# Minimally invasive technique in lung cancer surgery

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Nowadays, lung cancer surgery is more minimally invasive due to the screening programs and to the early detection of lung cancer

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Evolution of Surgical Treatment
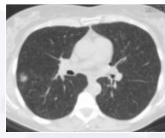
Posterolateral Thoracotomy

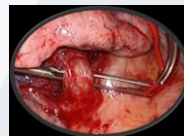**Lateral Muscle Sparing Thoracotomy**
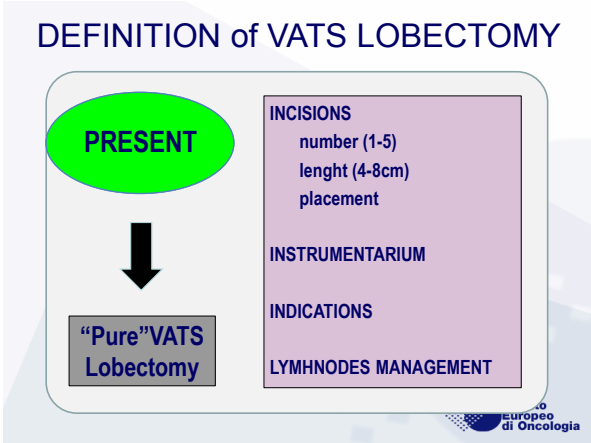
VATS Approach

Robotic Approach
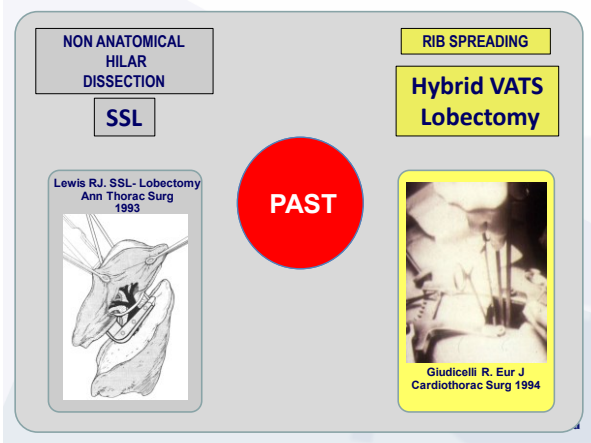

VATS pulmonary resection

"We define VATS pulmonary resection as a video assisted, minimally access approach in which the surgeon operates primarily by watching the television monitor and uses no rib spreading throughout the entire procedure"

Yim AP. Pearson, 2008

➤ Full Endoscopic Procedure (Monitor-based)
➤ Individual Dissection & Stapling of Hilar Structures
➤ No Rib Spreading

Slide 1 (top-left):

NON ANATOMICAL HILAR DISSECTION

SSL

RIB SPREADING

Hybrid VATS Lobectomy

Lewis RJ. SSL- Lobectomy Ann Thorac Surg 1993

PAST

Giudicelli R. Eur J Cardiothorac Surg 1994

Slide 2 (top-right):

A standard muscle-sparing utility thoracotomy for VATS procedures

L. SPAGGIARI, P. CARBOGNANI, P. SOLLI, M. RUSCA

From the Department of General Thoracic and Vascular Surgery University of Parma, Parma, Italy

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Slide 3 (bottom-left):

DEFINITION of VATS LOBECTOMY

PRESENT

"Pure"VATS Lobectomy

INCISIONS
number (1-5)
lenght (4-8cm)
placement

INSTRUMENTARIUM

INDICATIONS

LYMHNODES MANAGEMENT

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Slide 4 (bottom-right):

Surgery for Early-Stage Non-Small Cell Lung Cancer: A Systematic Review of the Video-Assisted Thoracoscopic Surgery Versus Thoracotomy Approaches to Lobectomy

Bryan A. Whitson, MD, PhD, Shawn S. Groth, MD, Susan J. Duval, PhD, Scott J. Swanson, MD, and Michael A. Maddaus, MD

