Parathyroid Localization Studies

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Outline

Clinical Context of Primary Hyperparathyroidism
Ultrasound, Sestamibi, and Other Imaging
Case Illustrations

Historical Evolution of Parathyroid Surgery

Bilateral parathyroid exploration without routine use of ultrasound or sestamibi imaging: 95% success rate in curing primary hyperparathyroidism
The Philosophy of Approaches to Parathyroid Surgery Shifted During 1998-2008
(Greene JACS 2009)

The Practice of Limited Parathyroidectomy by Surgical Specialty
(Greene JACS 2009)

De-evolution of Parathyroid Disease Severity

Goals of Parathyroid Surgery

- Ensure appropriate patient selection with clear biochemical diagnosis of 1°HPT
- Achieve a normocalcemic state and normal long-term PTH
- Avoid injury to the laryngeal nerves
- Engender minimal postoperative morbidity and negligible mortality
- Achieve cosmetic scar appearance acceptable to the patient

Mazzaglia Arch Surg 2008
Ultrasound and Sestamibi imaging should only be performed once biochemical diagnosis of 1°HPT is known

+ imaging studies do not confirm diagnosis
- imaging studies do not exclude diagnosis

"the only localizing study needed is to locate a parathyroid surgeon."
John Doppman, NIH 1986

Roles of Preoperative Imaging for 1°HPT

- Assist surgeon in identifying anatomic location of abnormally functioning or enlarged parathyroids
  - guides focally directed surgeries
  - aids conduct or sequence of exploration
  - reduces OR time
  - “challenge of the hunt” vs “smooth sailing”

- Alert to potential ectopic disease, particularly in the mediastinum
- Assess the feasibility of surgery in re-operative cases

Three Philosophical Approaches to Parathyroidectomy

- Focal
- Unilateral
- Bilateral (BE)
- “Limited” (LE)

Modern Options for Parathyroid Surgery

- Radioguided
- Video-assisted MIP
- Endoscopic gas vs gasless
- Selective/ “image-directed”/ targeted
- Focused open lateral
- Open anterior minimally-invasive
- Robotic
- Focal without IOPTH
- Trans-areolar/ ?trans-oral
- Bilateral
- “MIPS”
**Parathyroid Localization Studies**

- **US only 2%**
- **Sestamibi 26%**
- **US and Sestamibi 62%**
- **Other 10%** (4D-CT, MRI, PET, FNA, venous sampling)

Greene JACS 2009

**US and Sestamibi Imaging for 1ºHPT**

- **Ultrasound**
  - images neck region only, not mediastinum
  - cost-effective, painless, non-invasive
  - no radiation exposure
  - accuracy is highly operator-dependant

- **Sestamibi**
  - most popular procedure
  - quality varies widely among institutions
  - many types of scans
  - major advantage is identifying ectopic sites

**Expectations for Accuracy in US and Sestamibi Imaging for 1ºHPT**

- **Ultrasound**
  - SN 82% SP 90% (PPV 70% for SA, 50% for MGD)
  - identifies coexisting thyroid disease (20-40%)
  - and thyroid cancer (4%)

- **Sestamibi**
  - most centers 50-75% accuracy
  - some series >90% accuracy
  - known to be as low as 27-55% for MGD

- **Both** 70-90% will be positive; success variably defined


**Normal Parathyroids are NOT Imaged**

Kim eMedicine 2009

Milas & Atten Otol 2009
Histology Cannot Distinguish Adenomas from Multigland Disease or Define the Clinical Etiology (1<sup>o</sup> vs 2<sup>o</sup> vs MEN)

Parathyroid Ultrasound Imaging
Correlation of Parathyroid Sonographic Distribution to Embryologic Origin

superior parathyroid glands

inferior parathyroid glands
3 Circles Sign:
Sonographic Appearance of Parathyroid Adenoma,
Carotid Artery and Jugular Vein in Transverse Imaging
Parathyroid Localization Studies Identify Thyroid Pathology

