Protocol optimization and dose variability for CT-guided interventions

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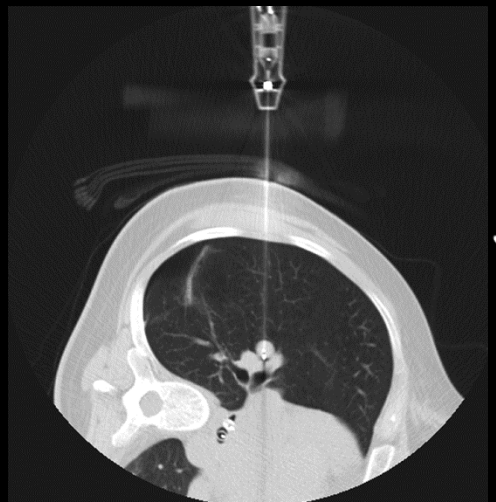
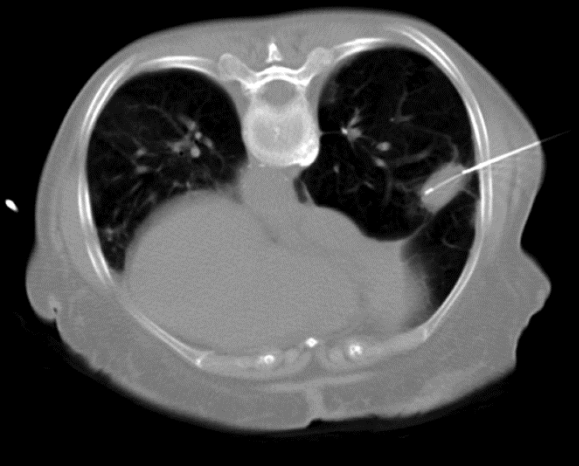
Disclosures

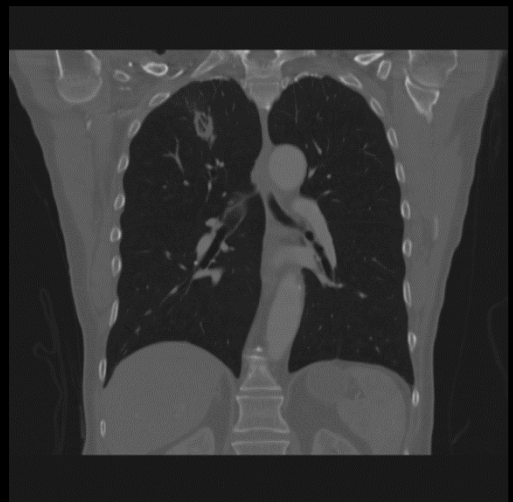
None

Unique characteristics of interventional CT imaging

- Repetitive irradiation of an anatomic territory
- Intent of imaging varies during a case
- Loosely defined protocols







