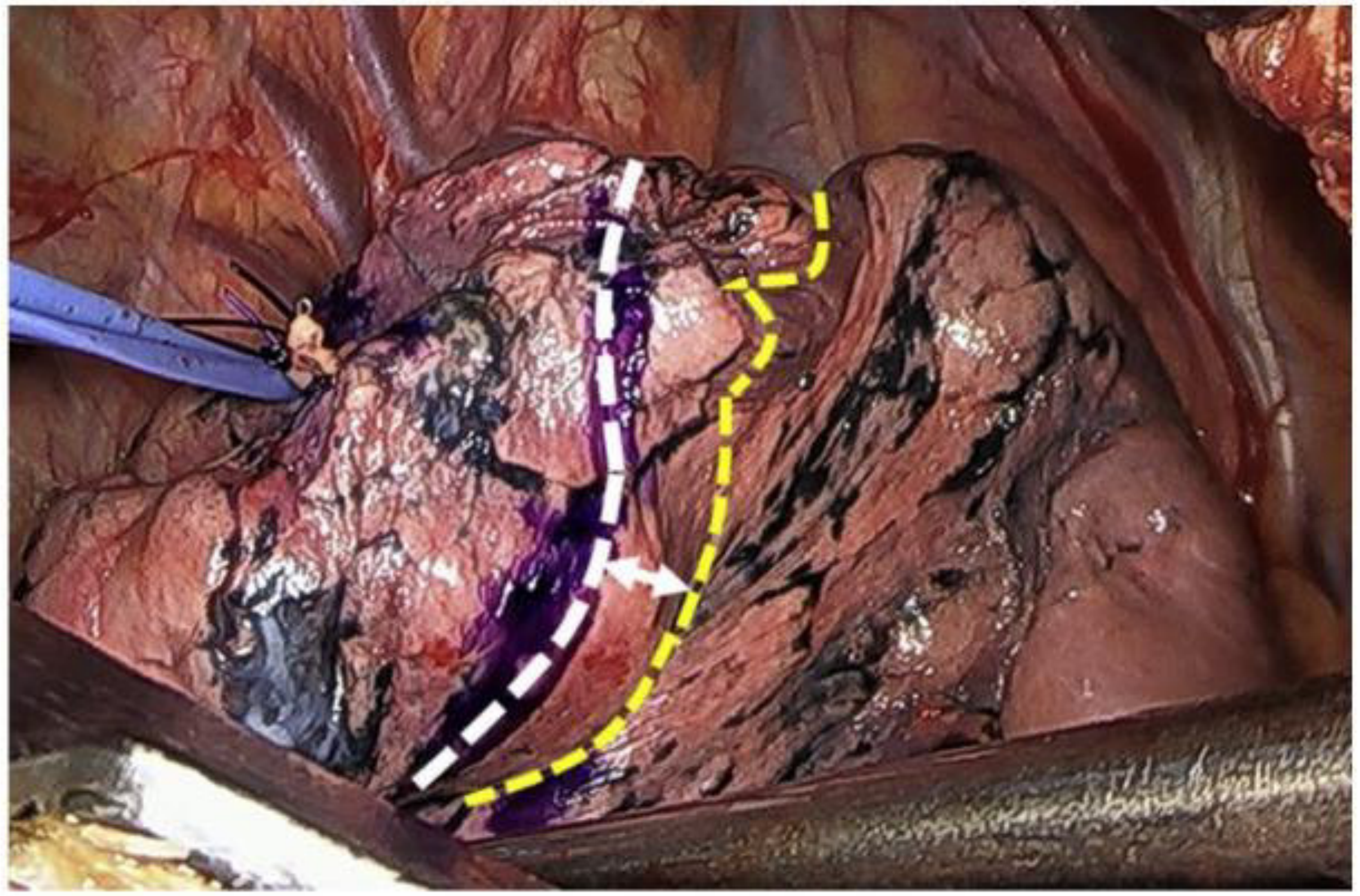
Affiliations — collapse

Affiliation

1 Department of Thoracic Surgery, National Cancer Center Hospital, Tokyo, Japan.

PMID: 34318180 PMCID: PMC8300924 DOI: 10.1016/j.xjtc.2020.12.005

"The use of ICG is a feasible and safe method regardless of the extent of resected segments or pulmonary function and tend to show a more restricted intersegmental plane than jet ventilation."



- *Inflation–deflation line yellow dashed line*
- *Fluorescent area white dashed line*

ICG in the Study of the Intersegmental Plane

Surgical Technique on Thoracic Surgery

Uniportal video-assisted thoracic lung segmentectomy with near infrared/indocyanine green intersegmental plane identification

Elisa Meacci, Dania Nachira, Maria Teresa Congedo, Marco Chiappetta, Leonardo Petracca Ciavarella, Stefano Margaritora

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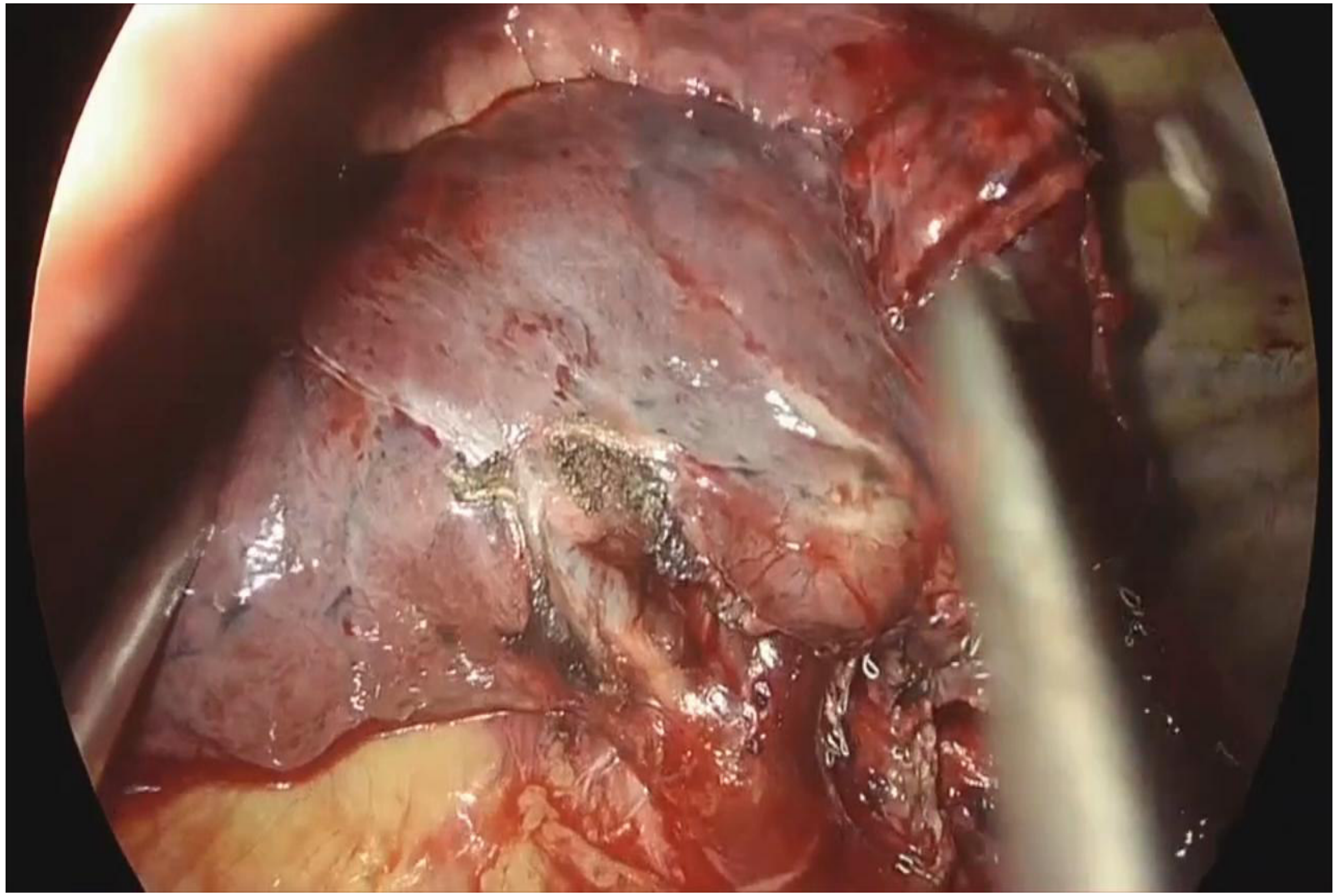

