

# ADVANCED IMAGING FOR LOCALIZATION OF PARATHYROID ADENOMA

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# ADVANCED IMAGING FOR LOCALIZATION OF PARATHYROID ADENOMA

- Objectives:
  1. 4D CT for localization of pathological Parathyroid gland
  2. Cost- utility analysis for use of 4D CT vs Sestamibi
  3. New imaging for localization of pHPTH

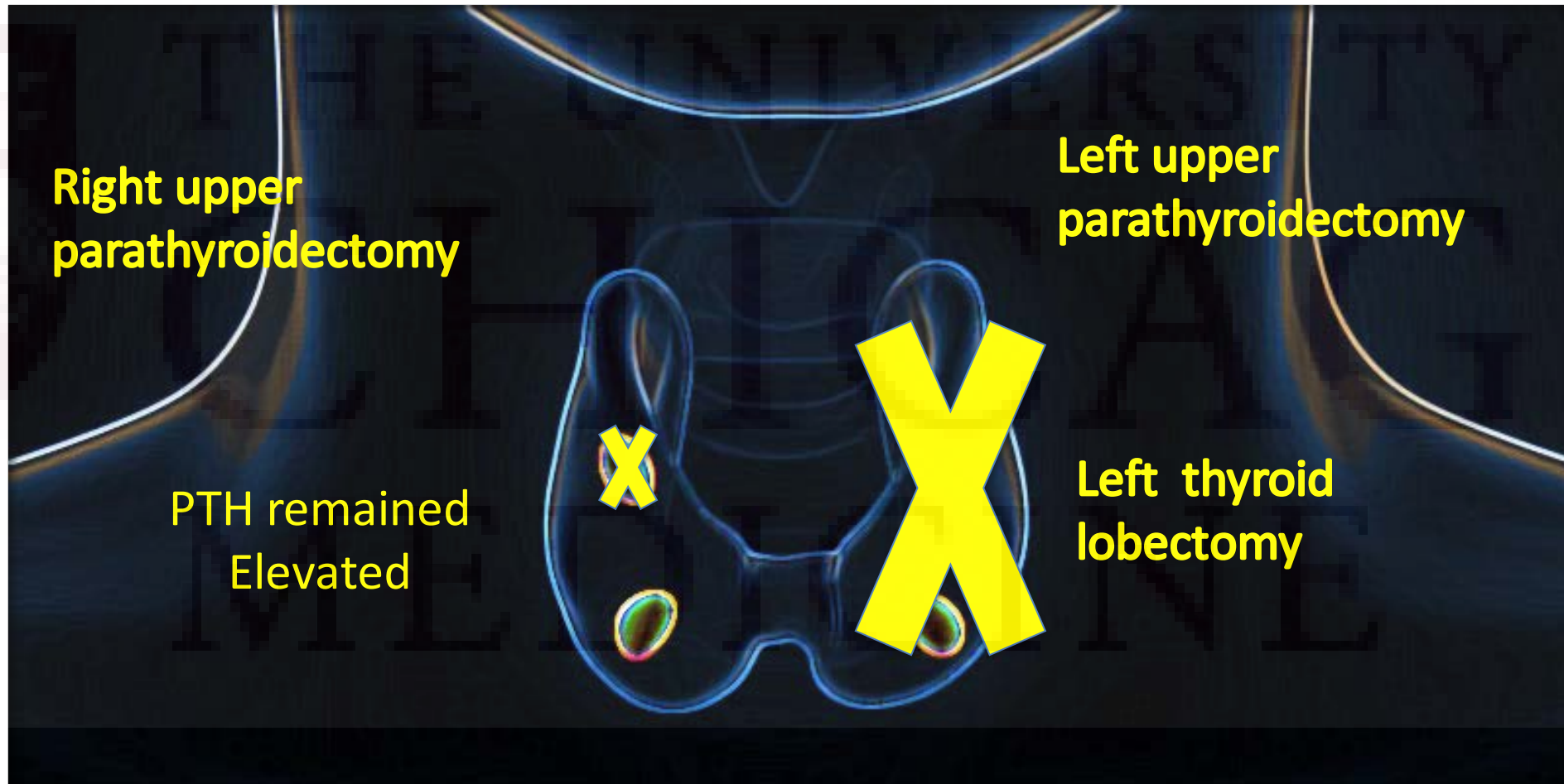
# CASE 1 PM 3679909

- CC: Kidney stone/ Osteopenia
- HPI:
  - 71 y.o F with persistent Primary hyperparathyroidism (PHPTH)
    - Came to see us in clinic after failed parathyroid exploration 2009.
  - 2009: elevated CA/PTH
    - Hx nephrolithiasis/ osteopenia
    - Pre-op localization study
      - US: **possible Right and Left upper pole adenoma**
      - Sestamibi: **Negative for localization**
    - 9/2009 for gland exploration with intra-operative PTH monitoring

# CASE 1 PM

- 9/2009
  - Left upper gland was removed initially
    - PTH remained elevated
  - Identified both right upper/lower
  - Removed the right upper
    - PTH elevated
  - Unable to identify the left lower.
    - Left thyroid lobectomy ( suspicious for intra-thyroidal PT gland)
    - PTH elevated