Parathyroid Sestamibi Imaging

2-D Planar Sestamibi Scan with Initial and Delayed Imaging

Sestamibi Iodine Subtraction Scan with SPECT imaging

99Tc Sestamibi | 123I Subtraction
Sestamibi Iodine Subtraction Scan with SPECT Imaging and CT Co-localization

$^{99m}$Tc Sestamibi -Iodine CT Co-localization

SPECT imaging

Sestamibi Imaging in Secondary Hyperparathyroidism

Typical negative findings

Rare positive study

parathyroid distribution in re-operations
Intrathymic Parathyroid via Cervical Operation

A surgeon’s contribution to viewing parathyroid imaging: anatomy, embryology, operative findings

Lower parathyroids

Upper parathyroids

Courtesy: N. Perrier, Houston
Radionuclide imaging for hyperparathyroidism (HPT): Which is the best technetium-99m sestamibi modality? (Sharma et al, *Surgery* 2006)

Other Parathyroid Imaging

- Venous Sampling
- 4D CT imaging
- MRI
- Pet Scans
- US-guided sampling of PTH from Internal Jugular Veins
- Endoscopic US ± FNA

Venous Sampling by Interventional Radiology: defines PTH gradient, gives region, not site

PET Scan Imaging for Parathyroid Disease
4-Dimensional CT Imaging

3-D CT method with 4\textsuperscript{th} dimension representing changes in perfusion of contrast over time: hyperfunctioning parathyroids have rapid uptake and washout.

MRI for Parathyroid Imaging

Harvey, Berber et al SAGES 2009

4-D CT

Source: G. Thompson, Mayo Clinic, ACS 2009

MRI Imaging Guided Robotic Parathyroidectomy
Harvey, Berber et al SAGES 2009
Effectiveness of “office”-based, ultrasound-guided differential jugular venous sampling (DJVS) of parathormone in patients with primary hyperparathyroidism

Denise Carriero-Poiz, MD, Charleston, SC

Background. Pre-operative localization is the first step for focused parathyroidectomy. Surgeon-performed ultrasoundography (SUS) is used often as a single method of localization; however, when equivocal results (MIBI) scan is still included, intra-operative differential jugular venous sampling (DJVS) is positive in 71-80% of patients. The purpose of this study is to evaluate the effectiveness of office based DJVS as the first method for localization when SUS is equivocal.

Methods. Twenty-one patients with an equivocal SUS underwent office-based, US-guided DJVS. The samples were collected from the most inferior portion of each internal jugular vein and sent for standardized parathormone (PTH) measurement. The side of the neck with the highest value of serum PTH was the initial side of exploration. DJVS localization was correlated retrospectively with operative findings.

Results. In 17 of 21 (81%) patients, DJVS was correct in indicating the side of the abnormal gland. DJVS was incorrect in 2 and negative in 2 other patients. Bilateral neck explorations were performed in only 6 of 21 patients because of other malignancies (3 patients), concurrent lymphadenopathy (2 patients), or surgeon’s judgment (1 patient). There were no complications from DJVS, and all patients became normocalcemic.

Conclusions. Office-based DJVS is accurate and easy eliminate the need for MIBI in patients with equivocal SUS. This simple technique can shorten the pre-operative evaluation of primary hyperparathyroidism. (Surgery 2009;146:1014-20.)
Challenging Parathyroid Localization

Summary

- Ultrasound and Sestamibi are part of comprehensive pre-operative evaluation for localization not diagnosis of parathyroid tumors
- Direct strategy, shorten operative time, address co-existing thyroid pathology
- Experience matters. Viewing the images matters.
Thank you

- Endocrinology
- Endocrine Surgery
- Head and Neck Surgery
- Genomic Medicine Institute
- Pathology
- Radiology
- Medical and Radiation Oncology

Endocrinology and Metabolism Institute

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