(Ann Thorac Surg 2008;86:2008–18)
© 2008 by The Society of Thoracic Surgeons

Benefits of VATS:
- Reduce in postoperative pain
- Rate of postoperative complications
- Better preserved respiratory functions
- Reduction of lenght of in-hospital stay
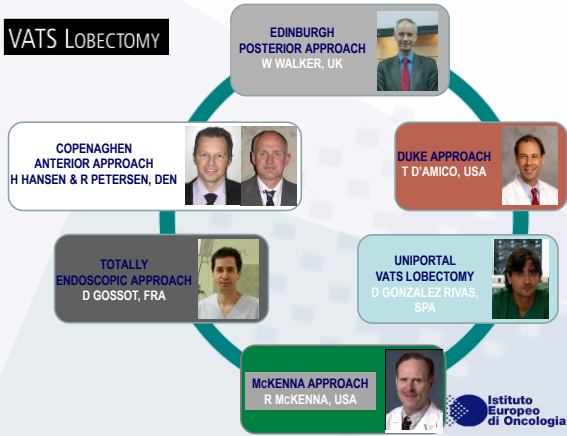- Fastern return to previous activity level

VATS = Standard approach for early stage lung cancer in USA

Video-Assisted Thoracoscopic Lobectomy Is Less Costly and Morbid Than Open Lobectomy: A Retrospective Multiinstitutional Database Analysis

Scott J. Swanson, MD, Bryan F. Meyers, MD, Candace L. Gunnarsson, EdD, Matthew Moore, MHA, John A. Howington, MD, Michael A. Maddaus, MD, Robert J. McKenna, MD, and Daniel L. Miller, MD

(Ann Thorac Surg 2012;93:1027–32)
© 2012 by The Society of Thoracic Surgeons

VATS LOBECTOMY

EDINBURGH POSTERIOR APPROACH
W WALKER, UK

COPENAGHEN ANTERIOR APPROACH
H HANSEN & R PETERSEN, DEN

DUKE APPROACH
T D'AMICO, USA

TOTALLY ENDOSCOPIC APPROACH
D GOSSOT, FRA

UNIPORTAL VATS LOBECTOMY
D GONZALEZ RIVAS, SPA

McKENNA APPROACH
R McKENNA, USA

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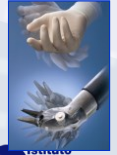

ROBOTIC SURGERY

To overcome vats limitations, micromechanic and robotic technology was introduced in the mid-1990.
Natural movements of the surgeon's hands are traslated into **precise instrument movements** inside the patient with tremor filtration.
Three dimensional view offers a visual magnification that compensate the absence of haptic feedback
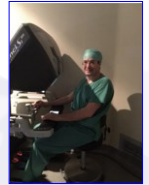
➢ Robotic system can made advanced thoracoscopic surgery accessible to surgeons who do not have advanced videoendoscopic training
➢ Expand indications
➢ Advantages for patients

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ROBOTIC SURGERY

Feasible?

Acceptable learning curve?

Adequate oncological results?

VATS or Robotic resection?

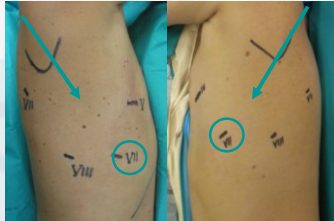Istituto Europeo di Oncologia

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ROBOTIC LOBECTOMIES
- Literature-

Lead Author	Year	Pts	OT (min)	LOS (Days)	Compl. (%)	Mortality (%)	Conversion (%)
Melfi	2004	107	220	5	na	1	na
Park	2006	30	218	4.5	26	0	12
Gharagozloo	2009	100	216	4	21	3	13
Dylewski	2011	165 / 35*	90	3	26	0	1.5
Cerfolio	2011	106 /16*	132	2	27	0	10
IEO	2010	54	224	4.5	20	0	9.4
Park, IEO, Pisa	2012	325	210	5	25	na	8
IEO	2012	91	213	5	20	0	10
Meyer	2012	185	211	4	17	2	2
Adam	2014	120	242	4.7	na	0	3.3
Melfi	2014	68/160	222/166	4.4/3.8	na	1/0	10/6
Velez-Cubian	2015	104/104	179/172	6/4	na	3/0	7/13
IEO	2018	339	192	5	25.6	0	6.5

