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Predictors and Characteristics of Rib Fracture Following SBRT for Lung Tumors

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Disclosures

I have no conflicts of interest.

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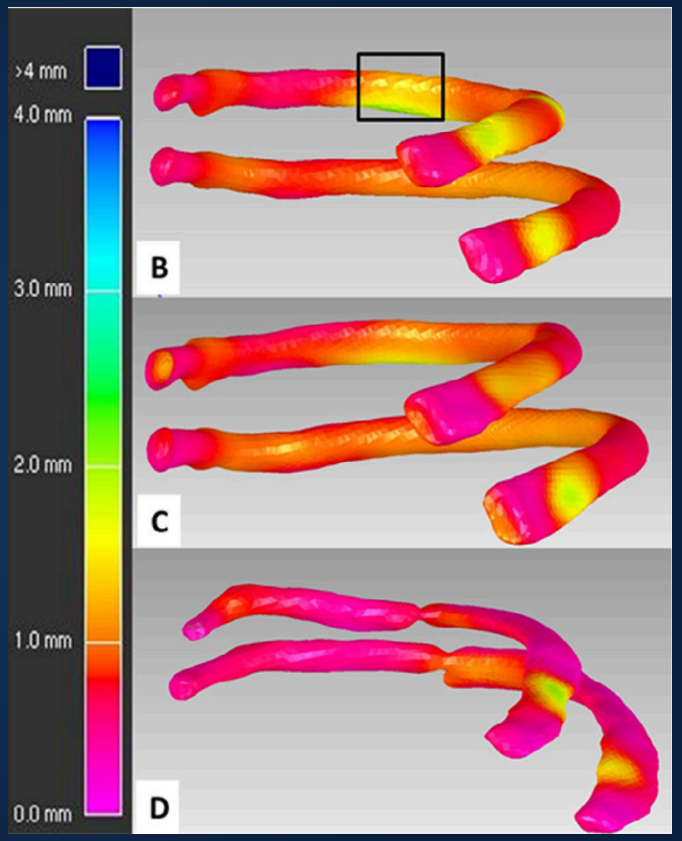
Introduction

- SBRT is the gold standard for medically inoperable, non-small cell lung cancer and delivers a high dose of radiation[1-4]
- Higher incidence of complications compared to traditional radiotherapy[5-8]
  - Radiation pneumonitis, esophagitis and brachial plexopathy
  - Particular concern for chest wall injury (pain, rib fracture, osteonecrosis; 8-46%)
  - Injury linked to dosage and proximity to bone[9]



Okoukoni et al 2016

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Introduction

- Increasing utilization of SBRT for NSLC[3]
  - Emerging alternative to surgery for medically operable patients
  - Option for advanced pulmonary tumors and oligometastases
- Poor understanding of risk factors and radiologic character in thoracic SBRT
- Rib fractures have important consequences
  - Chronic pain may interfere with respiration
  - Chronic chest wall instability increases the risk of significant injury

Chipko et al 2019

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Objectives & Hypothesis

Specific Aims

1. What is the incidence of rib osteonecrosis and fracture after SBRT for early-stage NSCLC?
2. Are there medical or demographic risk factors for chest wall injury?
3. Do radiation-induced rib fractures show unique radiographic character and clinical presentation compared to traumatic fractures?
4. Are post-SBRT rib fractures underreported?

Hypotheses

1. Post-SBRT rib fractures will show radiographic evidence of osteonecrosis
2. Incidence of chest wall toxicity will be higher than reported in traditional radiotherapy
3. Distance between the tumor location and bone, dosage intensity, and pre-existing comorbidity will correlate with increased fracture incidence