# CASE 1 PM



# CASE 1 PM

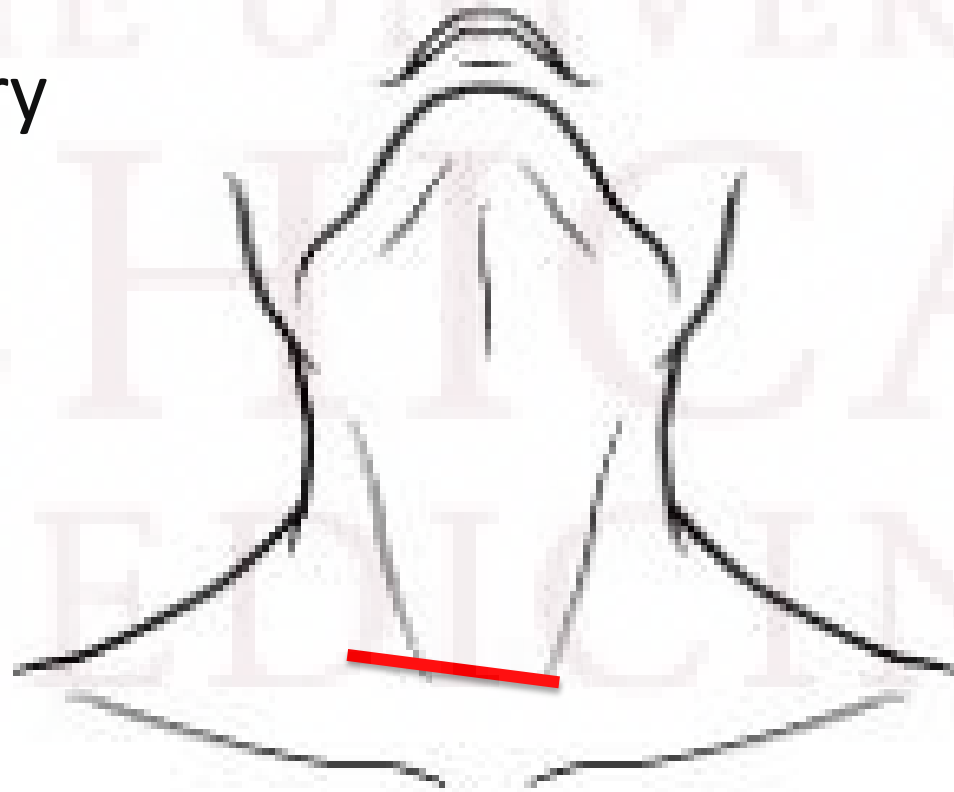
- HPI (con't)
  - Post-op continue to have elevated Ca and PTH
    - Ca in the 11 mg/dl range
  - Patient started on Sensipar
    - Her current Ca 10.5 and PTH 106
    - Sx of Tiredness/Bone pain/Kidney stone/constipation
    - Medication cost
      - **Reoperative parathyroidectomy.**

# CASE 1 PM

- PMHx:
  - Factor V leiden
  - HTN
  - Osteoarthritis/Osteopenia
  - Hyperparathyroidism
  - Hypothyroidism
  - DVT x2/PE > 15 years ago
  - Anxiety
- PSHx:
  - C-section
  - Hip replacement
  - Parathyroidectomy/Hemithyroidectomy
- Family hx:
  - Father: PHPTH
  - Son: PHPTH
- Medication:
  - Synthroid 75mcg
  - Sensipar 30mg
  - Valsartan 320mg
  - Xarelto 20mg
  - Xanax/ Temazepam
  - Nortriptyline

# CASE 1 PM

- Physical Exam:  
Noncontributory





NM: RECON TOMO / TRANS-OSEM-AC  
CT: CTTRANS 3.2  
NM: 8/24/2017  
CT: 8/24/2017

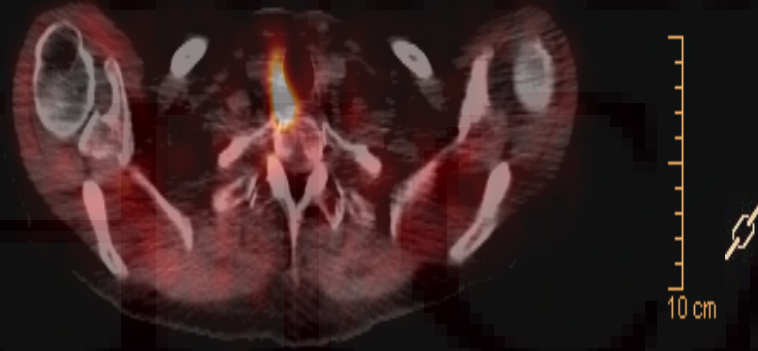
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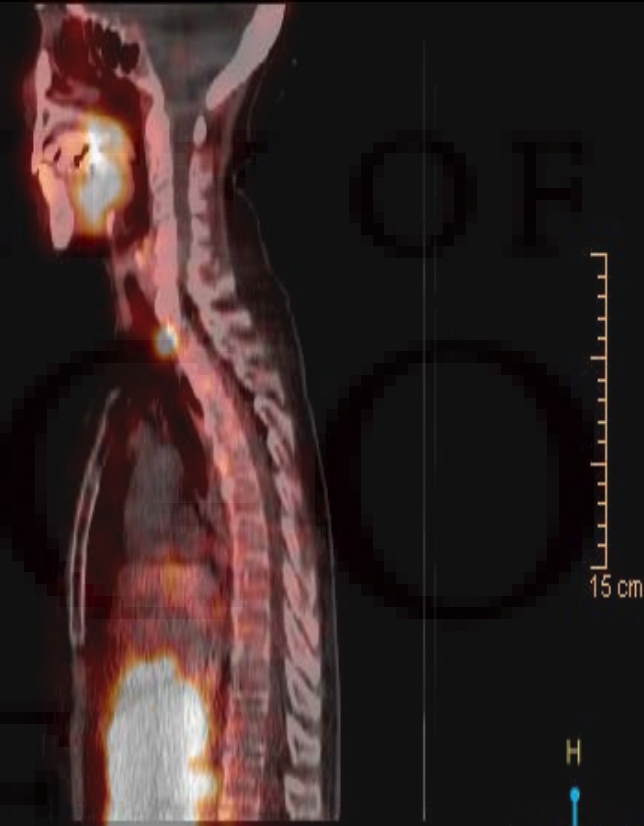
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CT: Series: 102 / Slice: 60

