Video Assisted Thoracoscopic Surgery (VATS) and One Lung Anesthesia Management

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Disclosure

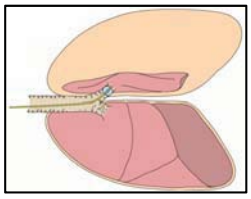
- **Advisory board member of the ET View Medical, Ltd.**
- **Paid consultant ET View Medical, Ltd.**

General Facts

- Each year in the US, 173,000 Americans are diagnosed with lung cancer
- 78,000 lobectomies and pneumonectomies are performed each year in the U.S.
- Approximately 5% are performed with video-assisted thoracoscopic surgery (VATS)
- Morbidity VATS (2-22%)
- Mortality VATS (0.5-2.0%)

Objectives

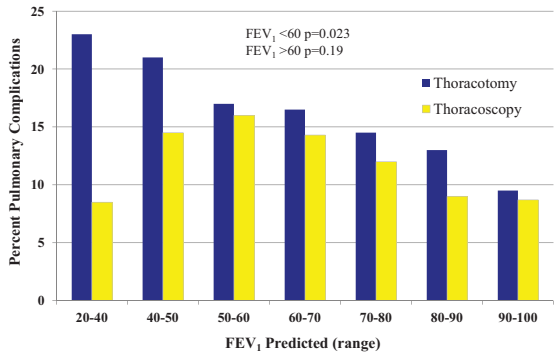
- Advantages
- Robotic assisted VATS
- Lung separation
- Ventilatory strategies
- Paravertebral blocks
- Outcomes
- Recommendations



Advantages of VATS

- Less pulmonary complications in pts with FEV_1 <60%
- Preserved postoperative pulmonary function
- Decreased blood loss
- Decreased pain
- Decreased inflammatory response
- Shorter length of stay

D'Amico TA: Thorac Surg Clin 2008; 18: 259-263
Ceppa DP, et al: Ann Surg. 2012;256:487-493
Paul S, et al: Eur J Cardio Thorac Surg 2013; 43: 813-817



Ceppa DP, et al: Ann Surg. 2012;256:487-493

Thoracoscopic Lobectomy is Associated with Lower Morbidity Compared with Thoracotomy

Overall Postoperative Complications (n=1079)		
Complication	**THOR (n=582)**	**VATS (n=697)**
Atrial fibrillation (%)	85 (22)	111 (16) SS
Transfusion n (%)	46 (12)	34 (5) SS
Atelectasis n (%)	47 (12)	27 (4) SS
Pneumonia n (%)	35 (9)	29 (4) SS
Prolonged air leak n (%)	73 (19)	77 (11) SS
Length of hospital stay	5 (4-7)	4 (3-5) SS
Death	22 (6)	14 (2) SS

Villamizar NR, et al: J Thorac Cardiovasc Surg 2009; 138: 419-425

VATS and Morbidity and Mortality

Author	n	End Points	Outcome
McKenna RJ, et al: Ann Thorac Surg 2006, 81:421-6	• n=1100 cases • Retrospective observation study	• Morbidity and mortality • safety	• Morbidity 15% • Mortality 0.8%
Onaitis MW, et al: Ann Surg 2006; 244: 420-5	• n=500 cases • Prospective consecutive patients	• Morbidity and mortality • Safety efficacy	• Morbidity 20% • Mortality 1.2%

VATS: Robotic Surgery

Author	n	End Points	Outcome
Gharagozloo F, et al: Ann Thorac Surg 2009; 88: 380-4	• n=100 • Retrospective review consecutive patients	• Robot-assisted lobectomy during VATS • Outcomes	• Morbidity 21% • Mortality 3.0%
Cerfolio RJ, et al: J Thorac Cardiovasc Surg 2011; 142: 740-6	• n=168 • Retrospective review consecutive patients	• Safety of robotic pulmonary resection	• Morbidity 27% • Shorter hospital stay (<1day) • Cost ??