Radiological coils (spirals) for precise nodule markin

Research Article

Uniportal VATS Coil-Assisted Resections for GGOs

Maria Teresa Congedo,[1,2] Roberto Iezzi,[2,3] Dania Nachira,[1,2] Anna Rita Larici,[2,3] Marco Chiappetta,[1,2] Lucio Calandriello,[2,3] Maria Letizia Vita,[1,2] Elisa Meacci,[1,2] Venanzio Porziella,[1,2] Mahmoud Ismail,[4] Riccardo Manfredi,[2,3] and Stefano Margaritora[1,2]

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[2]Università Cattolica del Sacro Cuore, Rome, Italy
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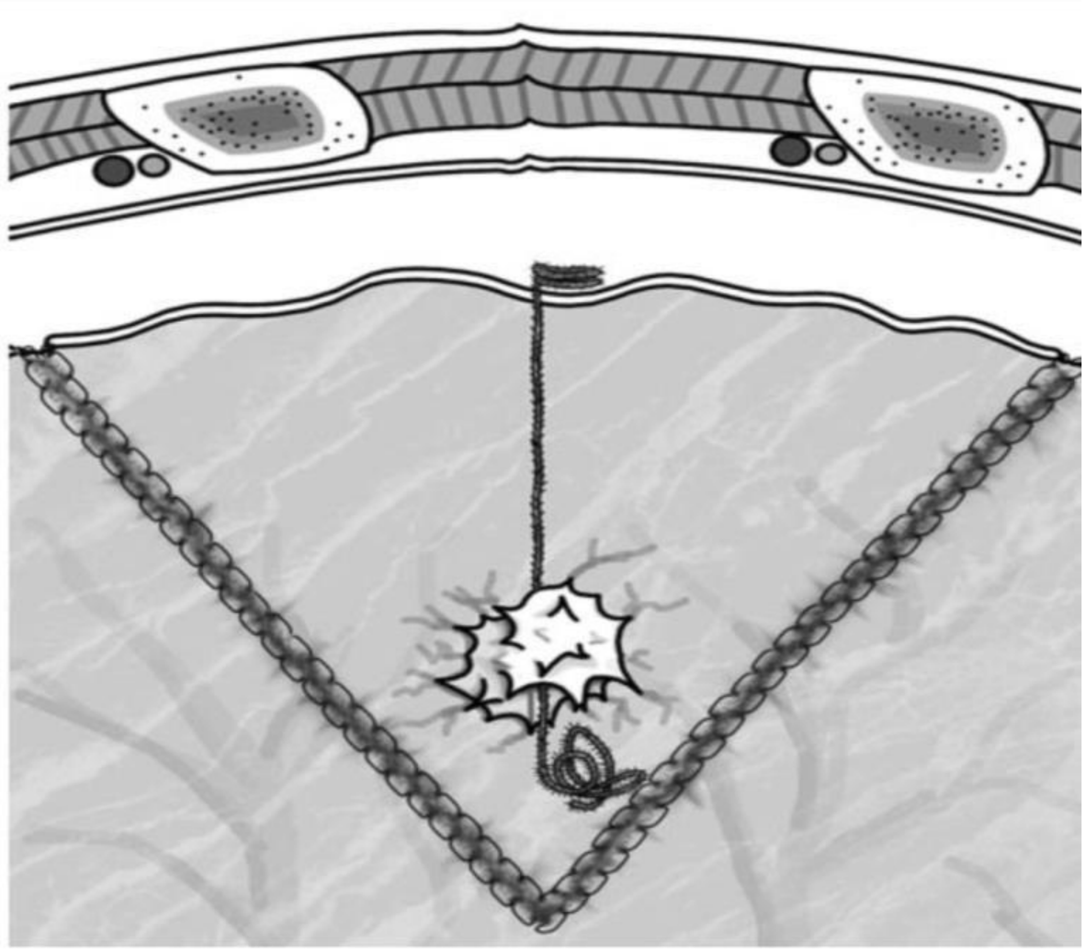
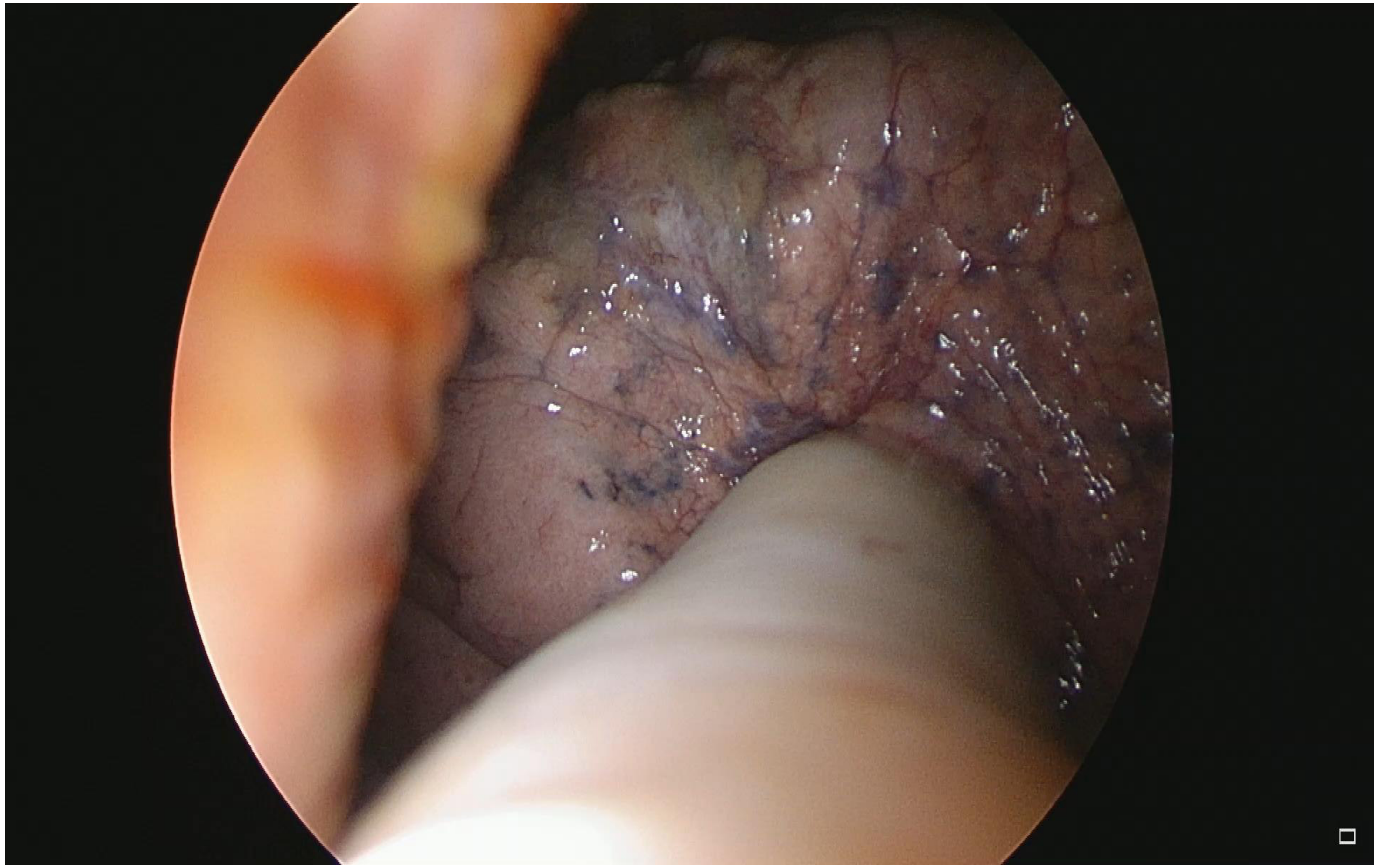
[4]Klinikum Ernst von Bergmann, Academic Hospital of the Charité – Universitätsmedizin, Humboldt University Berlin, Potsdam, Germany