LL:0.00 UL:2716.16  
Width:360 Level:60



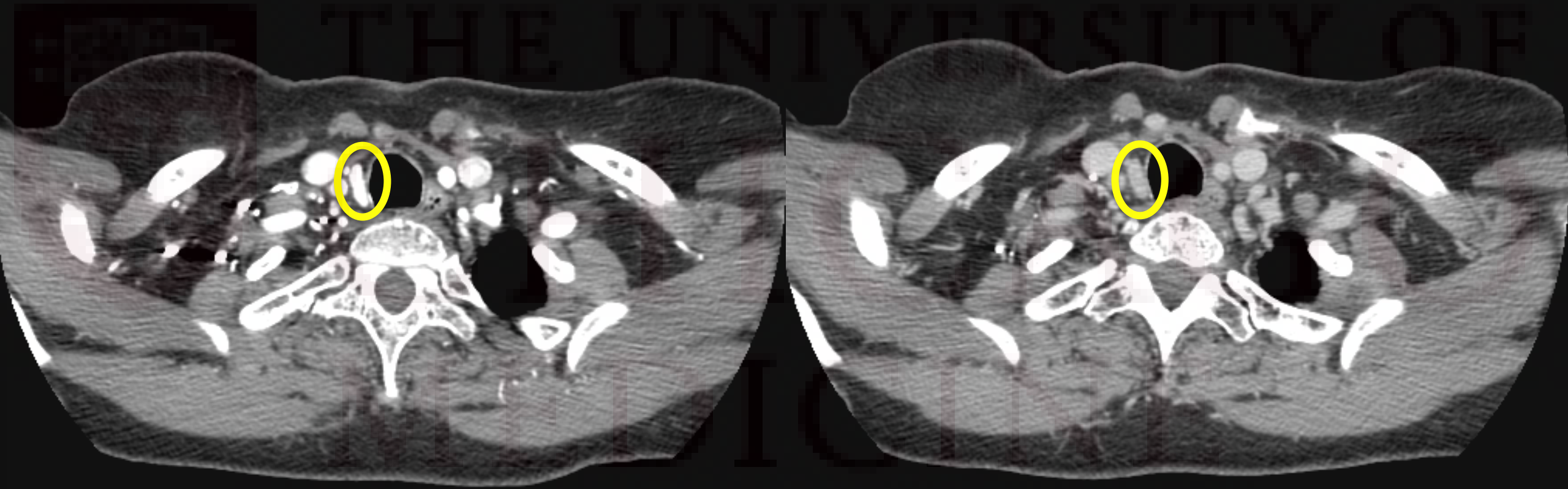
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CT: Series: 102 / Slice: 67

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# CASE 1 PM

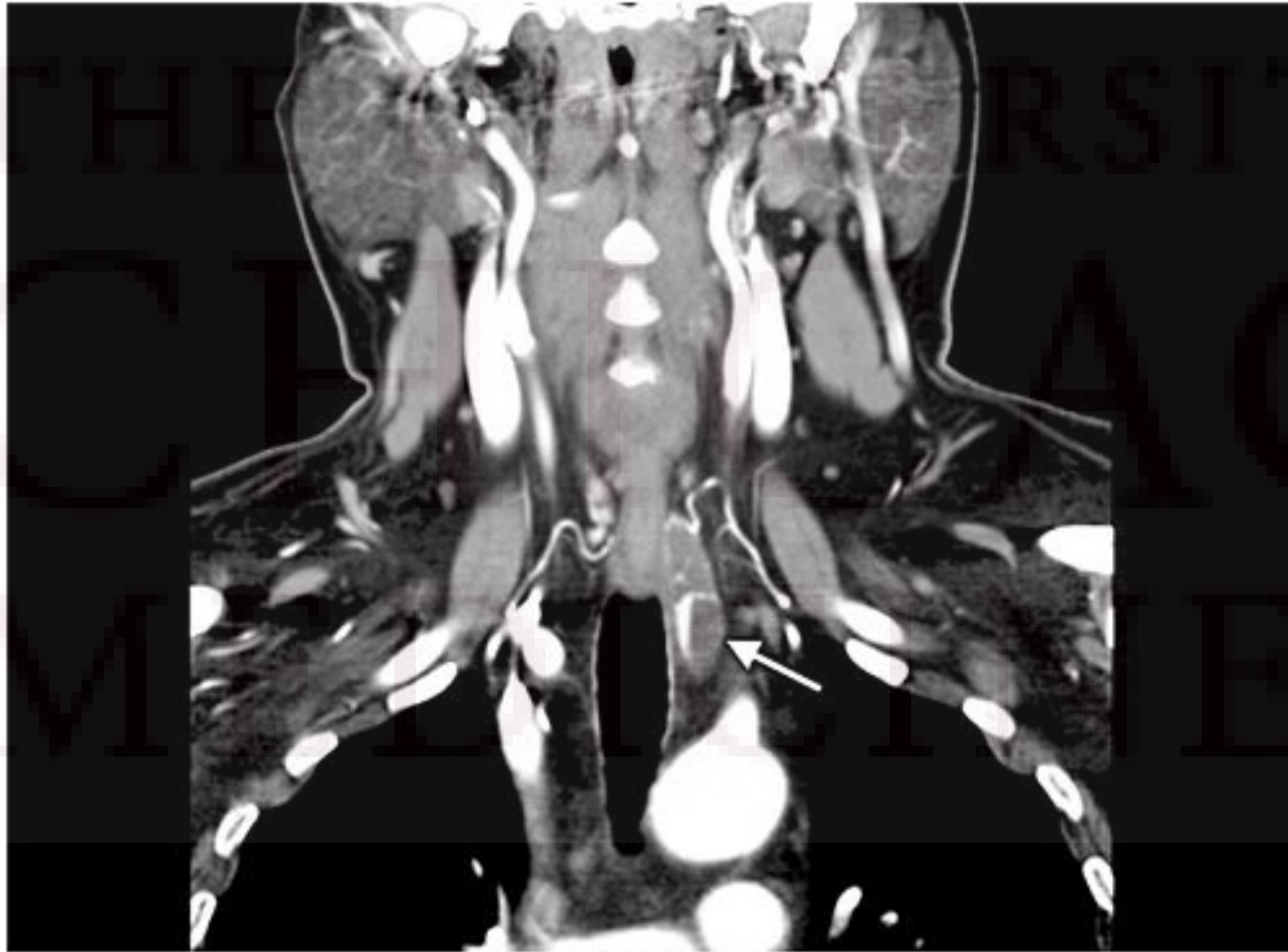
- OR
  - Parathyroidectomy
  - Intra-operative PTH
  - Possible Autotransplant.