* segmentectomies
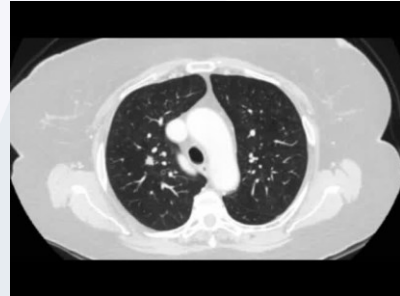
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ROBOTIC LOBECTOMY
- IEO tecnique -

- Lateral position
- Robot at the head posteriorly
- Four incisions including a small utility incision
- Camera arm: VII space mid axillary line
- No rib spreading
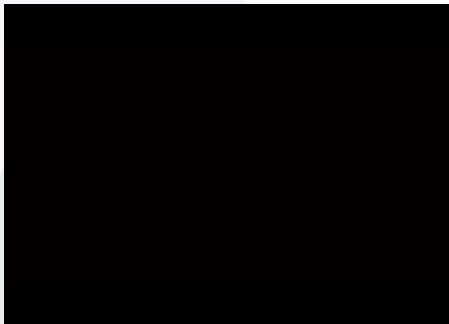- Individual ligation of hilar elements

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Right upper lobectomy

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LYMPHADENECTOMY

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Spaggiari L. Ann Thorac Surg. 2011

ROBOTIC SURGERY

Feasible?

Acceptable learning curve?

Adequate oncological results?

VATS or Robotic resection?

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LEARNING CURVE

ROBOTIC AND VATS LOBECTOMIES

Author	Year	Operation	No. of operations
Melfi	2008	Robotic lobectomy	20
Gharagozloo	2009	Robotic lobectomy	20
Louie	2012	Robotic lobectomy	6
IEO	2010	Robotic lobectomy	18
IEO	2011	VATS lobectomy	30-50
Lee	2009	VATS lobectomy	30-50
Belgers	2010	VATS lobectomy	25-30
Petersen	2010	VATS lobectomy	50

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**ROBOTIC LOBETCOMY
Mean duration: 220 min**

Plateau reached after the first 18 cases
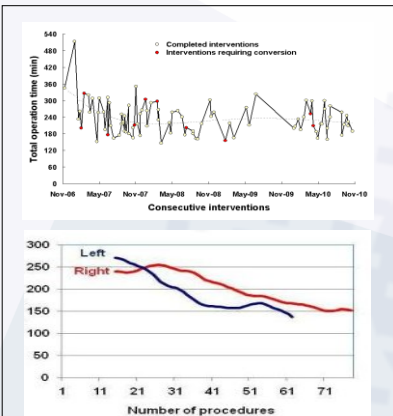
IEO, Innovation 2011

**VATS LOBECTOMY
Mean duration: 206 min**

Plateau reached after 50 cases

Lee, AATS 2009

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Four-arm robotic lobectomy for the treatment of early-stage lung cancer

Giulia Veronesi, MD,[a] Domenico Galetta, MD,[a] Patrick Maisonneuve, DipEng,[b] Franca Melfi, MD,[c] Ralph Alexander Schmid, MD,[d] Alessandro Borri, MD,[a] Fernando Vannucci, MD,[a] and Lorenzo Spaggiari, MD, PhD[a,e]

JTCVS 2010

LEARNING CURVE - SAFETY - RADICALITY

	ROBOT (54)			OPEN (54)	p value I vs II+III	p value II+III vs Open
	I	II	III			
Complications	33%	22%	6%	19%	0.04	0.77
Operative time	260	213	235	154	0.02	<0.0001
Postop days	6 days	5 days	4 days	6 days	0.002	0.002
Median N° LN	15	17	17	18	0.24	0.72

1) Learning curve include 18 pts, complications, postoperative days and operative time declines with experience
2) Postoperative stay was SHORTEN after robotic than open procedures
3) Complications and N° lymph nodes removed were comparable in open and robotic lobectomies

ROBOTIC SURGERY

Feasible?

Acceptable learning curve?

