VATS Metastasectomy

Inderpal (Netu) S. Sarkaria, MD, FACS

Vice Chairman, Clinical Affairs
Director, Robotic Thoracic Surgery
Co-Director, Esophageal and Lung Surgery Institute

UPMC/UPCI Lung SPORE CEP Report
No Financial Disclosures
Pulmonary Metastasectomy: Complex

- Multiple Diseases & Histologies
- Combined modality therapy
- Involvement of pulmonary lymph nodes
- Repeat pulmonary resections and resection multi-organ disease
- Surgical approaches
  - VATS vs Open
- Ablative therapy
- Studies w/ surgical arms only
- How do we study this?
- Evidence for benefit?
Osteogenic Sarcoma under the Age of Twenty-one: A REVIEW OF ONE HUNDRED AND FORTY-FIVE OPERATIVE CASES (MSKCC).

MARCOVE, RALPH C.; MIKE, VALERIE; HAJEK, JOSEPH V.; LEVIN, ARTHUR G.; HUTTER, ROBERT V. P.


- 145 patients w/ resected long-bone disease
- 121 w/ pulmonary metastasis
- 5-year survival 17%
- Overall
  - 83% developed pulmonary metastases within two years and all were dead within next two years
Multiple Pulmonary Resections in the Treatment of Osteogenic Sarcoma (MSKCC).

Nael Martini, Andrew G. Huvos M.D., Valerie Miké Ph.D., Ralph C. Marcove M.D., Edward J. Beattie Jr. M.D.


- 29 consecutive pts underwent thoracotomy
- 22 completely resected and re-resected
- 32% five-year survival
- 18% twenty-year survival
- DOUBLED 5-year survival w/ metastasectomy
Alexander & Haight. Pulmonary resection for solitary metastatic sarcomas and carcinomas. 
SGO 1947;85:129-146

- Criteria for resection
  1. Primary disease controlled
  2. No evidence of metastatic disease elsewhere
  3. Patient able to tolerate resection
  4. (no better alternative therapy)
  5. (able to resect all gross disease)
  6. (slow pace of disease–long DFI)
  7. (limited number of lesions)
Bilateral disease: clamshell thoracotomy
LONG-TERM RESULTS OF LUNG METASTASECTOMY: PROGNOSTIC ANALYSES BASED ON 5206 CASES

The International Registry of Lung Metastases*
Writing Committee:
Ugo Pastorino, MD
Marc Buyse, ScD
Godehard Friedel, MD
Robert J. Ginsberg, MD
Philippe Girard, MD
Peter Goldstraw, MD
Michael Johnston, MD
Patricia McCormack, MD
Harvey Pass, MD
Joe B. Putnam, Jr., MD

JTCVS. 113(1):37-49, 1997

Negative prognostic factors
- DFI ≤ 36 mos
- Multiple mets (>1)

- 18 Institutions: US, Europe, Canada
- 88% underwent complete resection
- Survival: Complete vs Incomplete resection
  - Complete: 36% 5-year, 26% 10-year, 22% 15-year
    - 45% 5-year if DFI > 36 mths, 33% if DFI <11 mths
    - 43% 5 year if single lesion, 27% four or more lesions
  - Incomplete: 13% 5-year, 7% 10-year

- Early Description of VATS for Metastases
- 21 resections in 15 patients
- All identified by CTs
- All CT lesions identified and resected
  - Nd:YAG and/or surgical stapler
  - Peripheral, small (0.2 – 1.5 cm)
  - Metastatic disease in 13 patients (2 benign)
  - All margins benign
- Thoracoscopic metastasectomy feasible
- May decrease morbidity, cost, LOS, recovery (rapid start of adjuvant)
Role of Video-Assisted Thoracic Surgery in the Treatment of Pulmonary Metastases: Results of a Prospective Trial

Patricia M. McCormack, MD, Manjit S. Bains, MD, Colin B. Begg, PhD, Michael E. Burt, MD, PhD, Robert J. Downey, MD, David M. Panicek, MD, Valerie W. Rusch, MD, Maureen Zakowski, MD, and Robert J. Ginsberg, MD

• Purpose: identify “failure” rate of CT nodule identification
• Patients undergoing VATS after CT (1-2 ipsilateral nodules – non-spiral CT)
  – Initial resection of lesions identified at VATS
  – Subsequent planned thoracotomy w/ bimanual palpation
• 18 pts (50 planned) – closed early
  – 4 (22%) no additional lesions at thoracotomy
  – 4 (22/5) w/ additional benign lesions
  – 10 (56/5) w/ additional occult lesions at thoracotomy
• Conclusion: Thoracotomy required to achieve complete resection and long-term survival
  – VATS for dx only

A Prospective Study to Determine the Incidence of Non-Imaged Malignant Pulmonary Nodules in Patients Who Undergo Metastasectomy by Thoracotomy With Lung Palpation

Robert J. Cerfolio, MD, Ayesha S. Bryant, MD, Todd P. McCarty, MD, and Douglas J. Minnich, MD

- High quality 64-slice CT w/ contrast, most w/ PET-CT
- 152 patients underwent thoracotomy, 2006 – 2010
  - 51/152 patients (34%) w/ 57 nodules not imaged pre-operatively
  - 32/57 (56%) non-imaged nodules malignant
  - 30/152 (20%) pts with non-imaged malignant nodules removed
- Conclusion: Bimanual palpation discovers non-imaged nodules in 20% of pts undergoing thoracotomy
- Unknown
  - Clinical significance of removal of non-imaged nodules
  - Excess morbidity of benign nodule removal

Fig 1. Patient flow.