# 4D CT SCAN

- Similar to CT angiography
- 3-D CT scanning with added dimension from change in perfusion of contrast over time.
- Allows visualization of differences in the perfusion characteristics of hyper-functioning parathyroid glands
  - Rapid uptake and washout
- Provides both anatomical and functional information
- Issues:
  - Availability
  - Radiation exposure
  - Contrast



# 4D CT SCAN



# Improved preoperative planning for directed parathyroidectomy with 4-dimensional computed tomography

Steven E. Rodgers, MD, PhD, George J. Hunter, MD, PhD, Leena M. Hamberg, PhD, DSc, Dawid Schellingerhout, MD, David B. Doherty, Gregory D. Ayers, MS, Suzanne E. Shapiro, MS, Beth S. Edeiken, MD, Mylene T. Truong, MD, Douglas B. Evans, MD, Jeffrey E. Lee, MD, and Nancy D. Perrier, MD, *Houston, Texas*

- Purpose:
  - Compare 4D CT with Sestamibi and US for pre-op localization of pHPTH.
- Methods:
  - 75 pts w pHPTH; US, Sestamibi, 4D CT performed in all pts pre-op
  - Results of imaging studies compared with operative finding.

# Improved preoperative planning for directed parathyroidectomy with 4-dimensional computed tomography

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- **Results:**

**Table III.** Sensitivity and specificity of imaging modalities for localization of parathyroid tumors to side of the neck and quadrant of the neck

<i>Variable</i>	<i>Sensitivity (%)</i>	<i>95% CI</i>	<i>Specificity (%)</i>	<i>95% CI</i>
Side of the neck				
4D-CT	88	81-95	88	80-96
Ultrasonography	57	47-67	94	88-99
Sestamibi	65	55-75	88	80-96
Precise location in the neck				
4D-CT	70	59-81	89	85-93
Ultrasonography	29	20-38	86	82-90
Sestamibi	33	24-42	83	79-87

- **Conclusion:**

- 4D CT provides significantly greater sensitivity than US/Sestamibi for Precise localization of pHPTH.



# A Meta-analysis of Preoperative Localization Techniques for Patients with Primary Hyperparathyroidism

Kevin Cheung, MSc, MD<sup>1</sup>, Tracy S. Wang, MD, MPH<sup>2</sup>, Forough Farrokhyar, MPhil, PhD<sup>1</sup>, Sanziana A. Roman, MD<sup>3</sup>, and Julie A. Sosa, MD, MA<sup>4</sup>

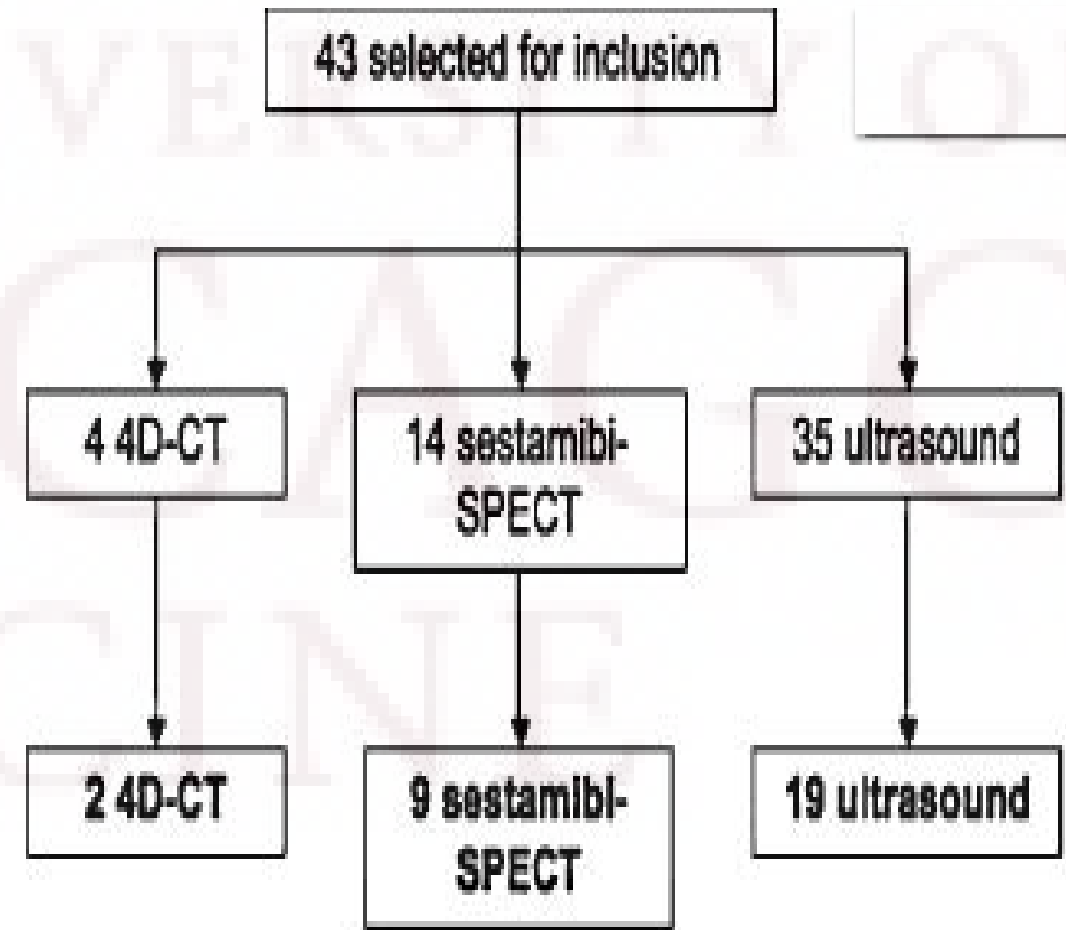
- Purpose:
  - Determine the accuracy of US, Sestamibi-Spect, 4D CT as pre operative localization strategies
- Methods:
  - Meta-analysis: studies lx accuracy of pre-op localization studies in pHPTH.
- Result:
  - 43 studies met criteria
    - 19 US
    - 9 Sestamibi-SPECT
    - 4 4D CT



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- Result con't:
  - Us: pooled sensitivity&PPV of
    - 76.1%& 93.2%
  - Sestamibi:
    - 78.9% & 90.7%
  - 4D CT:
    - 89.4% & 93.5%
- Conclusion:
  - US & Sestamibi similar in ability to preop localized abnormal parathyroid glands.
  - 4D CT: improved Accuracy.