Adequate oncological results?

VATS or Robotic resection?

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ROBOTIC LOBECTOMY FOR NON-SMALL CELL LUNG CANCER (NSCLC): LONG-TERM ONCOLOGIC RESULTS
B.J. Park, F. Melfi, P. Maisonneuve, L. Spaggiari, R Da Silva, G. Veronesi
Journal of Thoracic and Cardiovascular Surgery 2011

Log-rank P=0.0001
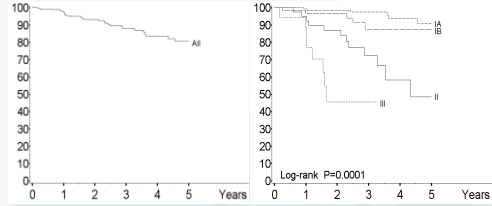
Pathologic stage	325	
IA	176	(54%)
IB	72	(22%)
IIA	41	(13%)
IIB	15	(5%)
IIIA	21	(6%)

Oncological results after 325 robotic lobectomies are comparable to open/ vats results. 90% 5 years survival in stage 1 disease

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Initial consecutive experience of completely portal robotic pulmonary resection with 4 arms

Robert J. Cerfolio, MD, FACS, FCCP, Ayesha S. Bryant, MD, MSPH, Loki Skylizard, MD, and Douglas James Minnich, MD, FACS

J Thorac Cardiovasc Surg, 2011

	Robotic operation (N = 106)	Rib- and nerve-sparing thoracotomy (N = 318)	P value
Estimated blood loss (mL, median ± SD)	30 ± 26	90 ± 22	.03
Operative time (h, median ± SD)	2.2 ± 1.0	1.5 ± 0.8	<.001
No. of mediastinal (N2) lymph node stations removed (median)	5	5	>.999
No. of mediastinal (N2) lymph nodes removed (median)	12	11	.906
No. of N1 lymph-node stations removed (median)	2	2	>.999
No. of N1 lymph node removed (median)	5	4	.89
Chest tube duration (d, median and range)	1.5 (1-6)	3.0 (1-67)	<.001
Hospital stay (d, median and range)	2.0 (1-7)	4.0 (1-67)	.01
Morbidity (no.)	28 (27%)	120 (38%)	.05
Operative mortality (no.)	0	11 (3%)	.11
Verbal pain score 3 wk postoperatively (median and range)	2.5 (0-7)	4.4 (0-8)	.04

No difference in lymph node dissection

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THORACIC: LUNG CANCER

The long-term survival of robotic lobectomy for non–small cell lung cancer: A multi-institutional study

Robert J. Cerfolio, MD, MBA,[a] Asem F. Ghanim, MD,[a] Mark Dylewski, MD,[b] Giulia Veronesi, MD,[c,d] Lorenzo Spaggiari, MD,[d] and Bernard J. Park, MD[e]
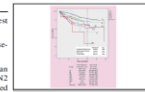
Objective: Our objective is to report the world's largest series with the longest follow-up of robotic lobectomy for non–small cell lung cancer (NSCLC).

Methods: This was a multi-institutional retrospective review of a consecutive series of patients from 4 institutions' prospective robotic databases.

Results: There were 1339 patients (men 55%, median age 68 years). The median operative time was 136 minutes, median number of lymph nodes was 13 (5 N2 stations and 1 N1), median blood loss was 50 cc, and 4 (0.005%) patients received intraoperative transfusions. Conversions occurred in 116 patients (9%) and for bleeding in 24 (2%). Median length of stay was 3 days. Major morbidity occurred in 8%. The 30-day and 90-day operative mortality was 0.2% and 0.5%, respectively. Follow-up was complete in 99% of patients with a median follow-up of 30 months (range 1-154 months). The 5-year stage-specific survival was 83% for the 672 patients with stage IA NSCLC, 77% for the 281 patients with stage IB, 68% for the 118 patients with stage IIA, 70% for 99 patients with stage IIB, 62% for 143 patients with stage IIIA (122 had N2 disease, 73%), and 31% for 8 patients with stage IIIB (none had N3 disease). The cumulative incidence of metastatic NSCLC was 15% (128 patients, 95% confidence interval, 12%-18%). The cumulative incidence of local recurrence in the ipsilateral operated chest was 3% only (26 patients, 95% confidence interval, 2%-5%).