Campos JH: Curr Opin Anaesthesiol 2010; 23:1–6

Robot-Assisted Lobectomy (RAL) vs VATS

Author	n	End Points	Outcome
Jan H J, et al: Innovations 2011; 6:305-10	• n=40 RAL • n=80 VATS • Consecutive patients • Observational study	• Comparison of the efficacy of RAL versus VATS	• Operative times RAL 240 ± 62 min VATS 161 ± 39 min • Postoperative comp RAL n= 4: 10% VATS n=13: 32.5% • Length of stay RALS n= 6 days VATS n= 7 days
Ye B, et al: World J Surg Onc 2013; 11: 157-62	• n=25 VATS • n=21 RATS	• Comparison of perioperatory outcomes for robot assisted TS vs VATS for thymoma	• Length of stay RATS n= 3.7 days VATS n= 6.7 days

Limitations with Robotic Surgery

- Lengthy operations (surgical times > 8 hrs)
- Conversion to an open procedure
- Failure of the equipment
- Cost/effectiveness
- Minimal net revenue

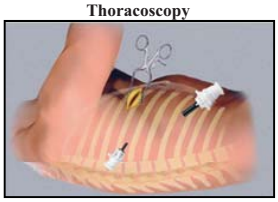
Campos JH: Anaesthesia International 2011; 19-22

Points to Consider While Robotic Surgical System is in Use

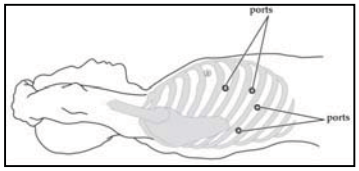
- No changes in patients position on OR table once the robot has been docked
  Campos JH: Curr Opin Anaesthesiol 2010; 23:1-6
- Protection of pressure points (arms and legs)
- Avoidance of stretching the arms
  Pandey R, et al: J Cardiothoracic Vasc Anesth 2009; 23: 584-586
- Attention to crushing injuries by robotic arms
  Campos JH: Minerva Anestesiol 2013; 79:1-6

Surgical Access for VATS or Robotic Surgery

Thoracoscopy



Robotic Assisted Surgery



VATS with a Single-Lumen Tube

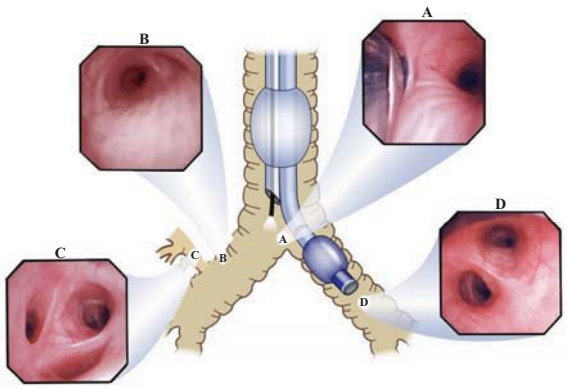
- n= 376 pts. VATS
- n=208 pts. underwent biopsy of parietal pleura and talc pleurodesis
- All received single-lumen endotracheal tube
- Apneic period (prior opening chest)
- Tidal volume 150-250 ml

Cerfolio JR, et al: Chest 2004;126:281-285

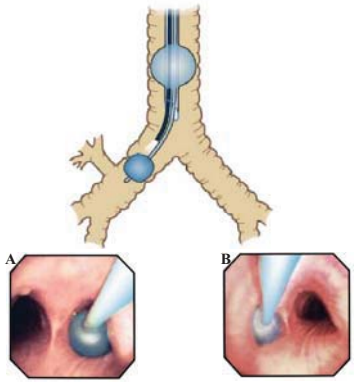
Lung Separation

Double Lumen Tube	Bronchial Blocker
L-DLT R-DLT	Arndt Cohen Fuji EZ Blocker
• Surgical exposure	• Video thoracoscopic surgery (VATS)
• Prevention of contamination	• Difficult airways (oral or nasal intubation)
• Differential lung ventilation	• Unique situations (tracheostomy pts)
	• Selective lobar blockade

Campos J: Lung Isolation. Chapter 16 in Principles and Practice of Anesthesia for Thoracic Surgery, 2011 pp 227-246.