# Diagnostic performance of computed tomography for parathyroid adenoma localization; a systematic review and meta-analysis

Wouter P. Kluijfhout<sup>a,b,\*,1</sup>, Jesse D. Pasternak<sup>c</sup>, Toni Beninato<sup>a</sup>,  
Frederick Thurston Drake<sup>a</sup>, Jessica E. Gosnell<sup>a</sup>, Wen T. Shen<sup>a</sup>, Quan-Yang Duh<sup>a</sup>,  
Isabel E. Allen<sup>d</sup>, Menno R. Vriens<sup>b</sup>, Bart de Keizer<sup>e</sup>, Thomas A. Hope<sup>f</sup>, Insoo Suh<sup>a</sup>

- Purpose:
  - Sensitivity and PPV of 4D CT
  - Compare different protocols ( contrast) and their performance in different pts group.
- Methods:
  - Meta-analysis 2000-20016 Ix diagnostic value of CT for Parathyroid localization.

# Outcome

- 34 studies (2563 pts)
- Localization: Pooled sensitivity of 73% PPV 81% ( quadrant)
- Lateralization: pooled sensitivity increase 81%
- Subgroup analysis
  - Only pt with inconclusive imaging and/or previous PTH surgery
    - Sensitivity: 62-76%
  - Number of contrast phases
    - 2 phase contrast 76%
- Conclusion:
  - CT performs well in localizing pathological glands in patients with pHPT.
  - 2 contrast phases seems to offer a good balance of acceptable performance with limitation of radiation exposure.

# Preoperative Localization Strategies for Primary Hyperparathyroidism: An Economic Analysis

Carrie C. Lubitz, MD, MPH<sup>1</sup>, Antonia E. Stephen, MD<sup>1</sup>, Richard A. Hodin, MD<sup>1</sup>, and Pari Pandharipande, MD, MPH<sup>2</sup>

- Purpose: compare comprehensive costs associated with common localization strategies.
- Methods:
  - Decision-analytic model evaluate comprehensive, short-term cost of localization strategies for pt with pHPTH.
  - 8 strategies were compared



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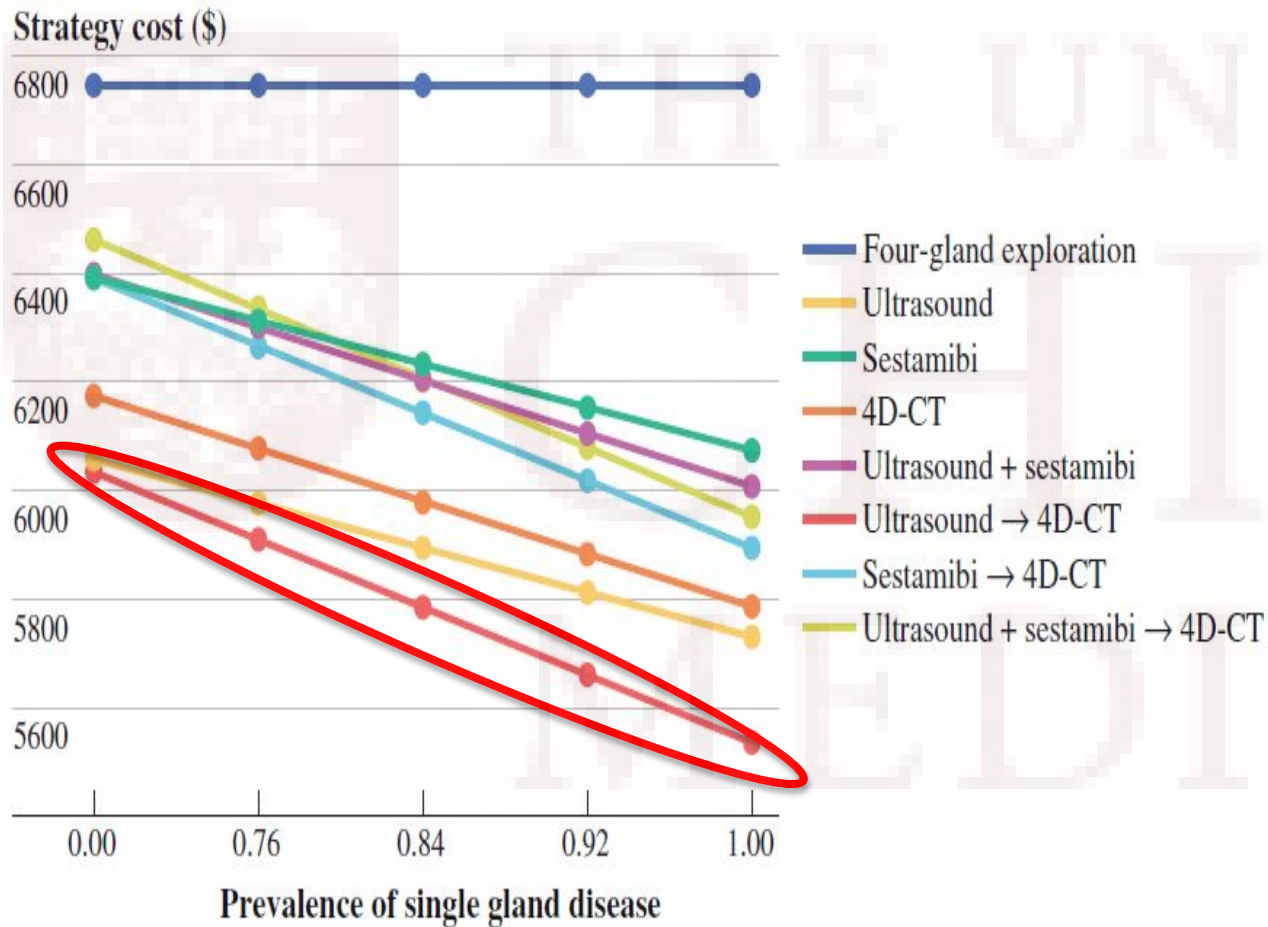
**TABLE 2** Differential cost and cost by rank of localization strategies