Conclusions: The oncologic results of robotic lobectomy for NSCLC are promising, especially for patients with pathologic N2 disease. However, further follow-up and studies are needed. (J Thorac Cardiovasc Surg 2018;155:778-86)

Stage-specific survival for non-small cell lung cancer after robotic lobectomy

Central Message
Our objective is to report the world's largest series with the longest follow-up of robotic lobectomy for non-small cell lung cancer.

Perspective
The mid-term oncologic results of robotic lobectomy for non-small cell lung cancer are quite promising, especially for patients with pathologic N2 disease.

See Editorial Commentary page 787.
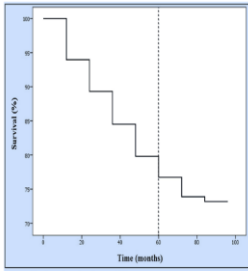
See Editorial page 777.

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Slide (top-left):

Survival (%) / Time (months)

Total number of patients = 1339
Number of patients with complete 5-year follow-up = 387
Estimated 5-year survival = 77% (95%CI=74-79)

FIGURE 1. Overall survival for non-small cell lung cancer after robotic lobectomy. CI, Confidence interval.

Log Rank (Mantel-Cox), Breslow (Generalized Wilcoxon), Tarone-Ware

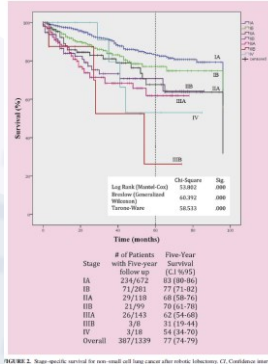| Stage	# of Patients with Five-year follow up	Five-Year Survival (CI (%-95)
IA	234/672	83 (80-86)
IB	71/281	77 (71-82)
IIA	29/118	68 (58-76)
IIB	21/99	70 (61-78)
IIIA	26/143	62 (54-68)
IIIB	3/8	31 (19-44)
IV	3/18	54 (34-70)
Overall	387/1339	77 (74-79)

FIGURE 2. Stage-specific survival for non-small cell lung cancer after robotic lobectomy. CI, Confidence interval.

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Slide (top-right):

Ten years' experience in robotic thoracic surgery for early stage lung cancer: evolution and lessons learned

M. Casiraghi, D. Galetta, A. Borri, A. Tessitore, R. Romano, C. Diotti, D. Brambilla, P. Maisonneuve, L. Spaggiari Thor Cardiovasc Surg. 2018

339 patients underwent RATS for clinical stage I (n=318) or II (n=21) NSCLC

	All N=339	Pneumonectomy N=3	Lobectomy N=307	Segmentectomy N=29
IA	264 (77.9)	1 (33.3)	236 (76.9)	27 (93.1)
IIA	17 (5.0)	1 (33.3)	16 (5.2)	-
Histology				
Squamous cell carcinoma	40 (11.8)	-	38 (12.4)	2 (6.9)
Other types	13 (3.8)	-	5 (1.6)	-
Median [range]	18 [3-98]	45 [23-98]	19 [3-85]	13 [6-34]

22 conversions (6.5%):
4 (1.2%) oncological reasons
3 (0.9%) bleeding
15 (4.4%) technical issue

Pneumonectomy N=3	Lobectomy N=286	Segmentectomy N=28

Median length of stay was 5 days (range 2-191)

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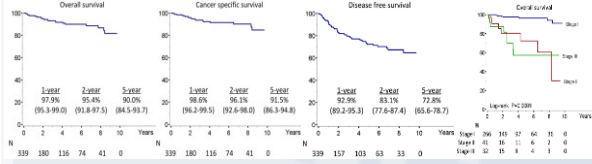

Slide (bottom-left):

Overall median N1+N2 station resected was 5 (range 1-8)
Overall median N1+N2 lymph nodes resected was 15 (1-55)