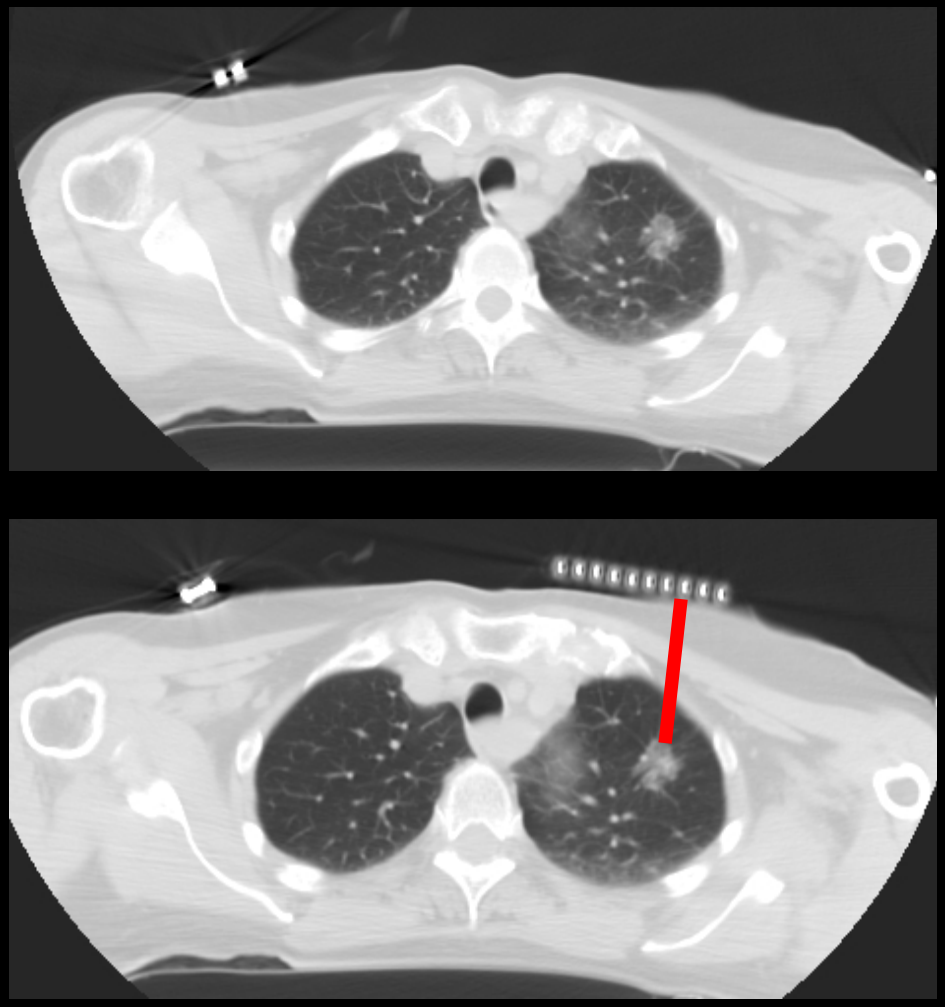
Structure of a CT-guided intervention

Localization

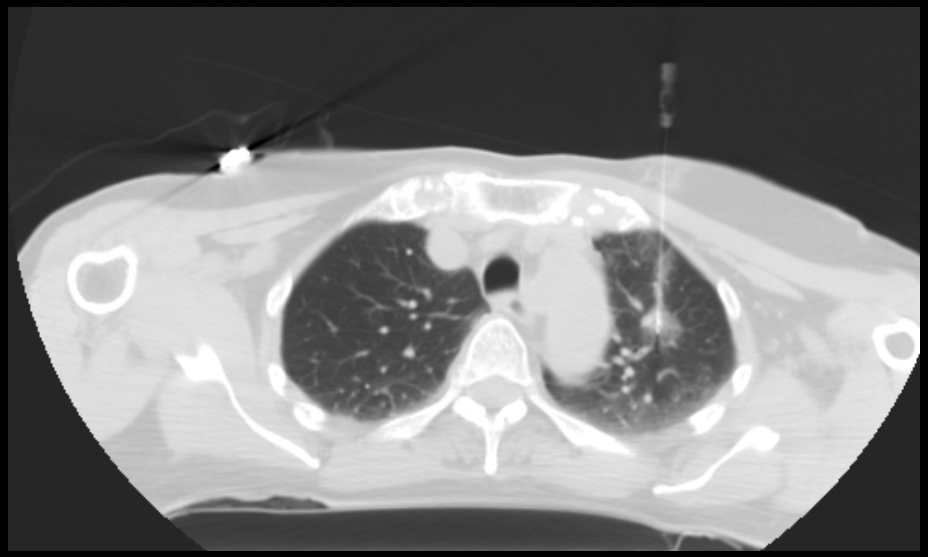
Guidance and Monitoring

Post-procedure evaluation

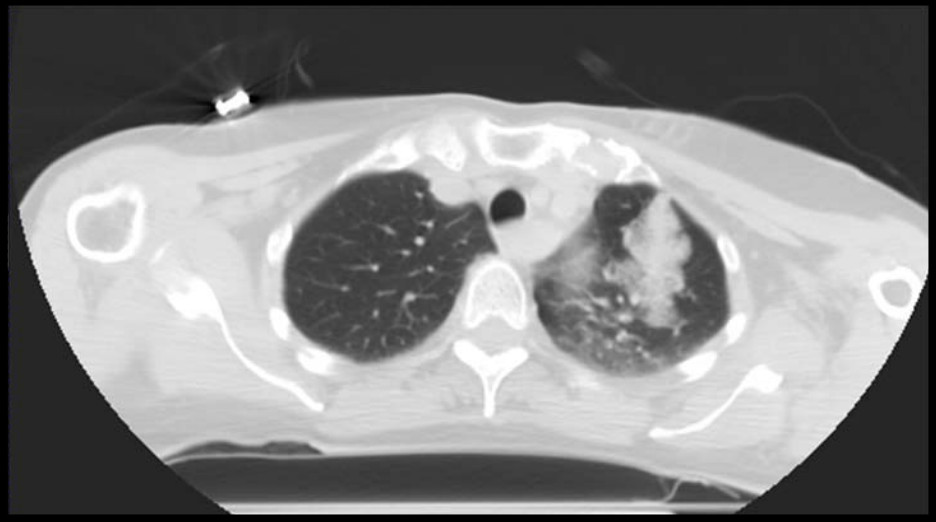
Localization



Procedural guidance

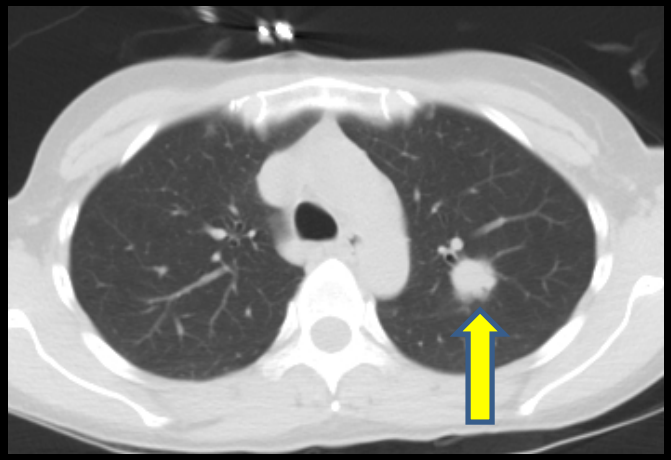


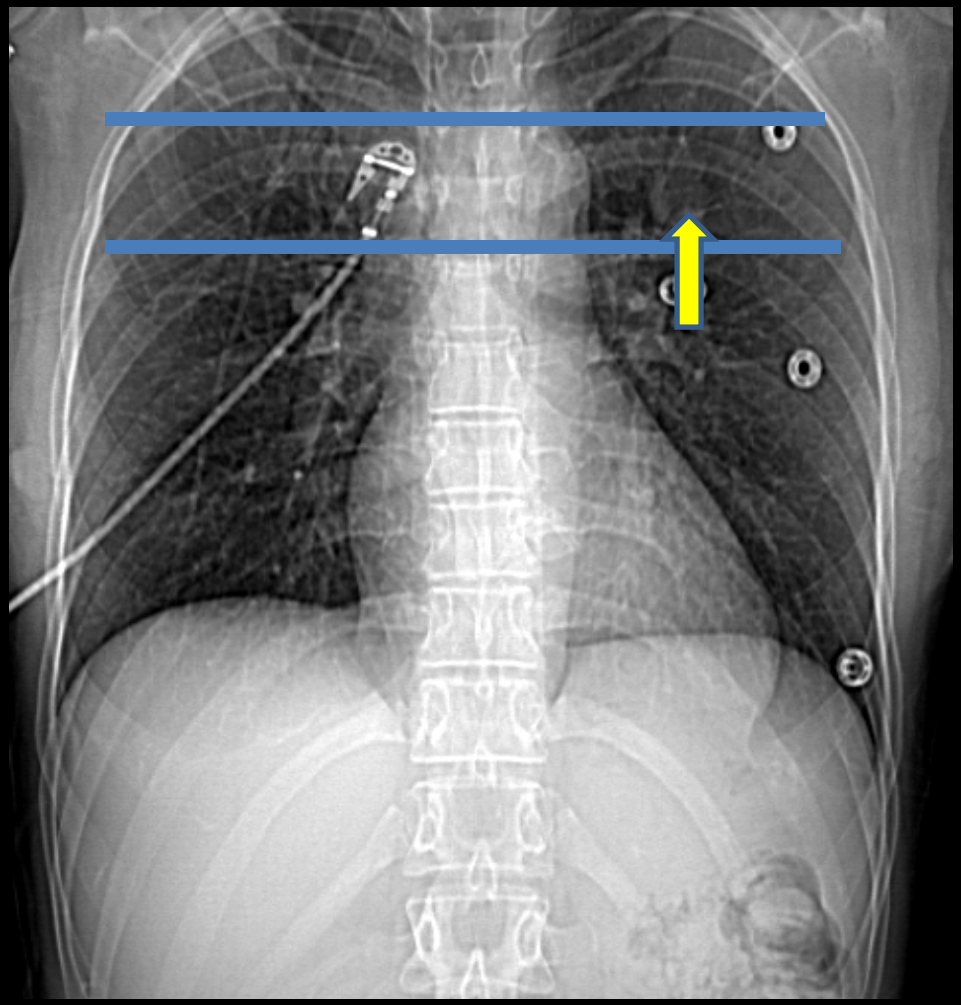
Post-procedure evaluation



Dose economy for CT localization

- Diagnostic imaging precedes intervention and should be available for reference at the time of intervention
  - *Opportunity: minimize extent of localization scans*





36/82 (44%) submitted CT biopsies 2009-2011 started with a complete scan of C, A or P.