Rank	Strategy	Cost (\$)	Incremental cost (\$) (compared with US → 4D-CT)
1	US → 4D-CT (if US indeterminate)	5,901	
2	US	6,028	127
3	4D-CT	6,110	209
4	SM → 4D-CT (if SM indeterminate)	6,266	365
5	US + SM → 4D-CT (if US and SM indeterminate or discordant)	6,319	418
6	US/ SM	6,329	428
7	SM	6,374	473
8	BNE	6,824	923

*US* ultrasound, *SM* sestamibi-SPECT, *BNE* four-gland, bilateral neck exploration

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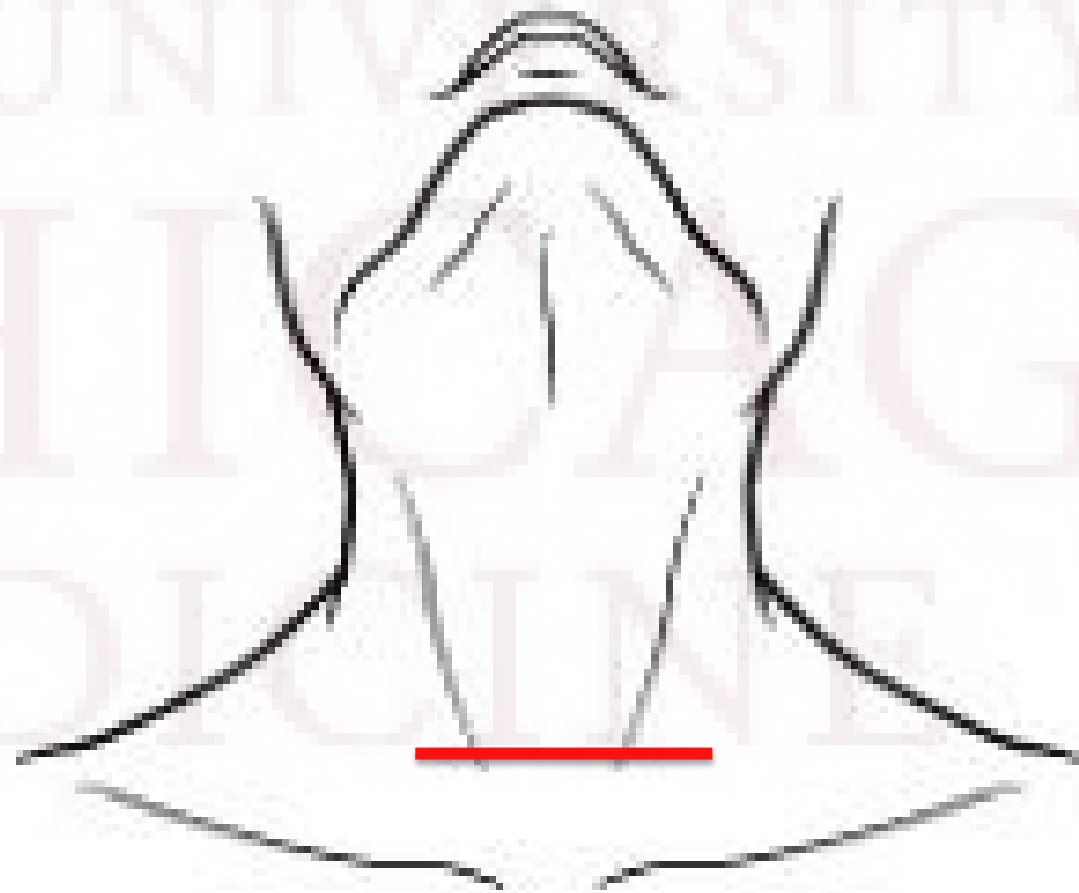
- Conclusions:
  - US followed by selective 4D-CT is the least expensive.

# CASE 2

- CC: Kidney stones
- HPI:
  - 66 y.o F with pHPTH.
  - Initially px with sx kidney stone was found to have pHPTH.
    - Osteoporosis
    - Previous hx of left thyroid lobectomy (toxic nodule) 2000
- PMH: CAD, HTN, Nephrolithiasis, Osteoporosis.
- PSH:
  - L thyroid lobectomy
  - Cervical laminectomy