J Oncol. 2019 May



Radiological coils (spirals) for precise nodule markin



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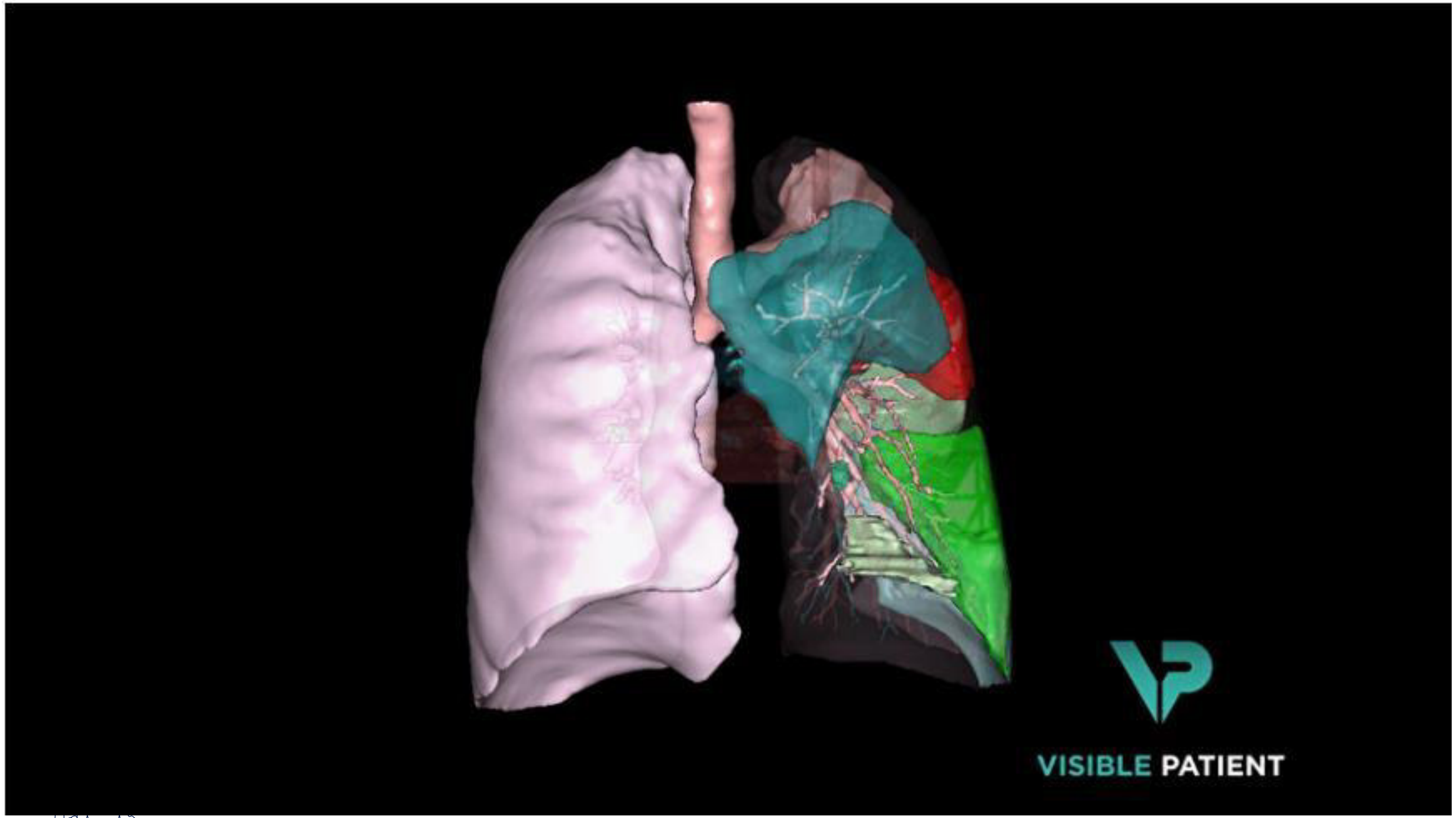
Advanced surgical planning using 3D imaging