Campos JH: Curr Opin Anaesthesiol 2009; 22: 4-10



Campos JH: Thorac Surg Clin 2005; 15; 71-83

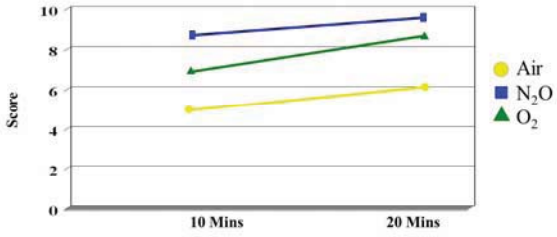
Campos JH: Cadaver Study with MDCT

Right-Sided Spherical Shaped Bronchial Blocker

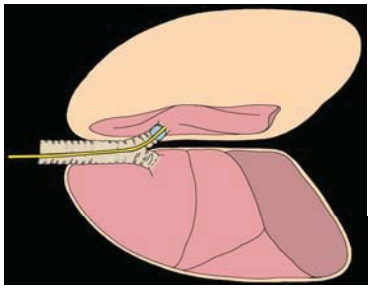
A B C

Campos JH: Curr Opin Anaesthesiol 2009; 22: 4-10

The Use of Air in the Inspired Gas Mixture During Two-Lung Ventilation Delays Lung Collapse During One-Lung Ventilation

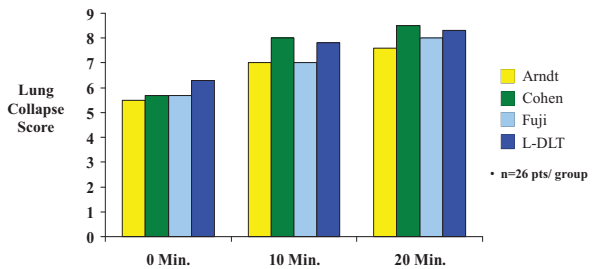


Ko R, Anesth Analg 2009; 108:1092-1096



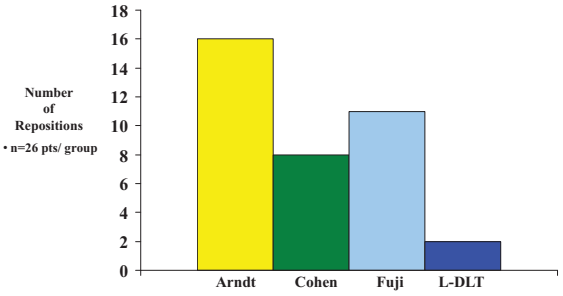
- Administer FiO_2 1.0%
- Prior to balloon inflation stop ventilation
- Under direct FOB insufflate balloon
- Start intermittent suction
- Reassume ventilation dependent lung

Performance Bronchial Blockers vs Double-Lumen Tubes



Narayanaswamy N, et al: Anesth Analg 2009; 108:1097–101

Performance Bronchial Blockers vs Double-Lumen Tubes



Narayanaswamy N, et al: Anesth Analg 2009; 108:1097–1101

A Comparison of the EZ-Blocker with a Cohen Flex-Tip Blocker for OLV

PRCT	Cohen Group n=20 Right/Left	EZ Group n=20 Right/Left
Malposition		
• Blocker balloon herniation into trachea	1/1	0
• Blocker balloon not visible below carina	3/0	0
• Both balloons of EZ-blocker going • into same main bronchus	NA	2/1
Surgeon Satisfaction (Lung Collapse)		
• Good	14	18
• Fair	6	2

Kus A, et al: J Cardiothorac Vasc Anesth (Aug) 2013

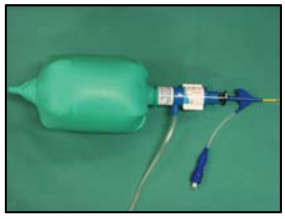
Predictors of Hypoxia During OLV

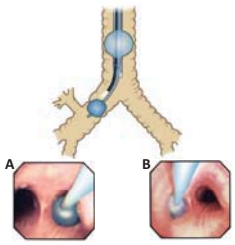
Author	n	End Points	Outcome
Slinger P, et al Can J Anaesth 1992; 39: 1030-35	– n=50 (retrospective) – n=30 (prospective)	• Potential predictors of PaO_2 during OLV – Side operation – Preoperative PFTs – Pre and intra PaO_2	• Side right of operation • Preoperative FEV_1% • Intraoperative PaO_2 2LV
Suemitsu R, et al Asian Cardiovasc Thorac Ann 2008; 16: 463-67	• n=822(retrospective)	• Effect BMI and complications in thoracic surgery	• BMI >30 kg/m^2 • >intraoperative hypoxemia • ↑ alveolar arterial O_2 Δ