Dose economy for procedural scans

- Imaging technique: adequate is often good enough
  - *Opportunity: Use low tube currents, rapid gantry rotation times*

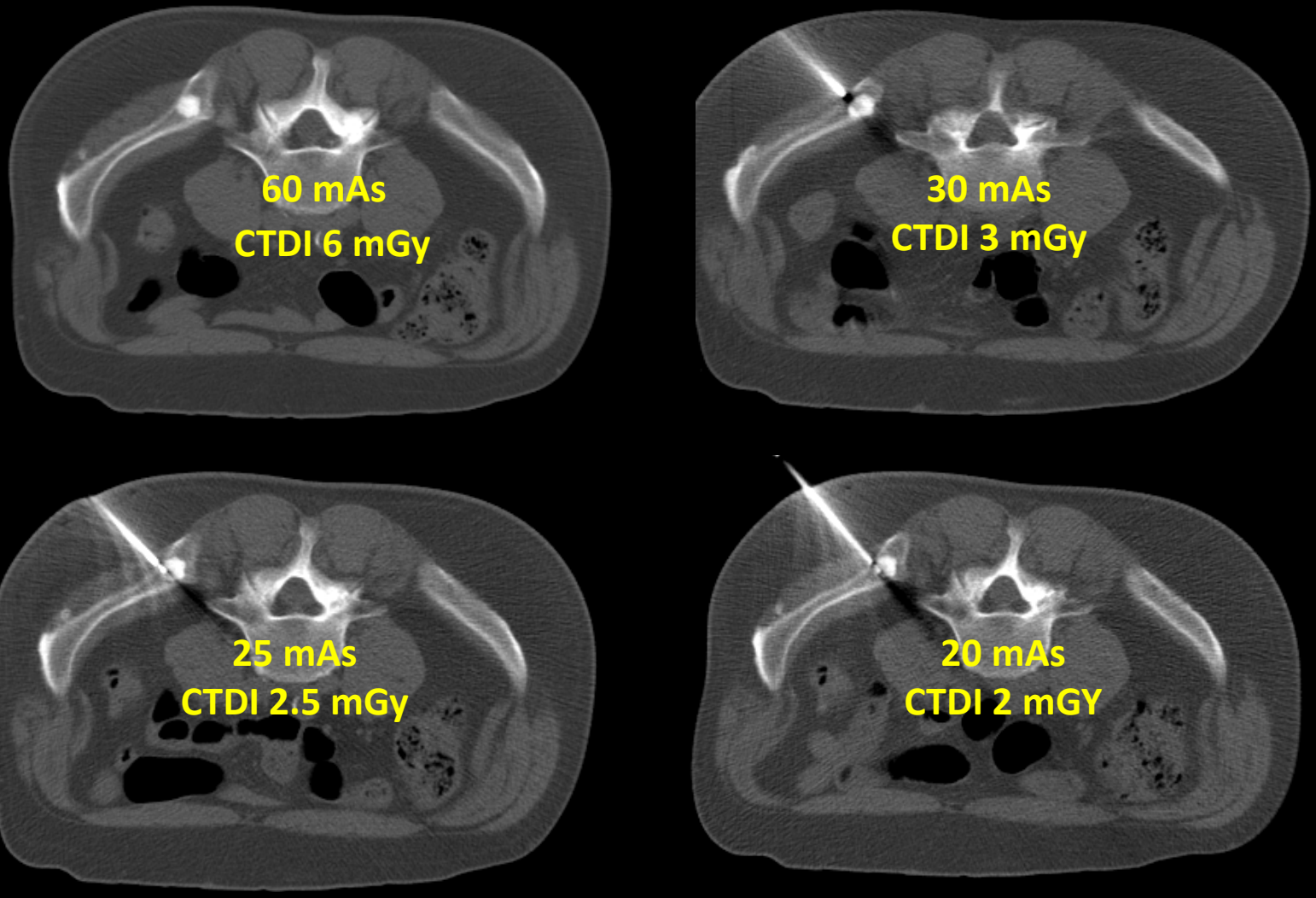
310 mAs

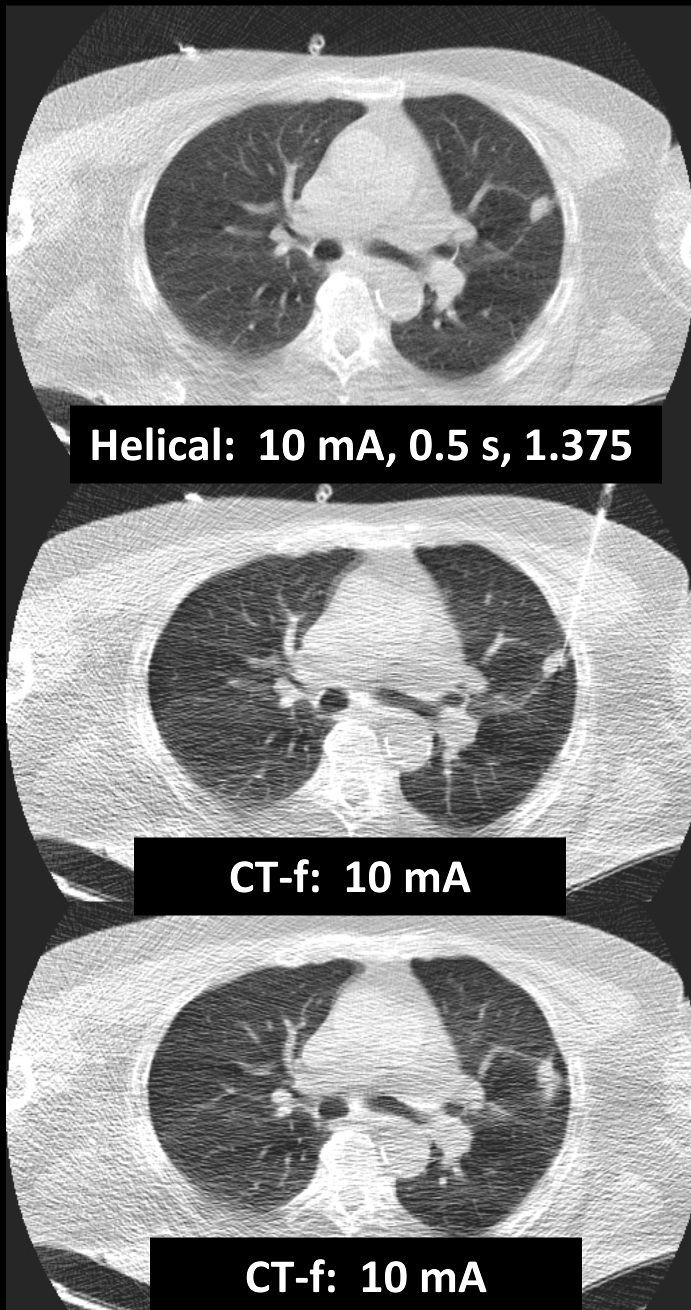
952 mGy-cm
14 mSv

30 mAs

73 mGy-cm
1.1 mSv

Bone biopsy


60 mAs
CTDI 6 mGy
30 mAs
CTDI 3 mGy
25 mAs
CTDI 2.5 mGy
20 mAs
CTDI 2 mGY



Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	I65.000-I135.000	0.46	6.19	Body 32
3	SmartStep	I100.000-I98.125	0.76	0.76	Body 32
3	SmartStep	I100.000-I98.125	0.76	0.76	Body 32
3	SmartStep	I100.000-I98.125	0.76	0.76	Body 32
3	SmartStep	I100.000-I98.125	0.76	0.76	Body 32
3	SmartStep	I100.000-I98.125	0.76	0.76	Body 32
3	SmartStep	I100.000-I98.125	0.76	0.76	Body 32
3	SmartStep	I100.000-I98.125	0.76	0.76	Body 32
3	SmartStep	I100.000-I98.125	0.76	0.76	Body 32
			Total Exam DLP:	12.27	

SmartStep Accumulated Exposure time 00:00:06.4

0.2 mSv

Dose economy for completion scans

- Intent and clinical judgment dictate the image quality required for post-procedure scans