Advanced surgical planning using 3D imaging

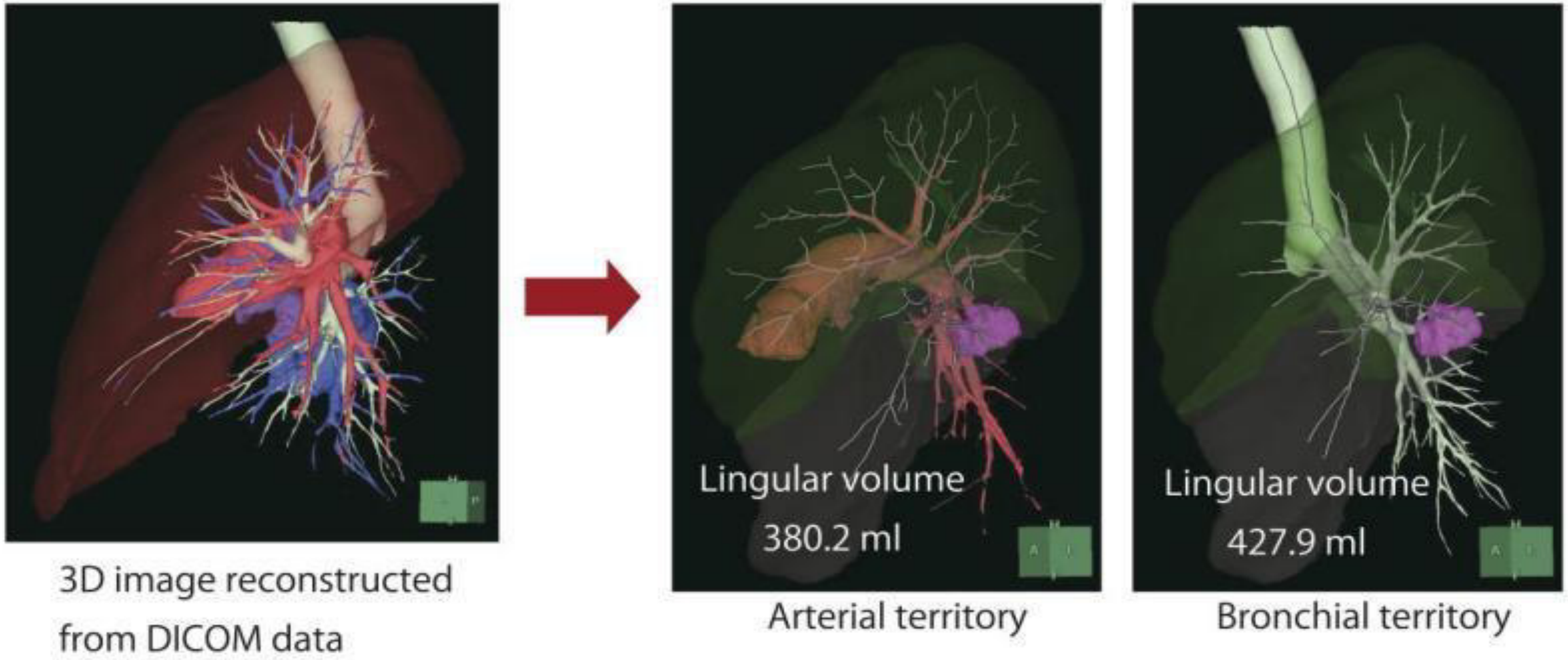
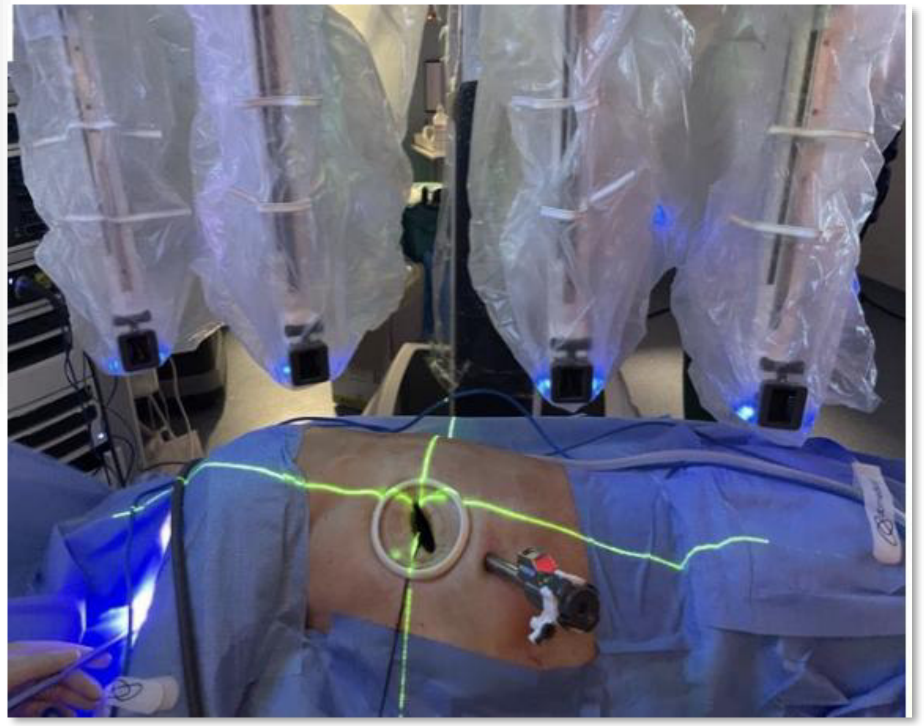


Figure 1: Schematic of the procedure for measuring bronchus- and artery-oriented segmental volume using 3-dimensional computed tomography reconstruction software. In this case with lingulectomy, the lingular volumes calculated by arterial and bronchial territories are 380.2 ml and 427.9 ml, and the tumour margins from each intersegmental plane, based on arterial and bronchial territories, are 6.4 mm and 7.0 mm, respectively. 3D: three-dimensional; DICOM: Digital Imaging and Communications in Medicine.

Gemelli's experience [May 2016 – 2025]

- ***More than 3800*** ***Uniportal VATS*** *procedures*
- ***40*** ***Bi-RATS*** *procedures*

Surgical Procedures U-VATS	
Esophagectomy (U-VATS)	75
Lung resection (U-VATS)	3700
- Lobectomy - Segmentectomy - Other procedures	1500 307 1893



Surgical Procedures Bi-RATS	40
Lobectomy (Bi-RATS)	18
Segmentectomy (Bi-RATS)	7
Wedge resection	15

Gemelli's experience

314 Segmentectomies Bi-RATS or U-VATS [2016 - 2025]

55% of segmentectomies performed with ICG (Bi-RATS or U-VATS)

Segmentectomy	314 (100%) (7 Bi-RATS – 307 U-VATS)
S1 S6	151 (48%)
Culmen Lingulectomy	157 (50%)
Other (S8-S2)	6 (2%)

Postoperative outcomes

Variables	
Reoperation for bleeding	4 (1,3%)
Pleural dranaige(days)	3,23 ± 1,50
Hospitalization (days)	3,86 ± 1,56
Minor complication (pneumonia 16, air leak 7)	23 (7,3%)
30-day mortality	0 (0%)

