

4D CT – A Diagnostic Tool to Localize an Occult Parathyroid Adenoma In a Patient With Primary Hyperparathyroidism

Michael D. Beland, MD, and Jack M. Monchik, MD

A 64 YEAR-OLD FEMALE PRESENTED WITH persistent primary hyperparathyroidism after undergoing two previous neck explorations for a suspected parathyroid adenoma. Twelve days after her most recent neck exploration, her parathyroid hormone level remained elevated and a **four-dimensional computed tomography (4D CT)** of the neck and upper chest was performed. The CT examination demonstrated early dense arterial phase enhancement and contrast washout within an 8 x 8 x 10 mm nodule immediately posterolateral to the left aspect of the esophagus at the level of the T3 vertebral body highly suspicious for an ectopic parathyroid adenoma. (Figures 1 and 2) Following recovery from the most recent surgery and confirmation of a persistently elevated parathyroid hormone level, the patient was taken back to the operating room for targeted exploration of the area seen on 4D CT.

An extensive dissection in the left paratracheal tissues behind the common carotid artery revealed a soft tissue mass that was removed. Frozen section confirmed parathyroid adenoma. The estimated weight of the adenoma was 389 mg. Parathyroid hormone levels were monitored during the case and demonstrated an appropriate response after resection. One third of the adenoma was used for autotransplantation in the forearm. The autologous autotransplanted parathyroid tissue was then removed approximately six weeks later after her calcium and parathyroid hormone levels remained normal.

DISCUSSION

Improvements in imaging localization of parathyroid adenomas in patients with **primary hyperparathyroidism (PHPT)** prior to surgical excision have allowed the transition from a traditional bilateral neck exploration to selective excision of an adenoma localized pre-operatively. The newest techniques of minimally invasive parathyroidectomy require precise pre-operative localization to be successful.¹ The current modalities used for routine pre-operative imaging localization of a parathyroid adenoma primarily consist of

nuclear medicine (NM) sestamibi scans with or without cervical **ultrasound (US)**. The two modalities are complimentary as the nuclear medicine scan offers functional information while US demonstrates more detailed anatomic information.

Despite improvements in US and NM technology, neither modality will detect all parathyroid adenomas. A recent meta-analysis demonstrated Tc-99m sestamibi scanning outperformed ultrasound with respective sensitivities of 88% versus 78% for single adenomas. Sensitivity for detection of multiple adenomas was sub-

