Image-Guided Thermal Ablation of Lung Lesions

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Goals of this lecture

• Compare the treatment options for localized lung cancer
• Describe the use of RFA in stage 1 NSCCA
• Review the current role of thermal ablation techniques for the treatment of small lung tumors

Local treatment of lung malignancy

Options

• Wedge resection (VATS)
• Limited pulmonary reserve
• Metastatectomy
• Radiation
• External beam (standard, SBRT)
• Brachytherapy
• Ablation
• Radiofrequency ablation (RFA)
• Cryoablation
• Microwave ablation

Limited resection of Stage I lung CA

Lung Cancer Study Group

• Multicenter randomized trial
• Wedge/segmentectomy vs lobectomy
  • Similar survival rates
  • 3x incidence of local recurrence for limited resection
  • 50% increase in death rate from lung CA
• No difference in long-term pulmonary function


Disclosures

• No relevant financial relationships or conflicts of interest related to this presentation

RUL nodule

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Thermal ablation in the treatment of localized lung tumors

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Monday

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Question: What has changed from 1988 to 2008?

Answer: Improved preoperative staging of lung CA.
1. PET and PET/CT
2. Mediastinal nodal staging (EUS/EBUS)

Stereotactic Body Radiation Therapy

- Radiation Therapy Oncology Group (RTOG) study
- 55 patients
  - Only tumors > 2 cm beyond central bronchi treated
  - Median followup of 34.4 months
  - Disease free/overall survival rates at 3 years 48%/56%
  - Local control rate = 91%

Timmerman R et al. JAMA 2010; 303:1070-1076.

Thermal ablation techniques-lung
- Radiofrequency ablation (RFA)
- Cryoablation
- Microwave ablation
- Irreversible electroporation (IRE)

Patient selection for lung RFA
- Primary lung cancer
  - Medically inoperable
  - XRT contraindicated
  - Refuses conventional treatment
  - Palliative
    - Pain
    - Paraneoplastic syndrome
  - Pulmonary/chest wall metastases
  - Potential survival benefit
  - Palliative
**RF ablation of lung**

**Limitations**
- Limited and irregular ablation zones in vivo
- Limited thermal conductivity/high impedance of lung
- Heat sink of vessels/bronchi
- Higher local recurrence rate than SBRT
- Grounding pads (burns)
- Electrical current (pacemakers/ICDs)
- Pain (particularly pleural-based lesions)

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**RAPTURE study**
- Multicenter study (USA, Europe, Australia)
- 183 tumors/106 patients
- Mean tumor diameter = 1.7 cm
- NSCCA = 33 patients
- Overall survival for NSCCA
  - 1 year/2 years = 70%/48%
  - Cancer specific survival = 92%/73%


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**RFA-T1 (stage 1A) NSCCA**

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**RFA of the lung**

**Results in NSCCA/mets**
- Complete necrosis (by contrast-CT & PET)
  - < 3 cm = 69-100%\(^1,2\)
  - > 3 cm = 23-39%\(^1,2\)
- Mean survival after RFA
  - complete necrosis - 19.7 months
  - partial necrosis - 8.7 months (P < .01)\(^7\)
- Complications
  - Pneumothorax - 10-35%
  - Cavitiation (+/- lung abscess) - 30%

\(^1\)Lee JM et al. Radiology 2004; 230:125-134.

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**Stable 7 years post RFA**

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**RF ablation – LUL NSCCA**

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**Baseline-LUL nodule**

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**RFA**
RF ablation – LUL NSCCA

1 month post RFA  
12 month post RFA

RF ablation – LUL NSCCA

18 months-cryoablation

RF ablation – LUL NSCCA

20 months post RFA  
Baseline exam

RF ablation of lung CA

Recurrence of disease
- Retrospective study of 79 patients with lung CA and RFA
- Mean size = 2.5 cm (range = 1.0-5.5 cm)
- 71% stage IA; 81% peripheral (outer 1/3rd of lung)
- 65% RFA only, 35% RFA + XRT/brachytherapy
- Results:
  - 57% no recurrence at mean f/u 17 months (max = 6 yrs)
  - Location of recurrence = 56% [local (38%) and intrapulmonary in (18%)]
  - Mean time to recurrence = 14 months
  - Increasing size related to recurrence
  - Median disease free survival = 23 months


Advantages-RFA/thermal ablation
- One stop shop
- Diagnosis and treatment
- Economical and patient friendly
- Low morbidity/mortality
- Organ preservation
- Limited collateral damage to lung function
- Treatment of future recurrences
- Repeated applications for recurrences

Future of thermal ablation
- Stage 1A NSCCA
- Non-surgical candidates
- Subsolid (preinvasive or MIA lesions)-screening
- Second primary NSCCA
- Local recurrence after XRT/surgery
- Stage 1 carcinoid tumors
- Oligomet from colorectal/other malignancies with survival benefit
- “Outlier” metastasis-one nonresponding metast
RFA of lung tumors
Conclusions

- Percutaneous lung RFA safe and effective
- Systems not initially developed for lung
- Optimize probes/treatment parameters for lung
- Real-time feedback of ablation zone
- Relative role of RFA for lung CA/mets unclear
- Patient/lesion selection criteria
- RFA complimentary to other treatments vs sole tx?
- Larger multicenter trials needed