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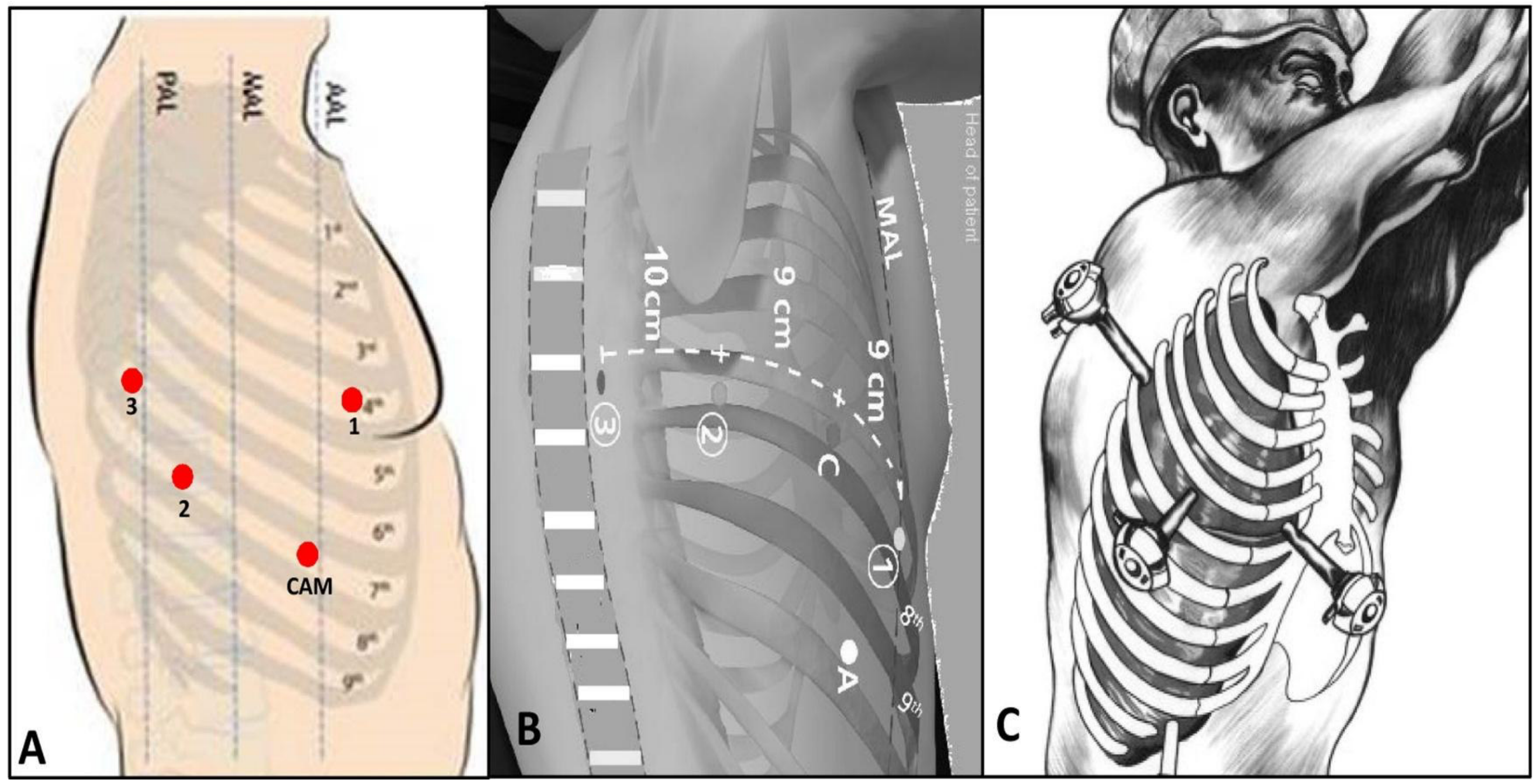
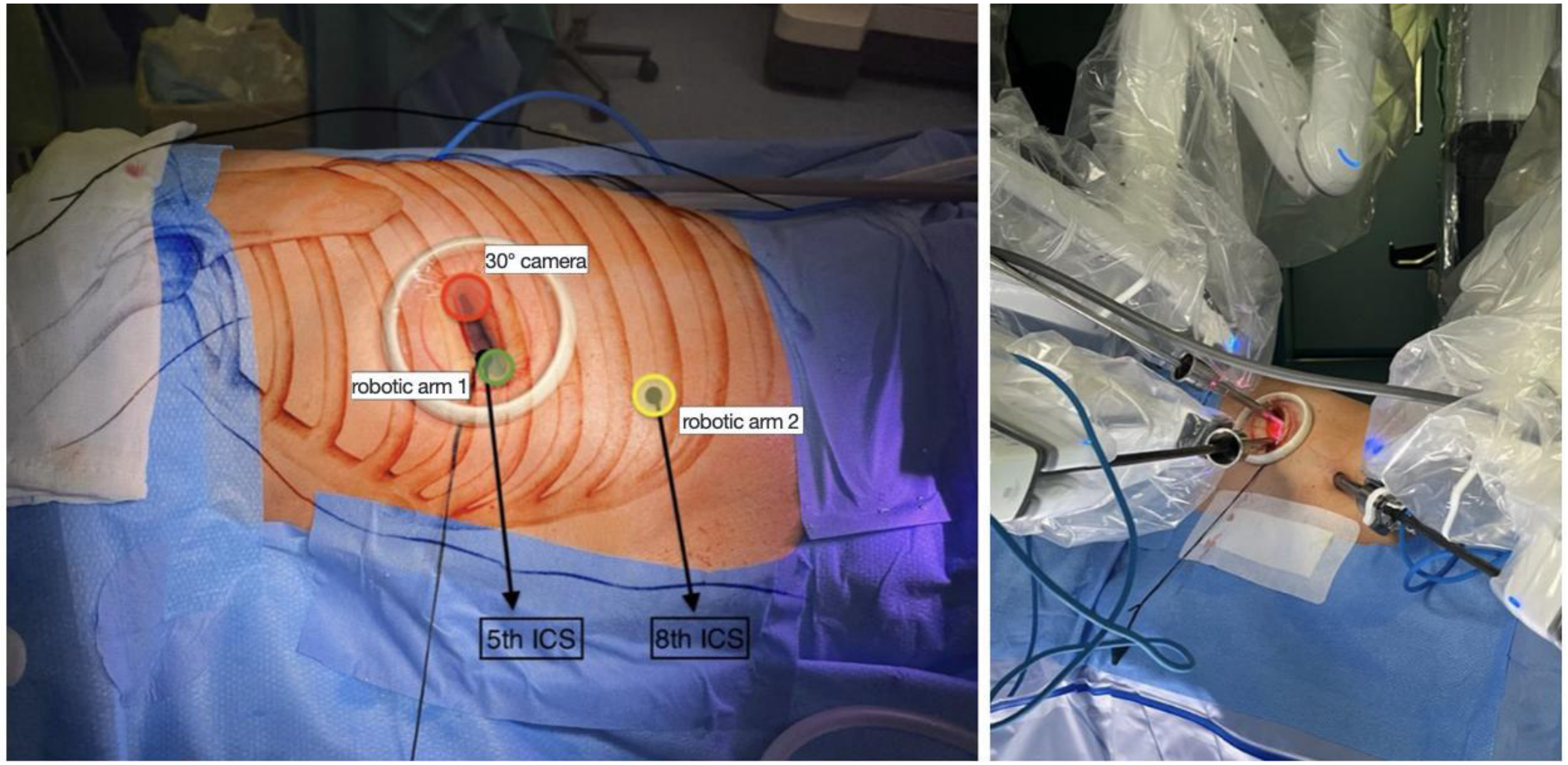
Our experience: From M-RATS to bi-RATS

Since 2023…



Port placement according to three different techniques for robotic lung lobectomy. (A) Park/Veronesi in New York-Milan (6); (B) Robert Cerfolio in Alabama (7); (C) Mark Dylewski in Miami (8).