Alveolar Recruitment Strategies

Author	n	End Points	Outcome
Unzueta C, et al Br J Anaesth 2012; 108: 517-24	n=40 PCT n=20 control (6ml•kg V_t) n=20 ARS study group	• Effects on oxygenation • Alveolar Recruitment – PIP 40cmH_2O – PEEP 5-20 cmH_2O for 10 breaths before and after OLV (1min)	• PaO_2 during OLV 20 min • Control group 182±79 • ARS study group 251±69 (mmHg)

- This may cause transient hypotension
- Also a transient further decrease in PaO_2
- Improvement on oxygenation and decrease alveolar dead space



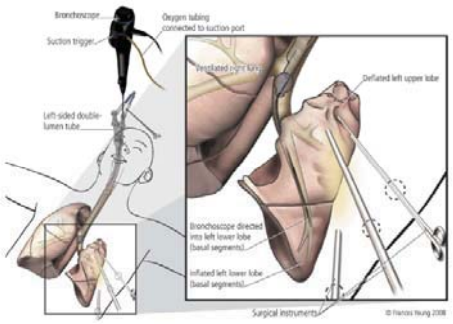


- CPAP must be applied to fully inflated recruited lung to be effective (5-10 Cm H_20)

Campos JH: Anesth Analg 1997; 85:583-586

Campos JH: Curr Opin Anaesthesiol 2009, 22:18-22

Fiberoptic Bronchoscopy Segmental O_2 Insufflation

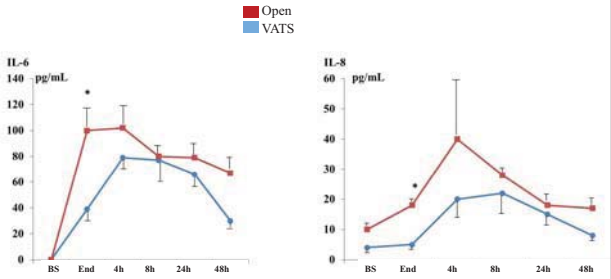


Ku CM, et al: J Cardiothorac Vasc Anesth. 2009; 23:850-852

VATS Lobectomy Reduces Cytokine Responses Compared with Conventional Surgery

- n = 36 pts (clinical stage I non-small cell cancer)
- Group 1, n = 18 VATS lobectomy
- Group 2, n = 18 open thoracotomy
- Plasma levels - tumor necrosis factor-α (TNF-α)
  - Interleukin (IL) 1β, IL-6, IL-8
  - anti-inflammatory cytokine IL-10

Yim APC, et al: Ann Thorac Surg 2000;70:243-7



Yim APC, et al: Ann Thorac Surg 2000;70:243-7

VATS with Local Anesthesia-Sedation

- n=115 VATS, ages (21-88)
- Sedation (midazolam, fentanyl, propofol)
- Propofol infusion 120ug/kg/min
- O_2 face mask, $ETCO_2$ monitor
- Local infiltration (lidocaine)

Katlic MR: Eur J Cardio Thorac Surg 2006; 30:529-532

Points to Consider During an Awake VATS

- Intraoperative pneumothorax
- Patient coughing or moving (upon touching cartilaginous bronchioles)
- Potential for conversion: general anesthesia/ open thoracotomy

Katlic MR: Eur J Cardio Thorac Surg 2006; 30:529-532

Feasibility and Results of Awake Thoracoscopic Resection of Solitary Pulmonary Nodules

- n = 60 pts randomized into two groups
  - Group 1 n = 30 VATS-OLV-general anesthesia
  - Group 2 n = 30 VATS-Thoracic epidural anesthesia (T_4)
- Surgical technique – lateral decubitus position
  - 3-flexible-thoracoscopic-trocar access
- VATS was easily and safely performed TEA 26/28 pts.