  (a) Detection of pneumothorax after lung biopsy

  (b) Detection of small perihepatic or perisplenic hemorrhage

Opportunity: Low dose scans of limited extent, when clinically appropriate

AJR 2007; 188:1187-1194

CT-Guided Intervention with Low Radiation Dose: Feasibility and Experience

Brian C. Lucey[1,2]
Jose C. Varghese[1]
Aaron Hochberg[1]
Michael A. Blake[3]
Jorge A. Soto[1]

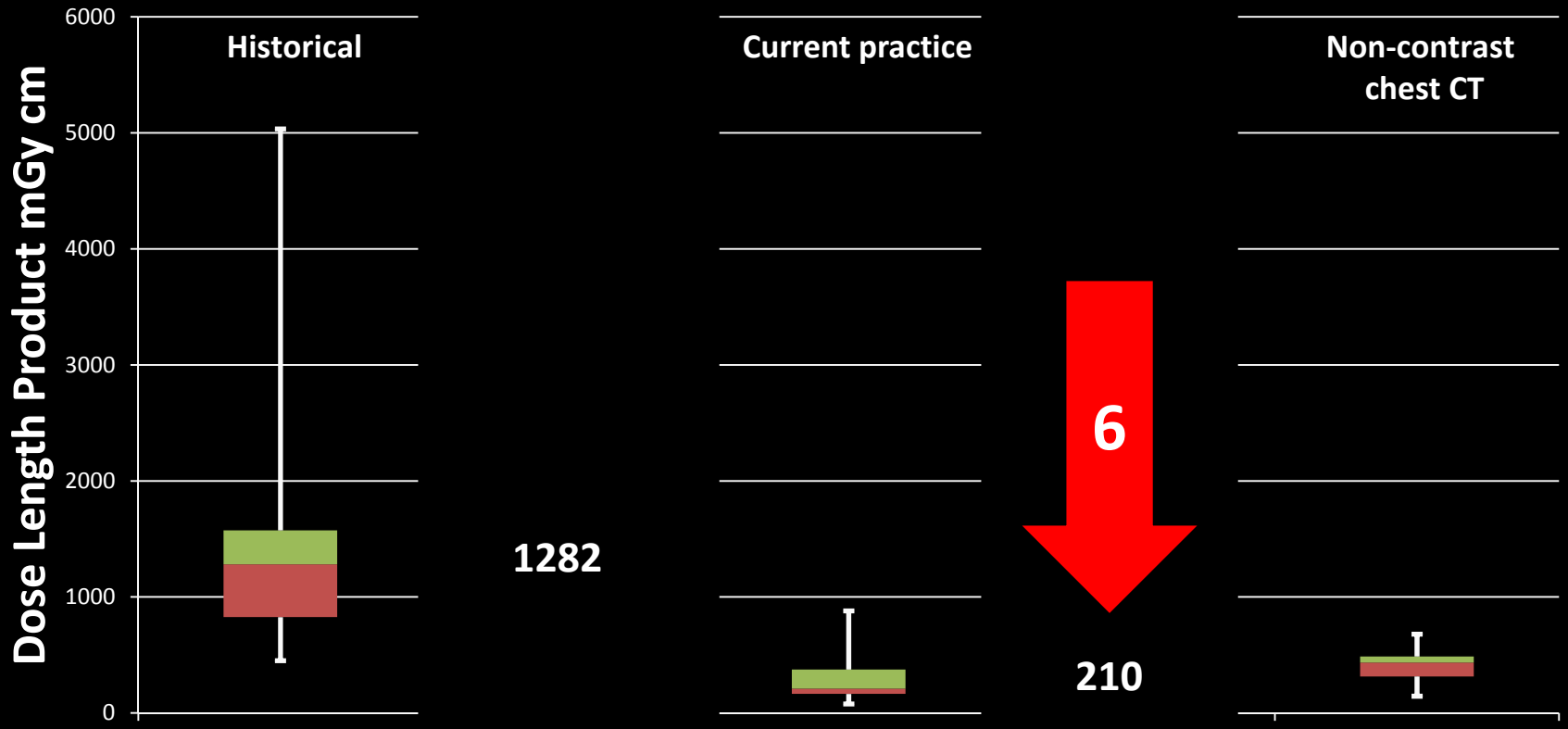
OBJECTIVE. The purpose of this study was to evaluate the feasibility of performing CT-guided interventional procedures with a very low radiation dose.