Ports placement and instrument positioning for a biportal robotic-assisted thoracic procedure. ICS, intercostal space

Shaping the Future

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Innovation

- Advances in technology
- Expanding surgical possibilities

Equity

- Access across centers & regions
- Training and dissemination

Cost-effectiveness

- Sustainibility for healthcare systems
- Balancing outcomes and costs

Access to minimally invasive surgery

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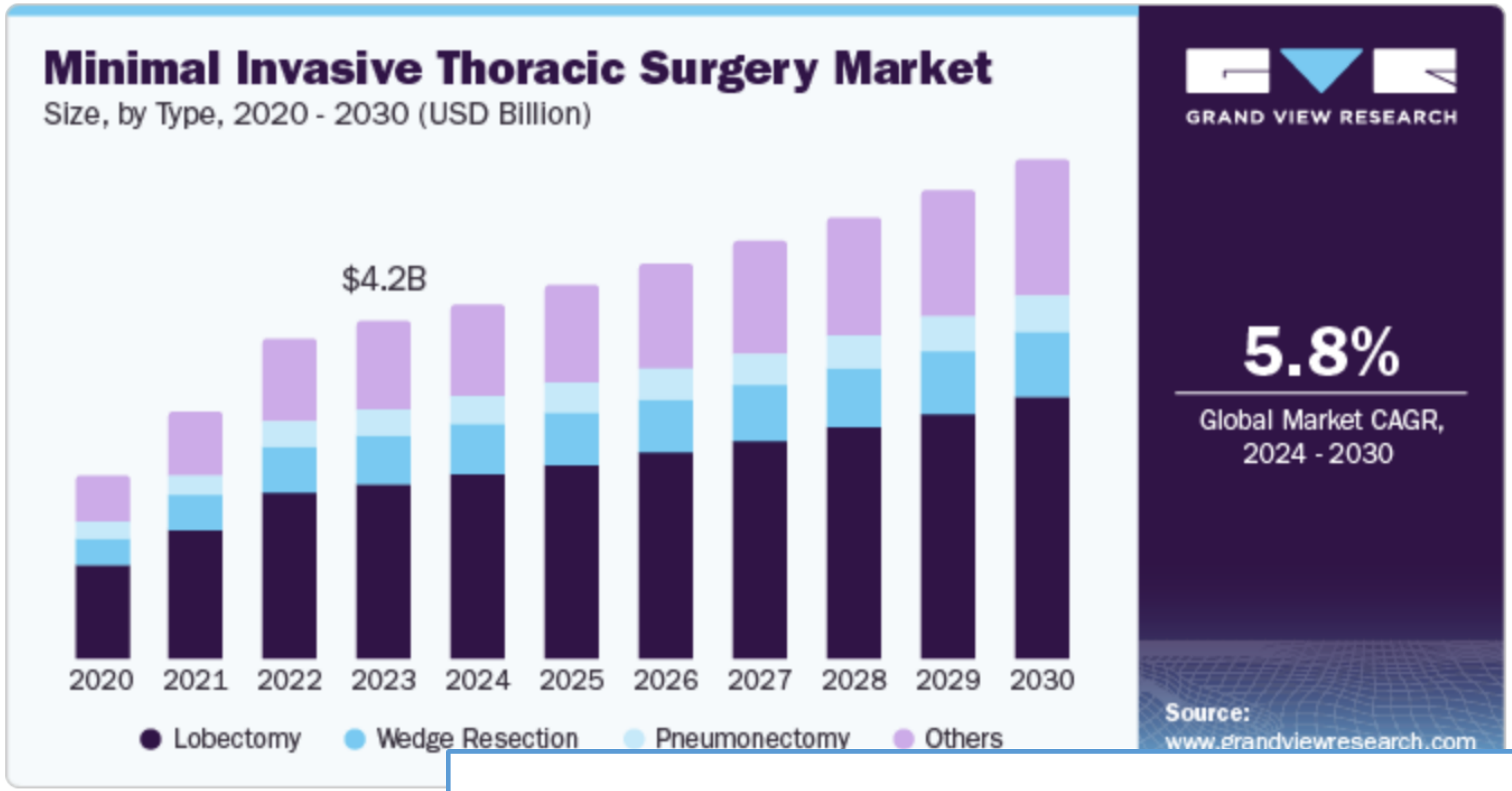
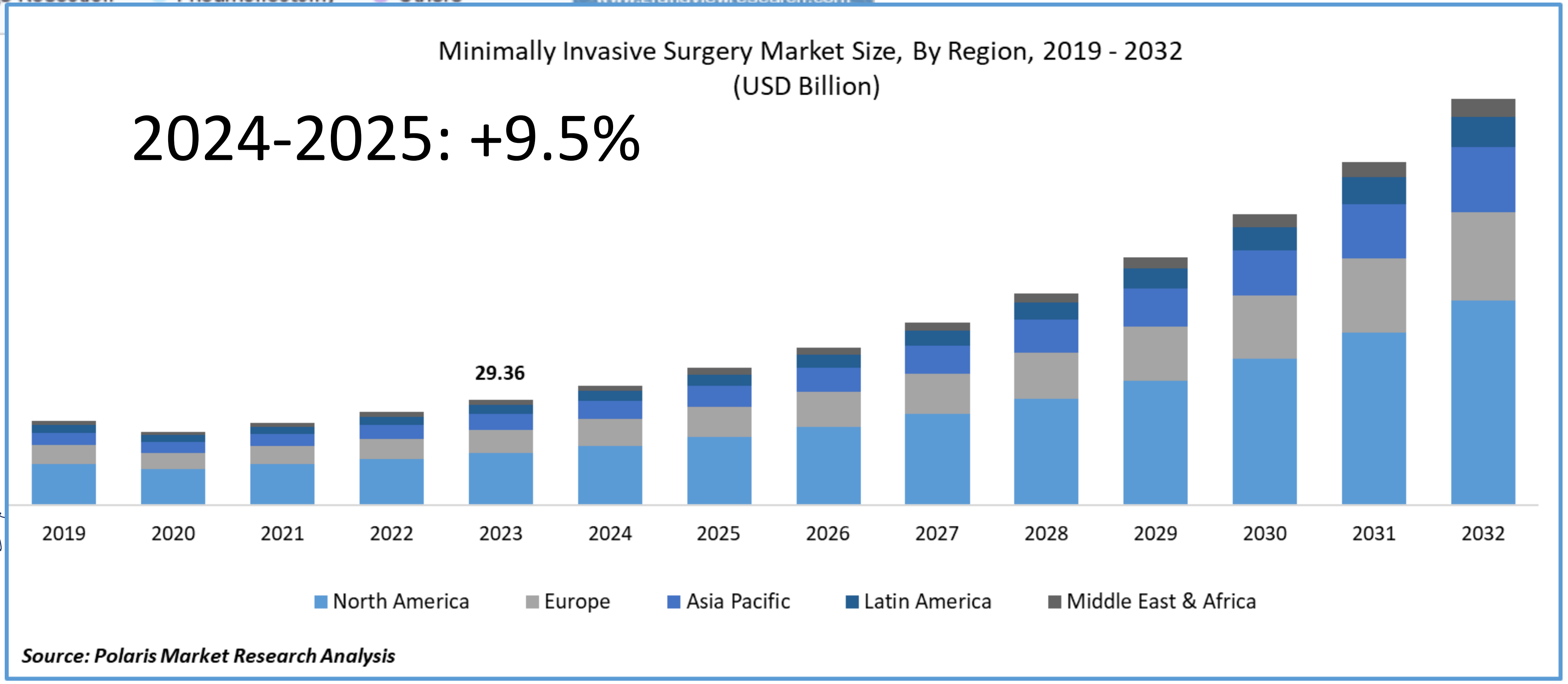
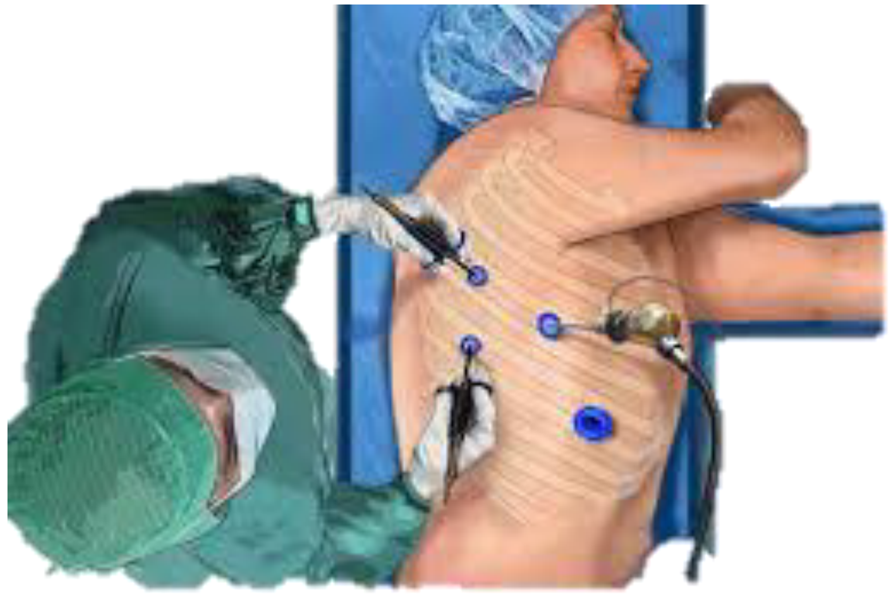
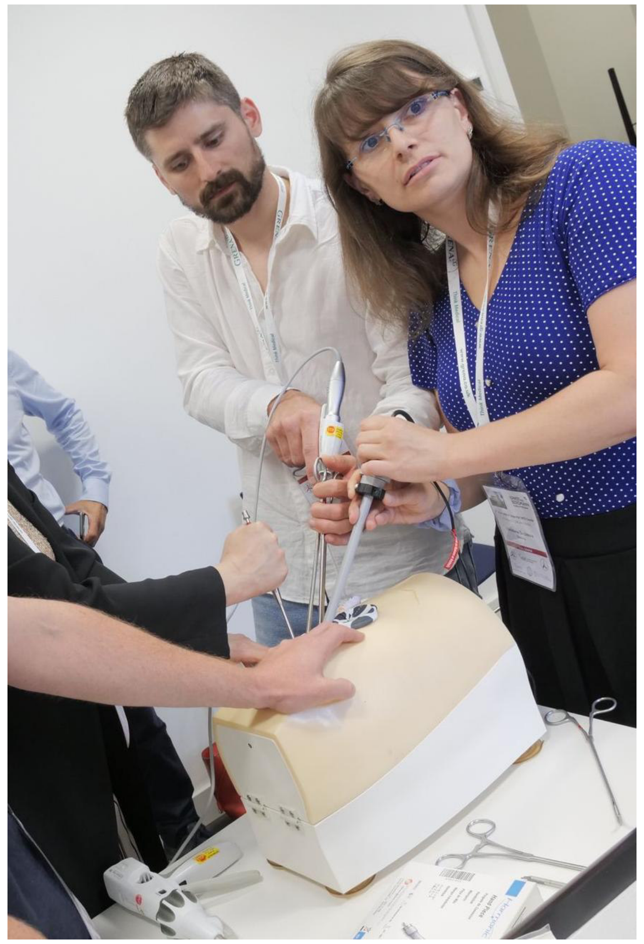
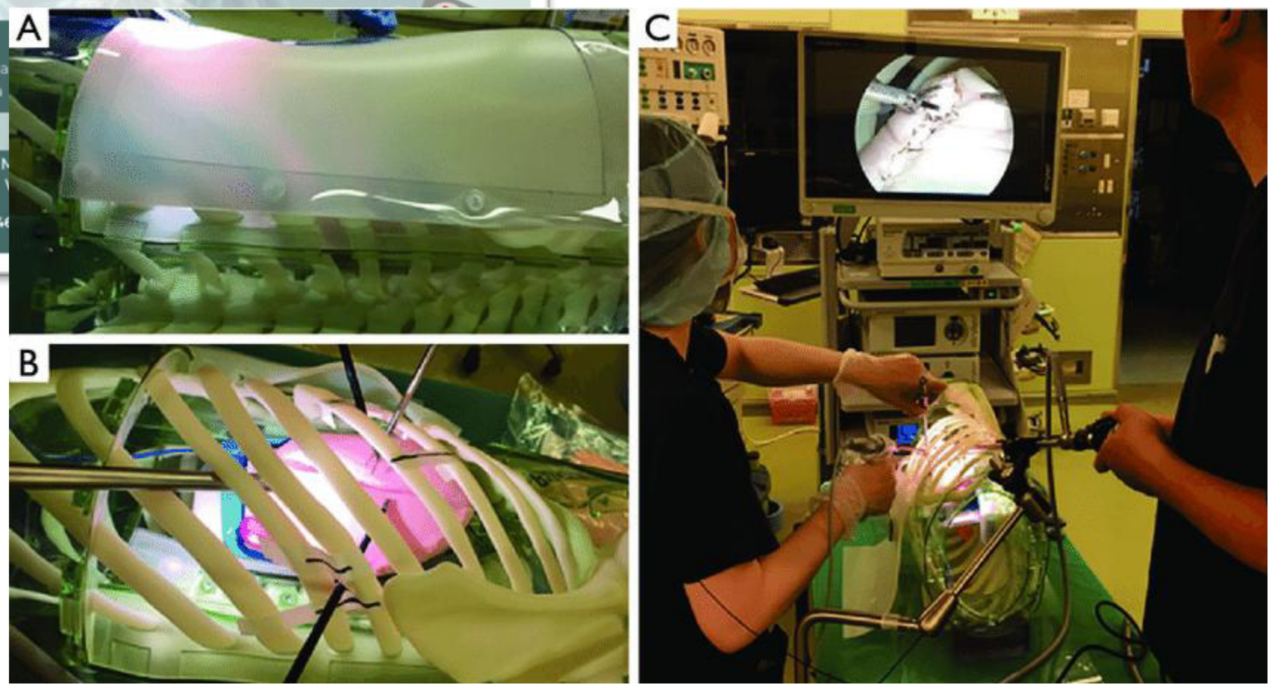