Pompeo E, et al: Ann Thorac Surg 2004;78:1761-68

VATS at 20 years: a Consensus Statement

- Summary of responses regarding perioperative management of VATS lobectomy (international panel 50 experts)
- Preferred postoperative pain management

Technique	n=Respondents (%)
PCA (only)	6 (12)
Epidural	17 (34)
Paravertebral	10 (34)
Intercostal nerve block	17 (34)

Yan TD, et al: Eur J Cardioth Surg 2013; 1-7

Thoracic Paravertebral Block for VATS

Author	n	End Points	Outcome
Vogt A, et al: Br J Anaesth 2005; 6: 816-21	• n=40 • PRCT – PVB_s group +PCA – Control group placebo +PCA	• Single injection PVB_s will reduce pain scores (bupivacaine)	• Single shot PVB <pain scores than PCA alone up to 48 hours
Hill SE, et al: Anesthesiology 2006; 104:1047-33	• n=80 • PRCT – Multilevel single dose PVB – Control group saline solution	• Efficacy of analgesia in VATS (bupivacaine 0.5%)	• Single dose multilevel PVB is effective in reducing pain only first 6 hrs after block • Not recommended for VATS
Kaya FN, et al J Cardiothorac Vasc Ansth 2012; 26:90-94	• n=50 • PRCT – Single injection vs – Multiple injection	• Efficacy of single injection vs multiple injection PVB_s on postoperative analgesia in VATS (bupivacaine 0.5%)	• Pain scores and morphine consumption were comparable both groups • Patient satisfaction was > in the single injection group

Summary

- Thoracoscopic surgery has many advantages over open thoracotomies
- Mortality (<), however morbidity (↑)
- Anesthesia techniques the best that suits your practice
- DLT for the vast majority of cases or BB
- Paravertebral blocks for analgesia
- Robotic assisted surgery needs further research

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Reference List

1. D'Amico TA: Long-term outcomes of thoracoscopic lobectomy Thorac Surg Clin 2008; 18: 259-263
2. Ceppa DP, et al: Thoracoscopic lobectomy has increasing benefit in patients with poor pulmonary function: a Society of Thoracic Surgeons Database analysis Ann Surg. 2012;256:487-493
3. Paul S, et al: Outcomes after lobectomy using thoracoscopy vs thoracotomy: a comparative effectiveness analysis utilizing the Nationwide Inpatient Sample database Eur J Cardio Thorac Surg 2013; 43: 813-817
4. Villamizar NR, et al: Thoracoscopic lobectomy is associated with lower morbidity compared with thoracotomy J Thorac Cardiovasc Surg 2009; 138: 419-425
5. McKenna RJ, et al: Video-assisted thoracic surgery lobectomy: experience with 1,100 cases Ann Thorac Surg 2006, 81:421-6
6. Onaitis MW, et al: Thoracoscopic lobectomy is a safe and versatile procedure: experience with 500 consecutive patients Ann Surg 2006; 244: 420-5
7. Gharagozloo F, et al: Robot-assisted lobectomy for early-stage lung cancer: report of 100 consecutive cases Ann Thorac Surg 2009; 88: 380-4
8. Cerfolio RJ, et al: Initial consecutive experience of completely portal robotic pulmonary resection with 4 armsJ Thorac Cardiovasc Surg 2011; 142: 740-6
9. Campos JH: An update on robotic thoracic surgery and anesthesia Curr Opin Anaesthesiol 2010; 23:1–6
10. Campos JH: Anaesthesia for robotic surgery: ediastinal mass resection and Pulmonary resections Anaesthesia International 2011; 19-22