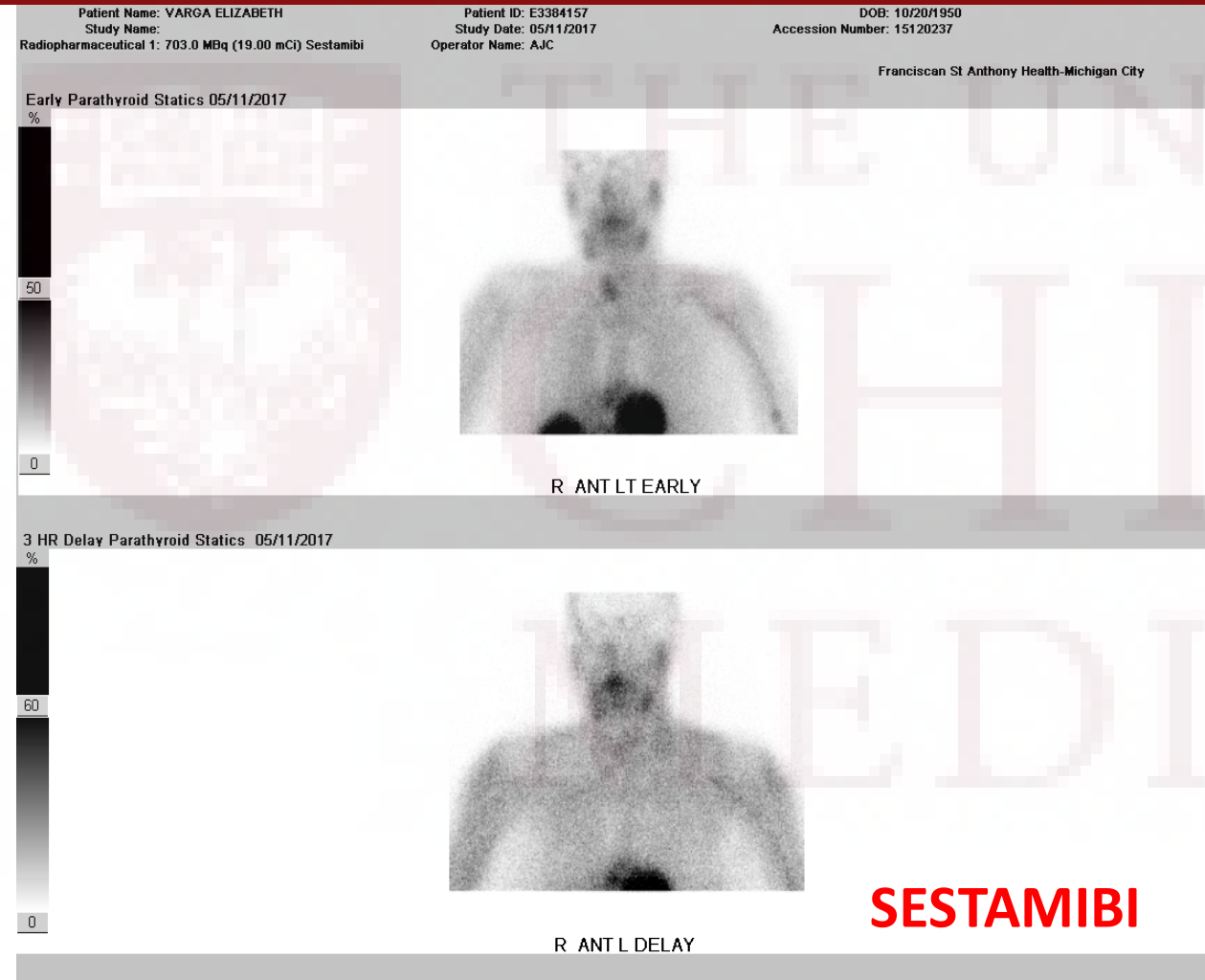
# CASE 2

- Physical Examination:
  - None contributory
- Lab:
  - CA: 10.4 mg/dl
  - PTH: 81 pg/ml
  - Vit D: 52 ng/ml