Training and Dissemination





Shaping the Future

Innovation

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Cost continues to be the principal limiting factor in the adoption of minimally-invasive approaches, such as RATS, by the healthcare systems

*“The **health structures** who have to chase an economic balance must clearly **understand** the differential **costs** between **alternative methods** of intervention in order to consciously and more appropriately and ethically **choose where to allocate the increasingly limited economic/ financial resources**"*

Di Filippo A, Galetta D, Spaggiari L. Economic assessment in minimally invasive oncological surgery: a high European volume center experience. Shanghai Chest 2019;3:14

VATS costs

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ORIGINAL ARTICLE

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A risk-adjusted financial model to estimate the cost of a video-assisted thoracoscopic surgery lobectomy programme†

Alessandro Brunelli*, Vasileios Tentzeris, Alberto Sandri, Alexandra McKenna, Shan Liung Liew, Richard Milton, Nilanjan Chaudhuri, Emmanuel Kefaloyannis and Kostas Papagiannopoulos

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Table 4: Differential postoperative costs associated with patient and surgical characteristics

	Difference in postoperative cost (Euros)	*P*-value
Elderly (>70 years of age)	−6	0.41
COPD	1997	0.0005
Diabetes	1614	0.019
CAD	−727	0.89
DLCO <60%	2236	0.039
Left-sided lobectomy	490	0.41
Upper lobectomy	−761	0.36

COPD: chronic obstructive pulmonary disease (FEV1 <80% + FEV1/FVC ratio <70%); DLCO: carbon monoxide lung diffusion capacity; CAD: coronary artery disease; FEV1: forced expiratory volume in 1 s; FVC: forced vital capacity.

The average overall cost of a **VATS lobectomy** was € **11 368** (range €6992–€62 535)

Average **intraoperative** (including surgical and anaesthetic time, overhead, disposable materials) and **postoperative costs** (including ward stay, high dependency unit (HDU) or intensive care unit (ICU) and variable costs associated with management of complications) were € **8226** (range €5656–€13 296) and € **3029** (range €529 – €51 970), respectively

A hypothetical patient with COPD and DLCO less than 60% would cost €4270 more than a patient without COPD and with higher DLCO values (€14 793 vs €10 523).

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Original Article

2020

Robot-assisted *vs*. video-assisted thoracoscopic lobectomy: a systematic review of cost effectiveness

Toby P. Keeney-Bonthrone[1,2], Lynn M. Frydrych[3], Monita Karmakar[3], Armani M. Hawes[2], Rishindra M. Reddy[2,3,4]

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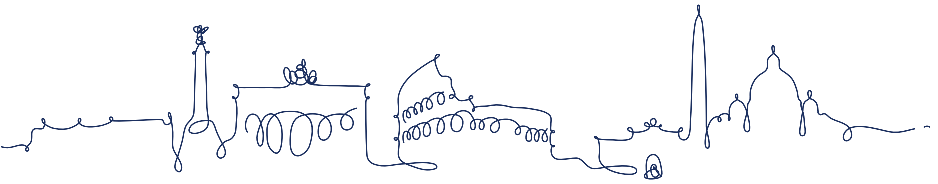
Table 1 Baseline characteristics of included studies

Study	Publication year	Study period	Country	Study type	Source	Total # patients	# Open patients	# VATS patients	# RATS patients	Conflicts of interest
Augustin *et al.*	2013	2001–2009	Austria	Cohort (retrospective)	Single site	52	None	26	26	None
Swanson *et al.*	2014	2009–2011	USA	Cohort (database)	Premier Hospital Database	15,502	None	3,818	335	Consulting (4 authors incl. senior). Industry employment (2 authors)
Deen *et al.*	2014	2008–2012	USA	Cohort (retrospective)	Single site	184	69	58	57	Financial relationships with Intuitive Surgical (3 authors incl. primary)
Paul *et al.*	2014	2008–2011	USA	Cohort (database)	Nationwide Inpatient Sample	40,093	None	37,595	2,498	None
Bao *et al.*	2016	2014–2015	China	Cohort (retrospective)	Single site	138	None	69	69	None
Novellis *et al.*	2018	2015–2016	Italy	Cohort (retrospective)	Single site	103	38	42	23	Consulting (senior author)
Worrell *et al.*	2019	2010–2012	USA	Cohort (retrospective)	Single site	98	None	73	25	Consulting (2 authors including senior)

VATS, video-assisted thoracoscopic surgery; RATS, robot-assisted thoracoscopic surgery.

Data quality and **comparability** were **variable**

- ✓ **RATS lobectomy** was consistently **more expensive** while exhibiting **no significant improvement** in outcomes **compared to VATS**.
- ✓ Pooled estimates indicated a reduced complication rate with VATS compared to RATS (odds ratio 0.83, 95% confidence interval: 0.77–0.90, P<0.0001)
- ✓ **Mean total cost of RATS was 25.7% greater** ($16,645 *vs.* $13,310).
- ✓ For the subset of studies which further delineated costs, the **mean operative costs of RATS were 54.4% higher**, while **mean non-operative costs were 6.5% lower**. Average cost of RATS supplies was 130.3% higher than VATS.



RATS vs VATS vs open: in summary

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Surgical Approach	Average Cost (EUR)
VATS	~€11,400 (hospital)
RATS	~€12,000–13,300
Open	~€12,600 (in published)

Difference RATS vs VATS: **€1,700–2,700** higher per case

Reimbursement & Break-Even Models (Italy)

• Lombardy-region reimbursement (~€11,500 lobectomy DRG) covers robotic costs with ~18% hospital profit margin for robotic surgeries, vs ~31–32% margin for VATS/open

Take-home message (Italy / Europe):

VATS is the most cost-effective minimally invasive method.
VATS shows modest higher effectiveness (QALYs) than open surgery with acceptable incremental cost, making it cost-effective under standard thresholds.

RATS is ~15% more expensive per case, primarily due to consumables and equipment depreciation, but ***remains viable if high volume and regional reimbursements are favorable***.

Conclusions

✓ **VATS** and **RATS surgery** can provide the best minimally-invasive treatments for **NSCLC**

✓ From a **cost-effectiveness standpoint**, VATS usually outperforms RATS—especially in contexts with strict willingness-to-pay thresholds.

Conclusions

- ✓ **RATS** remains **more expensive** and its financial viability can be influenced by **institutional reimbursement structures**, **high volumes**, **program maturity** and **potential advantages in clinical/oncological outcomes**