Pathological upstaged → 17.6% (56/317)

STAGE II → 76.4%
STAGE I → 96.4%
STAGE III → 57.8%

Median follow-up of 2.4 years (0.1-9.7)

Overall survival

1-year	2-year	5-year
97.9%	95.4%	90.0%
(95.3-99.0)	(91.8-97.5)	(84.5-93.7)

N 339 180 116 74 41 0

Cancer specific survival

1-year	2-year	5-year
98.6%	96.1%	91.5%
(96.2-99.5)	(92.6-98.0)	(86.3-94.8)

N 339 180 116 74 41 0

Disease free survival

1-year	2-year	5-year
92.9%	83.1%	72.8%
(89.2-95.3)	(77.6-87.4)	(65.6-78.7)

N 339 157 103 63 33 0

Overall survival

Stage | 296 149 97 60 31 0
Stage II | 41 16 11 6 2 0
Stage III | 12 15 8 8 1 0

Thor Cardiovasc Surg. 2018

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Slide (bottom-right):

ROBOTIC SURGERY

Feasible?

Acceptable learning curve?

Adequate oncological results?

VATS or Robotic resection?

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Slide 1

"La volpe e l'uva" di Esopo

Una volpe affamata vide dei grappoli d'uva che pendevano da un pergolato, e tentò di afferrarli. Ma non ci riuscì. "Robaccia acerba!" disse allora tra sé e sé; e se ne andò.

Così, anche fra gli uomini, c'è chi, non riuscendo per incapacità a raggiungere il suo intento, ne dà la colpa alle circostanze.

## Slide 2

ROBOT vs VATS

ADVANTAGES

1. Intuitive movements
2. Tremor filtration
3. Increased degrees of freedom
4. Motion scaling
5. Stereoscopic vision
6. Stable camera platform
7. Equivalence between the dominant and non-dominant hands
8. Motion analysis
9. Eye-hand-target alignment
10. Possibly shorter learning curve

DISADVANTAGES

1. Costs
2. Loss of tactile feedback
3. Limited instrumentation available
4. Significant system set-up time
5. Need of at least one experienced assistant
6. Possible delayed response by the surgeon in case of catastrophic event

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Slide 3

Eye-hand-target alignment

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Slide 4
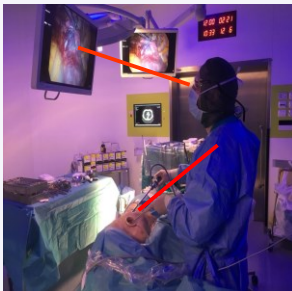
Robot-Assisted Thoracoscopic Surgery versus Video-Assisted Thoracoscopic Surgery for Lung Lobectomy: Can a Robotic Approach Improve Short-Term Outcomes and Operative Safety?

Julien Mahieu, Philippe Rinieri, Michael Bubenheim, Emile Calenda, Jean Melki, Christophe Peillon, Jean-Marc Baste

Thorac cardiovasc Surg 2015

	V Group (n = 28)	R Group (n = 28)	p-Value
Preincision time, median (min)	60	80	<0.0001
Operative time, median (min)	185	190	0.55
Length of stay, median (d)	7	6	0.40
Conversion, no. (%)	5 (17.8)	3 (10.7)	0.5
Emergency, no.	4	1	
Other reasons, no.	1	2	
Morbidity, no. (%)	12 (42.8)	14 (50)	0.9347
Grade I (Clavien–Dindo Classification)	8 (28.5%)	8 (28.5%)	
Grade ≥ III (Clavien–Dindo Classification)	4 (14%)	6 (21.4%)	
Grade IIIA	4	1	
Grade IIIB	0	2	
Grade IV	0	3	
30-day mortality, no.	0	0	
Intraoperative bleeding, median (mL)	200	100	0.1147
Drainage time, median (d)	5	5	0.7897
Drainage > 7 d, no. (%)	5 (17.8)	7 (25)	0.7458

Perioperative outcomes are similar even in the learning period but robotic approach seems to offer **more operative safety with fewer conversions** for uncontrolled bleeding.