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Approach & Results

- Retrospective chart and imaging review of SBRT 2015-2018, n=106
- 12 month post-SBRT CT, office notes, pre-procedural screening
- Inclusion criteria:
  - SBRT performed for primary lung cancer or 2^{o} lung tumor
  - Available pre-SBRT data, 1 year follow up, procedural data
- Exclusion criteria:
  - Concurrent/overlapping traditional radiotherapy
  - History of prior ipsilateral chest wall trauma or radiotherapy
- Primary endpoints
  - Rib fracture visible on CT
    - Fracture location and lobe
    - Fracture-associated chest wall pain
    - Degree of fracture discontinuity
- Statistical methods
  - Univariate analysis and T-test
  - Stepwise multivariate regression modelling

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Approach & Results

- 106 patients met inclusion criteria
- Incidence of fracture: 32%
  - 60 total fractured ribs, 35 patients
  - Average follow up: 29 months
  - Average interval: 22 months
- Independent risk factor: posterolateral location
  - No medical or procedural correlates
- 76% showed characteristic rib discontinuity

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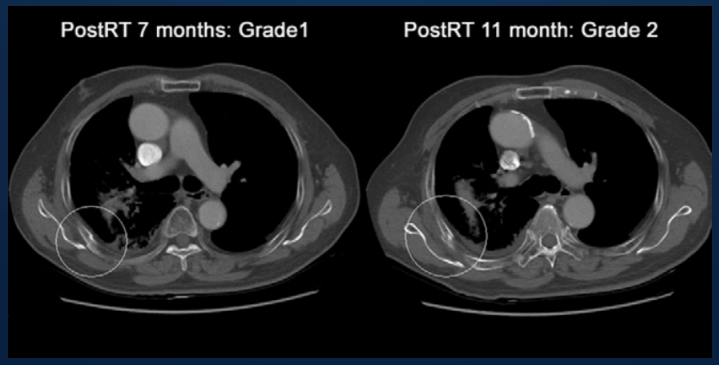
Approach & Results

- Ribs 2-4 and 7-9 were the most commonly affected
- In 29%, 2+ ribs were affected
- 77% of fractures showed characteristic discontinuity
  - 29% showed significant discontinuity (Gr2)
- 34% associated with pain
- 89% discovered on routine imaging
- 41% of fractures were never mentioned on radiologist's report



Kim et al 2013

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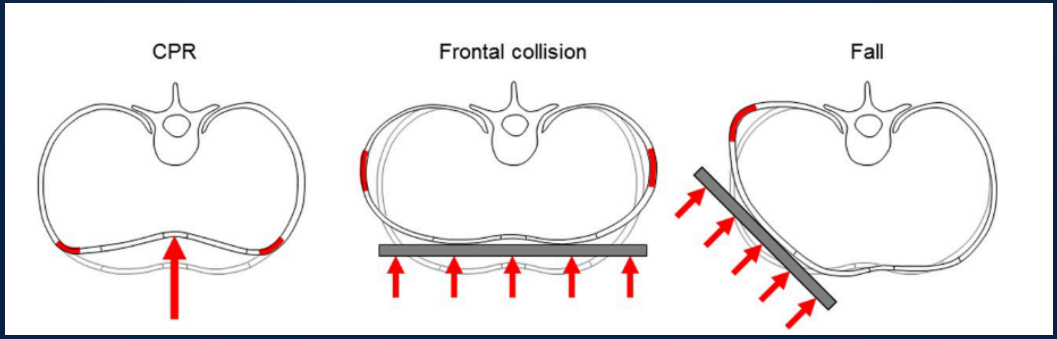
Conclusions

- Posterolateral tumor location along the chest wall was the most significant risk factor for fracture
  - Rib biomechanics
- Healthier patients may have similar rates of rib fracture
- Fracture discontinuity is a characteristic finding
- Fractures may carry important risks, and patients should be counseled of such risks prior to thoracic SBRT



Liebsch et al 2019

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Future Directions

- Healing patterns or SBRT-induced osteonecrotic fractures
  - Strict follow up protocol
- Etiology of discontinuity
  - PET/CT to evaluate soft tissue fibrosis
  - Cortical bone studies
- Respiratory sequelae
  - Pulmonary function testing
  - Overlap with respiratory pneumonitis

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