# CASE 2



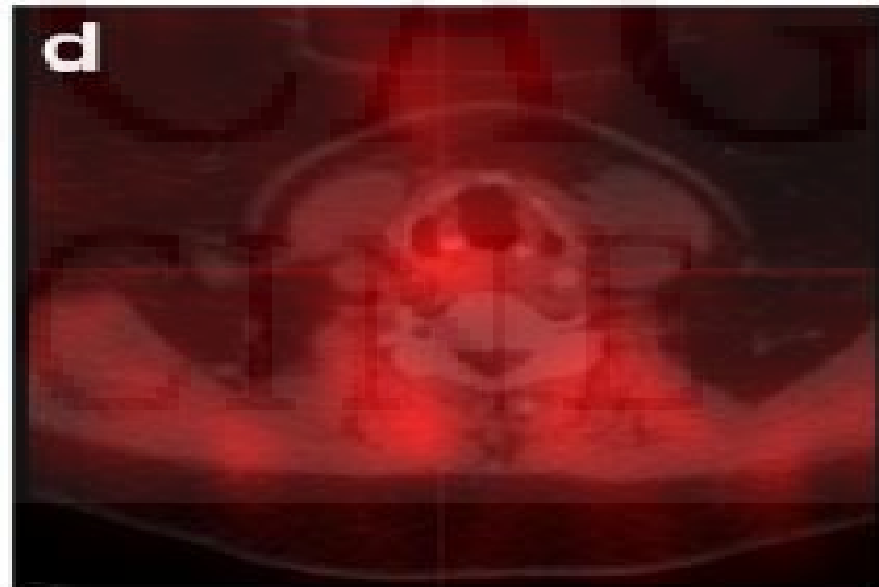
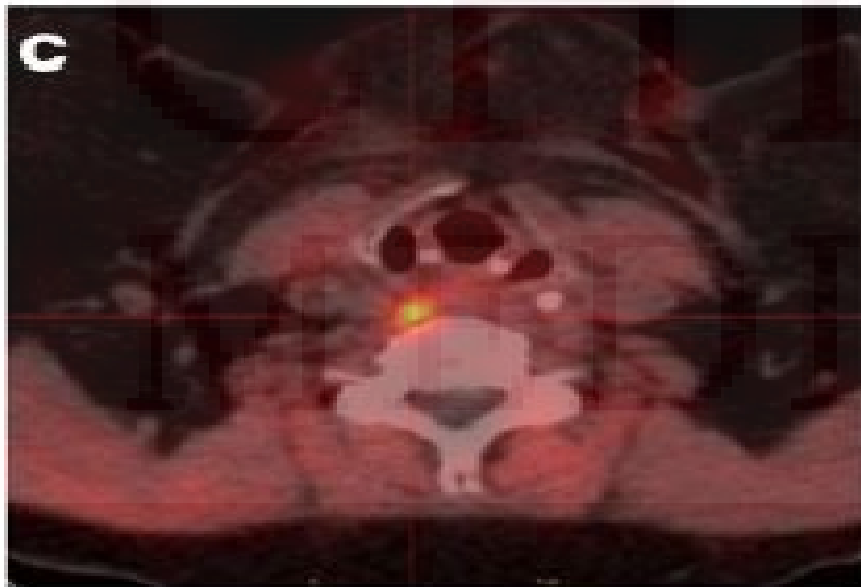
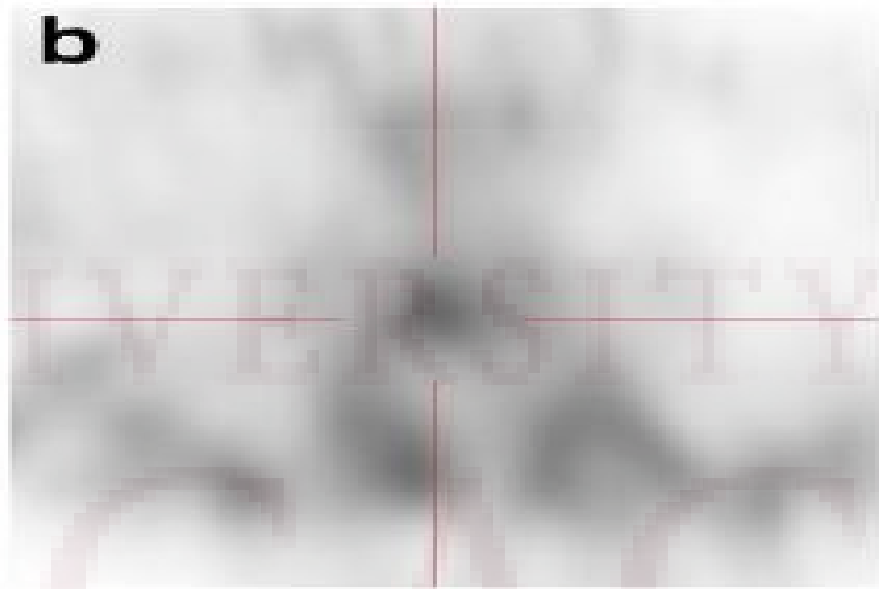
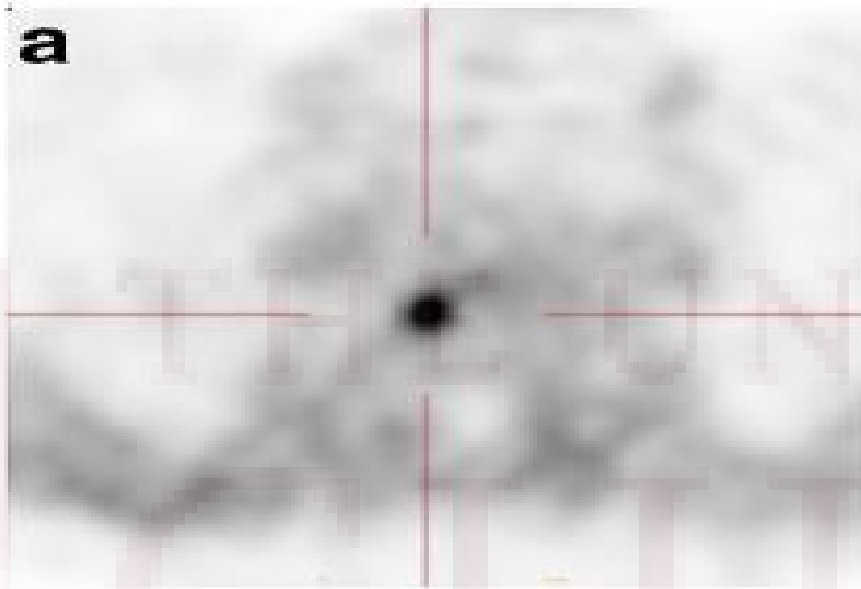
# CASE 2

- Localization Study:
  - US: -ve
  - Sestamibi: -ve
  - 4D CT: -ve
  - Selective venous sampling: -ve
- What is the next step?
  - Surgery ?
  - Further Imaging ?

## **$^{18}\text{F}$ -Fluorocholine PET/CT for localization of hyperfunctioning parathyroid tissue in primary hyperparathyroidism: a pilot study**

Luka Lezaic • Sebastijan Rep • Mojca Jensterle Sever •  
Tomaz Kocjan • Marko Hocevar • Jure Fettich

- Purpose:
  - Evaluate the usefulness of  $^{18}\text{F}$ -fluorocholine PET/CT for preoperative localization of pHPTH
- Method: Pilot study
  - PET/CT and SESTAMIBI performed in 24 pts
  - Diagnostic performance compared with histopath/Ca/iPTH



**Table 3** Diagnostic performance of <sup>18</sup>F-fluorocholine PET/CT and conventional scintigraphic imaging methods

	PET/CT	SPECT/CT	Subtraction	Dual-phase	Combined
All patients (24 patients, 39 lesions)					
Sensitivity (%)	92	49*,***	46*,***	44*,***	64***
Specificity (%)	100	100	100	100	100
Accuracy (%)	98	83	82	82	88
PPV (%)	100	100	100	100	100
NPV (%)	96	80	79	79	85
Solitary parathyroid adenoma (17 patients)					
Sensitivity (%)	94	70	65	59*	82
Specificity (%)	100	100	100	100	100
Accuracy (%)	99	94	93	92	96
PPV (%)	100	100	100	100	100
NPV (%)	99	93	92	91	96
Multiple parathyroid adenomata and parathyroid hyperplasia (7 patients, 22 lesions)					
Sensitivity (%)	91	32***	32***	32***	50**
Specificity (%)	100	100	100	100	100
Accuracy (%)	94	57	57	57	57
PPV (%)	100	100	100	100	100
NPV (%)	87	46	46	46	46