Long term survival of thoracoscopic metastasectomy vs metastasectomy by thoracotomy in patients with a solitary pulmonary lesion


• 35 patients single peripheral, < 3cm CT nodule
  – 19 with confirmatory thoracotomy, 16 without
  – 2 pts (11%) with additional disease at thoracoscopy
  – More complications w/ thoracotomy (5 vs 0)
• 7 benign, 8 second primary cancers
• 20 confirmed metastasis
  – VATS vs Open: No difference in 2-year survival, OS, or recurrence
1960 studies identified, 8 included, 571 pts
- 337 open, 234 VATS

VATS w/ slightly higher OS & DFS (1, 3, 5-year)
- No statistical differences

VATS is a suitable alternative to open thoracotomy
8 studies included
337 VATS, 485 Open
VATS higher OS
  - Not statistically significant
Equivalent DFS
  - Also in CRC
Pulmonary metastasectomy with therapeutic intent for soft-tissue sarcoma

Neel P. Chudgar, MD, a Murray F. Brennan, MD, a Rodrigo R. Munhoz, MD, b Peter R. Bucciarelli, MD, a Kay See Tan, PhD, c Sandra P. D’Angelo, MD, b Manjit S. Bains, MD, a Matthew Bott, MD, a James Huang, MD, a Bernard J. Park, MD, a Valerie W. Rusch, MD, a Prasad S. Adusumilli, MD, a William D. Tap, MD, b Samuel Singer, MD, a and David R. Jones, MD a

539 pts undergoing 760 therapeutic intent resections

Factors associated with lower Hazard of Death on multivariable analysis

- Leiomyosarcoma
- Primary tumor < 10 cm
- Increasing DFI
- Solitary metastasis
- Minimally invasive resection

Independent of extent of resection

JTCVS 154(1):319-30, 2017
80 patients with CRC pulmonary mets
Thin cut CT identified all lesions
Mean interval from primary to VATS 41 mths
Solitary lesion in 60 pts, multiple in 20
All lesions resected by VATS
  – 4 conversions to improve margins
Mean survival
  – One lesion: 35 months
  – Multiple lesions: 27 months
  – > 3 year DFI: 28 months
  – <3 year DFI: 20 months
Prognostic Factors for Recurrence After Pulmonary Resection of Colorectal Cancer Metastases

Mark W. Onaitis, MD, Rebecca P. Petersen, MD, John C. Haney, MD, Leonard Saltz, MD, Bernard Park, MD, Raja Flores, MD, Nabil Rizk, MD, Manjit S. Bains, MD, Joseph Dycoco, BS, Thomas A. D’Amico, MD, David H. Harpole, MD, Nancy Kemeny, MD, Valerie W. Rusch, MD, and Robert Downey, MD

- 378 patients, 1998-2007
- 44% previous extra-thoracic metastasectomy
- Median DFI 24 months
- 60% single resected, 20% two, 10% three, 10% 4 or more
- Multivariable predictors of recurrence
  - Age < 65, female sex, DFI < 1 year, >3 metastases
- 44 pts: > 2 lesions, DFI < 1 year → none cured
  - Recommend medical management only
- 3 year RFS 28%
  - 49% RFS at 3 years if one lesion and DFI > 1 year (28% overall)
2008-2010, 532 patients, 1,050 lung resections
- 90% segment or wedge

Multivariable predictors of morbidity
- Lobectomy or greater resection, respiratory and cardiovascular co-morbidities
- VATS showed protective effect vs thoracotomy
Improved survival with pulmonary metastasectomy: An analysis of 1720 patients with pulmonary metastatic melanoma

Rebecca P. Petersen, MD, MSc, Steven I. Hanish, MD, John C. Haney, MD, Charles C. Miller III, PhD, William R. Burfeind, Jr, MD, Douglas S. Tyler, MD, Hilliard F. Seigler, MD, Walter Wolfe, MD, Thomas A. D’Amico, MD, and David H. Harpole, Jr, MD

• 1970-2004
• Multivariable predictors of survival
  – Nodular histologic type, DFI, number of pulmonary mets, pulmonary metastasectomy
• Survival advantage with surgery
  – 12 months (19 vs 7) if DFI > 5 years
  – 10 months (18 vs 8) if no extrathoracic disease
• Surgery recommended in select pts
MIS Nodule Localization