MATERIALS AND METHODS. We performed 291 CT-guided interventional procedures using a low dose of radiation. The subjects were 165 men and 126 women 22–89 years old with a mean age of 65 years. CT fluoroscopy was not used. The procedures were 201 percutaneous biopsies and 90 percutaneous aspiration or drainage procedures. Before the procedure, images were obtained with standard mAs of 175–250 mAs. All subsequent CT was performed at a reduced mAs. Technical success of catheter placement and biopsy was calculated, and the results were compared with those of procedures performed over the previous 12 months with standard radiation doses. Patient weight, lesion size, and number of CT acquisitions needed to complete the procedure were recorded.

RESULTS. All but three aspiration or drainage procedures performed at 30 mAs were successful, for a success rate of 96.7%. The technical success rate of biopsy performed at 30 mAs was 93.5%. In the cases of 13 patients undergoing biopsy, the masses were not identified with low-dose technique, and these procedures were completed at a higher dose. Results were independent of patient weight and lesion size. The technical success rate was 98% for percutaneous drainage performed at a standard radiation dose in the 12 months before introduction of the low-dose technique. The technical success rate was 87.5% for biopsy performed at a standard radiation dose in the 12 months before introduction of the low-dose technique. The complication rate of the low-dose technique was comparable to that of the standard-dose technique.

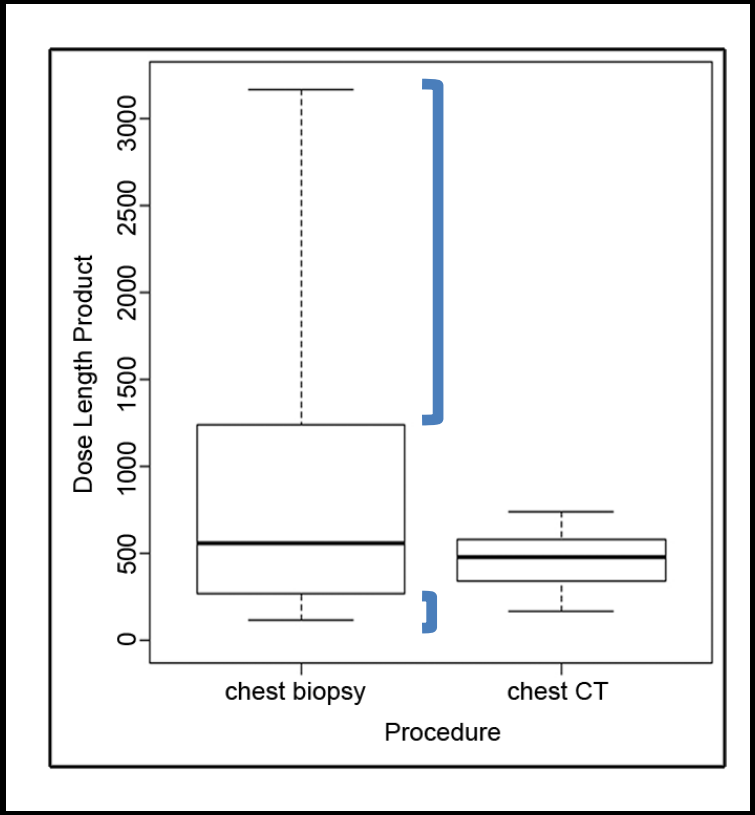
CONCLUSION. Low-dose radiation technique using 30 mAs results in technical success for both catheter placement and percutaneous biopsy comparable to standard radiation dose.

MSKCC Lung Biopsy



Thornton R. Unpublished data.

CT guided thoracic biopsy



Thornton R, et. al. Under review.

NSD: weight, lesion size, depth, # procedural scans

Lowest dose/CT	Highest dose/CT
19 scans	14 scans
36 mA	770 mA
116 mGy-cm	3170 mGy-cm
< 1 chest CT	7 chest CTs