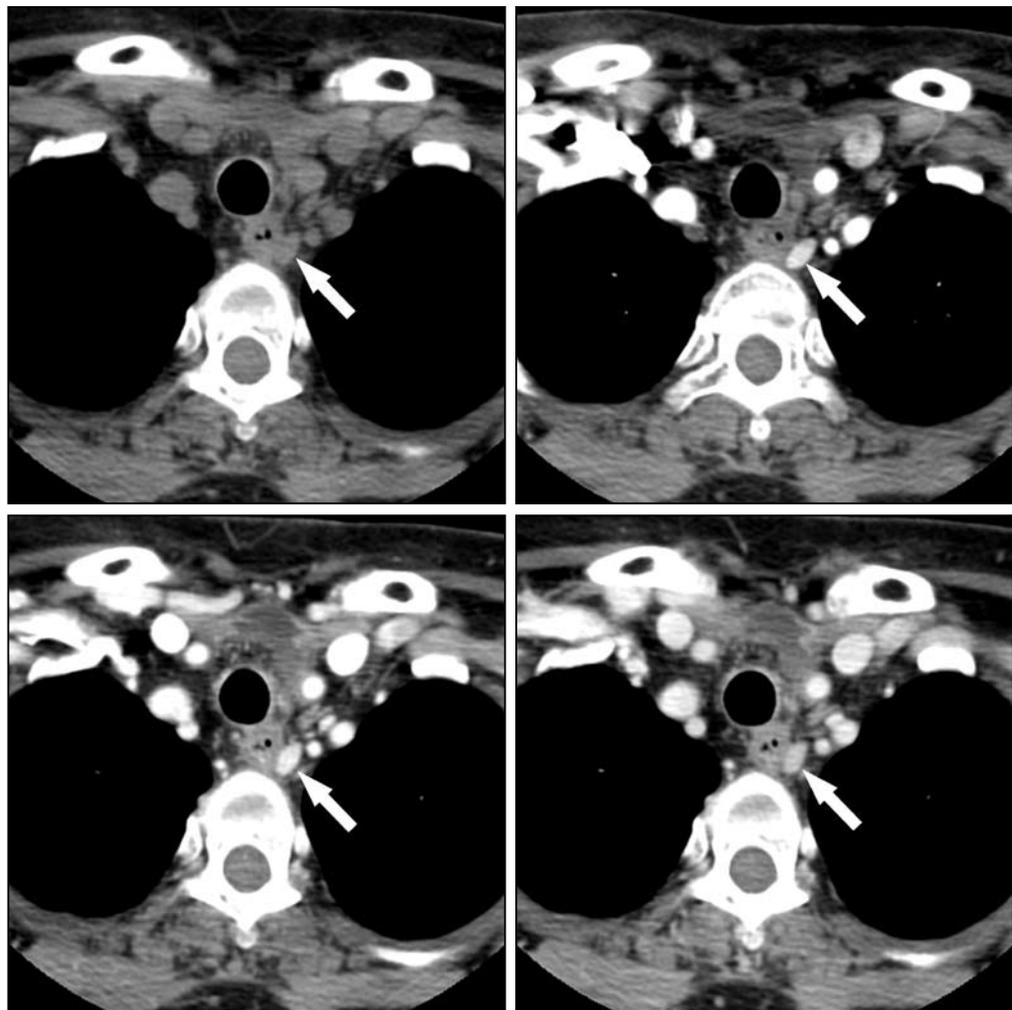


Figure 1. Axial CT examination (a. upper left) before, (b. upper right) 30 seconds, (c. lower left) 60 seconds and (d. lower right) 90 seconds after intravenous contrast administration demonstrate early arterial phase enhancement and washout of the ectopic parathyroid adenoma (arrows).

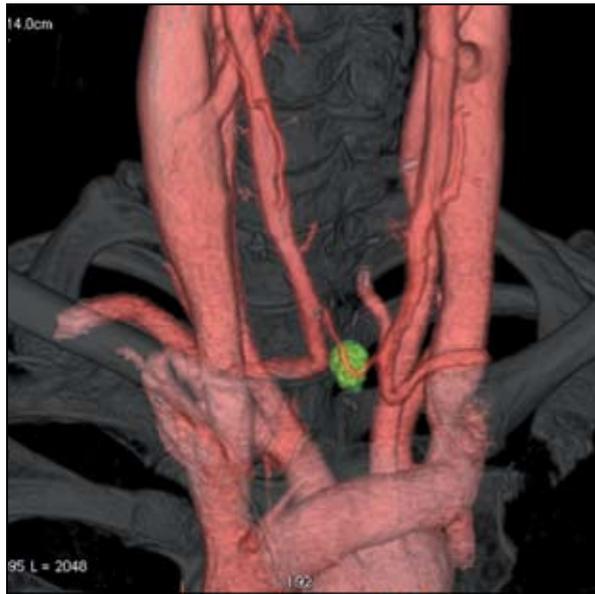


Figure 2. Volume rendered post-contrast CT image demonstrating the parathyroid adenoma (green) relative to the adjacent cervical and upper thoracic vascular and skeletal anatomy.

stantially less being 30% for sestamibi and 16% for US.² Some institutions are now routinely using SPECT/CT for localization as a single test that can offer both functional and anatomic information although the literature has shown conflicting evidence of additional clinical value.^{3,4}

Localization is especially important in the setting of persistent or recurrent PHPT after surgical exploration. Before proceeding with reoperation, the current consensus is that two concordant preoperative imaging studies should localize hyperfunctioning parathyroid tissue to the same anatomic region of the neck.⁵ The goal of accurate localization is to minimize morbidity and maximize the likelihood of success.⁶ There are recent reports in the surgical literature describing the use of single phase contrast-enhanced CT to localize parathyroid adenomas, particularly in patients who have already undergone a surgical neck exploration.⁷⁻⁹ 4D CT, a technique which employs precontrast and multiphase post contrast images through the neck typically at 30, 60 and 90 seconds, has been described as a potentially more robust method of localization exploiting the differential early enhancement of parathyroid adenomas.^{1,6,10}

Our group at Rhode Island Hospital has reported one of the largest series in the literature using 4D CT, demonstrating a mean sensitivity and specificity of 82%

and 92% respectively for precise localization of occult parathyroid adenomas when prior surgery or localization with US and sestamibi NM scans have been unsuccessful.¹⁰ We showed fair to excellent interobserver reliability across all pairs with an overall excellent reliability. In addition, we demonstrated that adenomas demonstrate a characteristic contrast enhancement pattern of early enhancement. This enhancement was significantly different at the 30 and 60 second phases compared with the progressive enhancement pattern demonstrated in normal lymph nodes.

Given that the majority of parathyroid adenomas will be found using a combined US and NM imaging algorithm, 4D CT should not be used in the standard evaluation. However, 4D CT will localize a majority of adenomas successfully in patients where conventional imaging is unsuccessful. While 4D CT may offer improved localization in the routine work-up of primary hyperparathyroidism,¹ the increased radiation dose should limit 4D CT to problem-solving cases.

In summary, parathyroid adenomas in patients with unsuccessful localization on conventional imaging can be accurately demonstrated pre-operatively on 4D CT. Parathyroid adenomas demonstrate characteristic rapid enhancement which can help differentiate these lesions from lymph nodes. Precise localization is critical to minimizing surgical morbidity, particularly in patients who have undergone prior surgery.

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Michael D. Beland, MD, is Director of Ultrasound at Rhode Island Hospital and Assistant Professor of Diagnostic Imaging, Warren Alpert Medical School of Brown University.

Jack M. Monchik, MD, is Chief of Endocrine Surgery at Rhode Island Hospital and Clinical Professor of Surgery, Warren Alpert Medical School of Brown University.

Disclosure of Financial Interests

The authors and/or their spouses/significant others have no financial interests to disclose.

CORRESPONDENCE

Michael D. Beland, MD
 Department of Diagnostic Imaging
 Rhode Island Hospital
 593 Eddy Street
 Providence, RI 02903
 phone: (401) 444-5184
 fax: (401) 444-5017