Reference List

11. Pandey R, et al: Brachial plexus injury after robotic-assisted thoracoscopic thymectomy J Cardiothoracic Vasc Anesth 2009; 23: 584-586
12. Campos J: Lung Isolation. Chapter 16 in Principles and Practice of Anesthesia for Thoracic Surgery, 2011 pp 227-246.
13. Cerfolio JR, et al: Video-assisted thoracoscopic surgery using single-lumen endotracheal tube anesthesia Chest 2004;126:281-285
14. Campos JH: Update on tracheobronchial anatomy and flexible fiberoptic bronchoscopy in thoracic anesthesia Curr Opin Anaesthesiol 2009; 22: 4-10
15. Campos JH: Progress in lung separation Thorac Surg Clin 2005; 15; 71-83
16. Ko R, The use of air in the inspired gas mixture during two-lung ventilation delays lung collapse during one-lung ventilation Anesth Analg 2009; 108: 1092-1098
17. Jan H J, et al: Comparison of the early robot-assisted lobectomy experience to video-assisted thoracic surgery lobectomy for lung cancer: a single-institution case series matching study Innovations 2011; 6:305-10
18. Ye B, et al: Video-assisted thoracoscopic surgery versus robotic-assisted thoracoscopic surgery in the surgical treatment of Masaoka stage I thymoma World J Surg Onc 2013; 11: 157-62
19. Unzueta C, et al: Alveolar recruitment improves ventilation during thoracic surgery: a randomized controlled trial. Br J Anaesth 2012; 108: 517-24
20. Campos JH: Effects of oxygenation during selective lobar versus total lung collapse with or without continuous positive airway pressure Anesth Analg 1997; 85:583-586

Reference List

21. Campos JH: Update on selective lobar blockade during pulmonary resections Curr Opin Anaesthesiol 2009, 22:18-22
22. Ku CM, et al: J Cardiothorac Vasc Anesth. 2009; 23:850-852
23. Narayanaswamy N, et al: A novel method of treating hypoxemia during one-lung ventilation for thoracoscopic surgery Anesth Analg 2009; 108:1097–101
24. Kus A, et al: A Comparison of the EZ-Blocker with a Cohen Flex-Tip Blocker for One-Lung Ventilation J Cardiothorac Vasc Anesth (Aug) 2013
25. Yim APC, et al: VATS lobectomy reduces cytokine responses compared with conventional surgery Ann Thorac Surg 2000;70:243-7
26. Katlic MR: Eur J Cardio Video-assisted thoracic surgery utilizing local anesthesia and sedation Thorac Surg 2006; 30:529-532
27. Addullatief MA, et al: Awake anaesthesia for major thoracic surgical procedures: an observational study Eur J Cardiothorac Surg 2007;32:346-350
28. Pompeo E, et al: Feasibility and Results of Awake Thoracoscopic Resection of Solitary Pulmonary Nodules Ann Thorac Surg 2004;78:1761-68
29. Yan TD, et al: Video-assisted thoracoscopic surgery lobectomy at 20 years: a consensus statement Eur J Cardioth Surg 2013; 1-7
30. Vogt A, et al: Single-injection thoracic paravertebral block for postoperative pain treatment after thoracoscopic surgery Br J Anaesth 2005; 6: 816-21

Reference List

31. Hill SE, et al: Efficacy of single-dose, multilevel paravertebral nerve blockade for analgesia after thoracoscopic procedure Asnesthesiology 2006; 104:1047-33
32. Kaya FN, et al Thoracic paravertebral block for video-assisted thoracoscopic surgery: single injection versus multiple injections J Cardiothorac Vasc Ansth 2012; 26:90-94
33. Mathisen DJ: Is video-assisted thoracoscopic lobectomy inferior to open lobectomy oncologically? Ann Thorac Surg 2013;96:755-756
34. Park BJ, et al: Park BJ, et al: Thorac Surg Clin 2008;18:297-300 Thorac Surg Clin 2008;18:297-300
35. Liu TJ, et al : Video-Assisted Thoracoscopic Surgical Thymectomy to Treat Early Thymoma: A Comparison with the Conventional Transsternal Approach Ann Surg Oncol. 2013 Aug 28
36. Hartwig MG, et al: Thoracoscopic lobectomy: the gold standard for early-stage lung cancer Ann Thorac Surg 2010;89:2098-2101
37. Daniels LJ, et al: Thoracoscopic lobectomy: a safe and effective strategy for patients with stage I lung cancer Ann Thorac Surg 2002;74:860-864
38. Hanna JM, et al: Contraindications of video-assisted thoracoscopic surgical lobectomy and determinants of conversion to open J Thorac Dis 2013;5:182-189
39. Chen JS, et al: Nonintubated thoracoscopic lobectomy for lung cancer Ann Surg 2011;254:1038-1043
40. Meyer M, et al:The learning curve of robotic lobectomy Int J Med Robot 2012;8:448-452