2 mSv

54 mSv

3 academic centers

MSKCC UNC-Chapel Hill SUNY-Syracuse

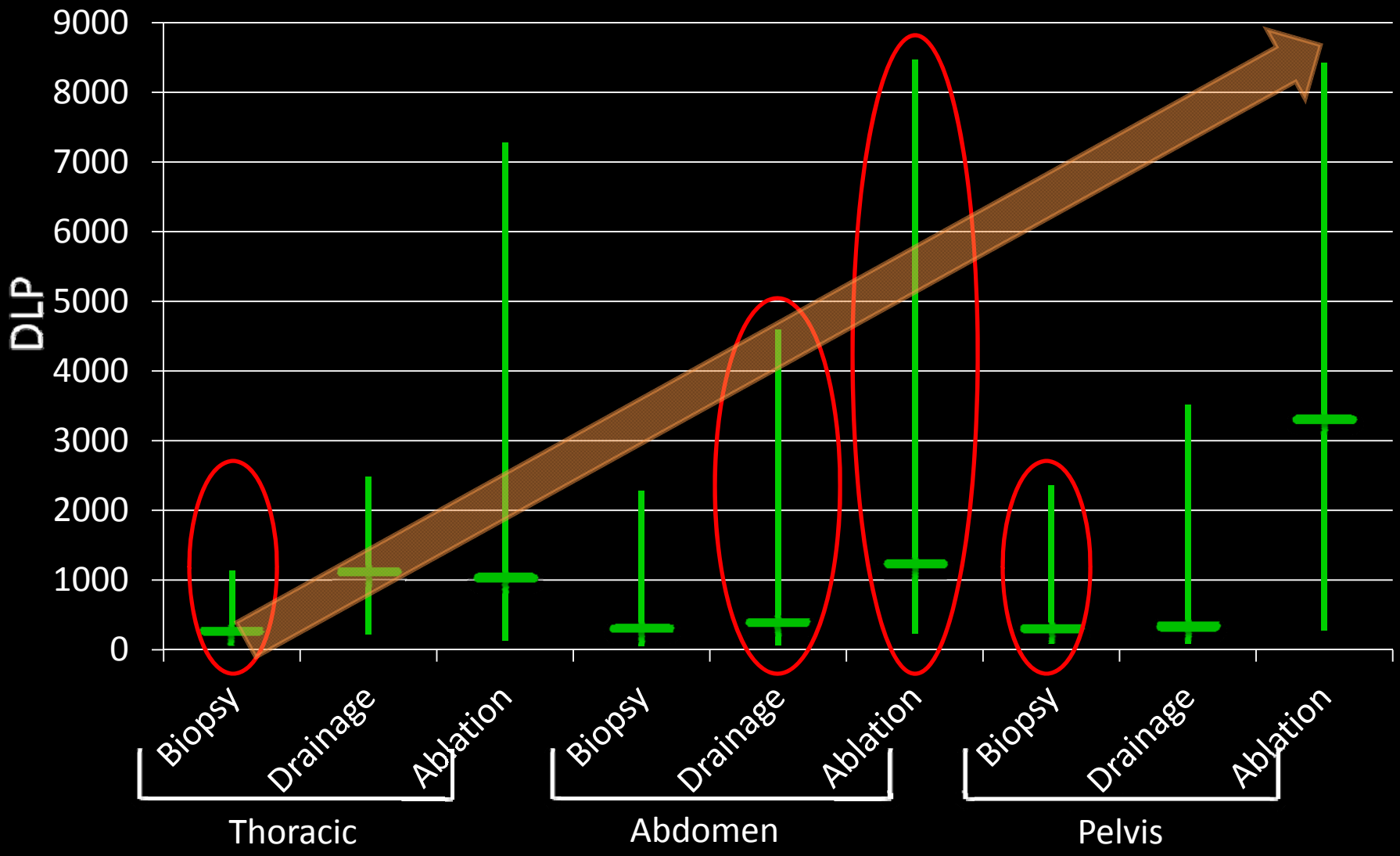
370 procedures
10/15/2009-4/15/2010

	Biopsy	Drainage	Ablation
Chest	50	22	45
Abdomen	50	50	42
Pelvis	50	41	20

Folz G, Thornton RH, Dauer L, Berry-Tony S, Roskopf M, Ogden K, Scalzetti V, Dixon R. A survey of radiation doses from CT-guided procedures at three teaching hospitals. SIR 2011.

Results: DLP

Mean 35-fold variation (range 11-74 fold)



Effective mAs

	Chest	Abdomen	Pelvis
Biopsy	0.0003		0.03
Drainage		0.002	
Ablation		0.0005	

	1	2	3	P-value
Localizing	174	57	174	<0.0001
Guidance	174	26	183	<0.0001
Post scans	191	55	183	<0.0001

Components of variable dose

- Unique components
  - Patient body habitus
  - Procedure complexity
  - Equipment
  - Operator skill
- Manageable components
  - Selection of technical factors (CTDI)
  - Extent of pre- and post-intervention scans (length)

Tracking radiation doses related to interventional CT

- Awareness, practical guidance and education
- Benchmarks
  - Reference levels, ranges
  - Dose f(imaging work)
- Intra-procedural display of accumulating dose