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The Prevalence of Nodal Upstaging During Robotic Lung Resection in Early Stage Non-Small Cell Lung Cancer

Jennifer L. Wilson, MD, Brian E. Louie, MD., Robert J. Cerfolio, MD, Bernard J. Park, MD, Eric Vallières, MD, Ralph W. Aye, MD, Ahmed Abdel-Razek, MD, Ayesha Bryant, MD, Alexander S. Farivar

302 patients
Pathologic nodal upstaging occurred in 33 patients (10.9%)
pN1   6.6%;
pN2   4.3%

Hilar (pN1) upstaging	Robot	Vats	Thoracotomy
cT1a	3.5	5.2	7.5
cT1b	8.6	7.1	8.8
cT2a	10.8	5.7	11.5

The rate of nodal upstaging for robotic resection appears to be superior to VATS and comparable to thoracotomy
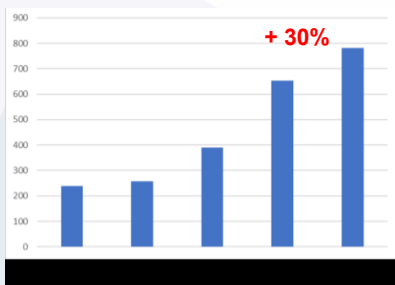

CONCLUSIONS

Modern medicine and diffusion of screening programs require less invasive treatment for very early stage lung cancers or mediastinal diseases

Robotic lobectomy with lymph node dissection is safe and associated with significantly shorter postoperative hospitalization than open surgery
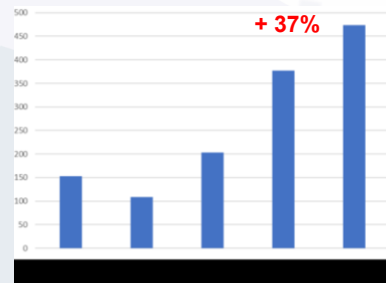
Most disadvantages of the robotics will be overcome when technological advances improves instrumentation and extended use of robotics reduces costs
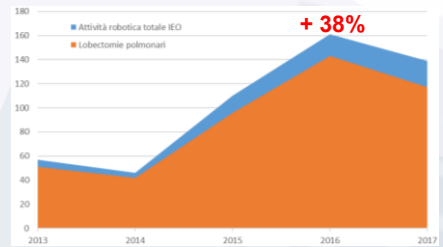
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Robotic Thoracic Surgery in Italy

+ 30%

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Robotic Pulmonary Lobectomy in Italy

+ 37%

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Slide 1 (top-left):

✓ Istituto Europeo di Oncologia - Milano
✓ Ospedale Humanitas - Rozzano

100

✓ Ospedale Universitario di Padova

✓ Ospedale Cisanello - Pisa

✓ Istituto Nazionale Tumori Regina Elena - Roma

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Slide 2 (top-right):

Robotic Thoracic Surgery at IEO

In our Division we performed 22% of the thoracic robotic surgery in Italy

+ 38%

- Attività robotica totale IEO
- Lobectomie polmonari

180
160
140
120
100
80
60
40
20
0

2013   2014   2015   2016   2017

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Slide 3 (bottom-left):

what's
NEXT

Slide 4 (bottom-right):

THE ANNALS
OF
THORACIC SURGERY

ARTICOLO FULL TEXT

Robotic Hybrid Approach for an Anterior Pancoast Tumor in a Severely Obese Patient

Articolo in stampa: Testo accettato

Alessio Vincenzo Mariolo MD, Monica Casiraghi MD, Domenico Galetta MD, PhD e Lorenzo Spaggiari MD, PhD
Annals of Thoracic Surgery, Copyright © 2018

Abstract

Several different surgical approaches to anterior Pancoast tumors have been proposed. The transmanubrial osteomuscular sparing approach (TMA) allows optimal exposure and control of apical chest wall structures, but requires an additional thoracotomy to perform the lobectomy with radical lymph node resection. The presented technique combines TMA with robotic-assisted upper lobectomy in a severely obese patient, reducing the invasiveness of the surgical approach and the postoperative complications.

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Not available for sale…yet!

Grazie