Preoperative computed tomography–guided microcoil localization of small peripheral pulmonary nodules: A prospective randomized controlled trial

The Journal of Thoracic and Cardiovascular Surgery • January 2015

Richard J. Finley, MD, a John R. Mayo, MD, b Kyle Grant, MD, a Joanne C. Clifton, MSc, a John English, MD, c Joyce Leo, MD, c and Stephen Lam, MD d

Thoracoscopic localization of intraparenchymal pulmonary nodules using direct intracavitary thoracoscopic ultrasonography prevents conversion of VATS procedures to thoracotomy in selected patients

The Journal of Thoracic and Cardiovascular Surgery • November 2012

Mohamed Khereba, MD, Pasquale Ferraro, MD, Andre Daranceau, MD, Jocelyne Martin, MD, MSc, Eric Goudie, Vicky Thiffault, BScN, and Maashe Liberman, MD, PhD

A Simple and Safe Technique for CT Guided Lung Nodule Marking prior to Video Assisted Thoracoscopic Surgical Resection Revisited

James A. Stephenson,1 Ayman Mahfouz,1 Sridhar Rathinam,2 Apostolos Nakas,2 and Amrita Bajaj1

Lung Cancer International
Volume 2015, Article ID 235720, 3 pages
Near Infrared Imaging Localization

A novel minimally invasive near-infrared thoracoscopic localization technique of small pulmonary nodules: A phase I feasibility trial

The Journal of Thoracic and Cardiovascular Surgery • August 2017

Hideki Ujie, MD, PhD, Takuya Kato, MD, PhD, Hsin-pei Hu, MHS, Priya Patel, MD,
Hiroohu Wada, MD, PhD, Kosuke Fujino, MD, PhD, Robert Weersink, PhD, Elsie Nguyen, MD,
Marcelo Cypel, MD, MSc, Andrew Pierre, MD, MSc, Marc de Perrot, MD, MSc, Gail Darling, MD,
Thomas K. Wadkell, MD, PhD, Shaf Keshavjee, MD, MSc, and Kazuhiro Yasufuku, MD, PhD

Intraoperative Molecular Imaging Combined With Positron Emission Tomography Improves Surgical Management of Peripheral Malignant Pulmonary Nodules

Jarrod D. Predina, MD, MTR, Andrew D. Newton, MD, Jane Keating, MD,
Eduardo M. Barbosa Jr., MD, Olugbenga Okusanya, MD, Leilei Xia, MD, Ashley Dunbar, BA,
Courtney Connolly, BA, Michael P. Baldassari, BA, Jack Mizelle, BA, Edward J. Delikatny, PhD,
John C. Kucharzuk, MD, Charushas Deshpande, MD, Sumith A. Kalaratte, PhD,
Phillip Low, PhD, Jeffrey Drobkin, MD, PhD, and Sunil Singhal, MD

Intraoperative electromagnetic navigational bronchoscopic localization of small, deep, or subsolid pulmonary nodules

Abbas Abbas, MD, Sagar Kadakia, MD, Vishnu Ambur, MD, Kimberly Muro, PA, and Larry Kaiser, MD

(J Thorac Cardiovasc Surg 2017;153:1581-90)
NIFI in Thoracic Surgery

- Vascular anatomic assessment
- Perfusion assessment
- Sentinel lymph node mapping
- Pulmonary nodule localization
NIFI ICG Tumor & SLN Localization
NIFI ICG Tumor & SLN Localization
Current Protocol

Pilot Trial of Near Infrared Fluorescence Imaging with Indocyanine Green in the Detection and Diagnosis of Neoplastic Pulmonary Nodules

Class: Diagnostic, open label pilot study
Principal Investigator: Inderpal Sarkaria, MD
Statistician: Brenda F. Kurland, PhD
(Not so Distant) Future Directions

• Targeted molecular fluorescence agents
  – Tissue specific
  – Tumor specific

• Multi-institutional trial in Pulmonary nodules
  – UPMC/UPCI Primary Site
  – Currently in IRB
  – Folate Receptor Alpha
  – Same day injection of drug

• Protocols for multiple solid tumor targets
6 mm LLL lung nodule
Intraoperative imaging
Identification of a subcentimeter pulmonary adenocarcinoma using intraoperative near-infrared imaging during video-assisted thoracoscopic surgery

Jane J. Keating, MD, Gregory T. Kennedy, BA, and Sunil Singhal, MD, Philadelphia, Pa

The Journal of Thoracic and Cardiovascular Surgery • Volume 149, Number 3
Frozen Section Diagnosis

1A and 1B: Few atypical cells in background of reactive lung, diagnosis deferred to complete examination of tiny nodule on permanent section.
LUL Nodule
Thank You

Inderpal S. Sarkaria, MD
Vice Chairman, Clinical Affairs
Director, Robotic Thoracic Surgery
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Department of Cardiothoracic Surgery
University of Pittsburgh Medical Center