False Positive Brown Adipose Tissue Uptake on Parathyroid ^{99m}Tc-Sestamibi Scan

Chetan Thapa[1]*, Tahleesa Cuda[2-4], Evyn Arnfield[2,4]

[1]*Department of Radiology, Gold Coast University Hospital, Southport, Australia*
[2]*Department of Nuclear Medicine and Specialist PET Services Queensland, Royal Brisbane and Women's Hospital, Brisbane, Australia*
[3]*Molecular Imaging and Therapy, Austin Health, Melbourne, Australia*
[4]*Faculty of Medicine, University of Queensland, Australia*

***Correspondence:** Chetan Thapa, Medical Imaging Department, Gold Coast University Hospital, 1 Hospital Blvd, Southport QLD 4215, Australia

chetan.thapa@health.qld.gov.au

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AUTHORS' CONTRIBUTIONS
Chetan Thapa: Manuscript preparation and submission.
Tahleesa Cuda: Study interpretation and manuscript preparation.
Evyn Arnfield: Study interpretation and manuscript review.

DISCLOSURES
Authors declare no conflict of interest.

CONSENT
N/A

HUMAN AND ANIMAL RIGHTS
N/A

ABSTRACT

An 18-year-old female was found to have hyperparathyroidism and severe chronic renal failure of unclear cause. Dual-isotope parathyroid imaging was performed to exclude a parathyroid adenoma. Pinhole scintigraphy following intravenous administration of ^{99m}Tc-pertechnetate showed homogenous activity throughout the orthotopically located thyroid gland. Early and delayed pinhole and planar scintigraphy following ^{99m}Tc-sestamibi administration showed discordant activity in the bilateral neck and supraclavicular regions, confirmed as brown adipose tissue on SPECT-CT. This case demonstrates false positive ^{99m}Tc-sestamibi uptake within brown adipose tissue in the neck and illustrates the value of SPECT-CT in differentiating brown adipose tissue from parathyroid activity.

CASE REPORT

BACKGROUND

Parathyroid imaging with ^{99m}Tc-sestamibi is used to localise parathyroid adenomas in patients with primary hyperparathyroidism. This case illustrates a false positive uptake of ^{99m}Tc-sestamibi by brown adipose tissue (BAT) and the importance of recognising this potential pitfall. It contributes to the literature on BAT-related challenges in parathyroid scintigraphy, and underscores the value of SPECT-CT in achieving an accurate diagnosis and reducing the risk of unnecessary surgical interventions.

CASE REPORT

A previously well 18-year-old female developed symptoms of gout, prompting review by her General Practitioner. She was found to have severe chronic renal failure with renal atrophy on imaging. No cause was identified despite autoimmune and vasculitis screens. The patient was commenced on peritoneal dialysis and worked up for a renal transplant. Hyperparathyroidism was detected with raised parathyroid hormone of 115 pmol/L (2.0-9.3 pmol/L) .

Dual-isotope parathyroid imaging was performed to exclude a parathyroid adenoma (Figure 1). Pinhole scintigraphy was acquired following intravenous administration of 77 MBq (2.1 mCi) of Technetium-99m (^{99m}Tc)-pertechnetate, which demonstrated homogenous activity throughout the orthotopically located thyroid gland. Early and delayed pinhole and planar scintigraphy and SPECT-CT was acquired following intravenous administration of 700 MBq (18.9 mCi)

of ^{99m}Tc-sestamibi, which demonstrated discordant activity within bilateral neck and supraclavicular regions. Early and delayed SPECT-CT confirmed that this ^{99m}Tc-sestamibi activity localised to cervical and supraclavicular fat, in keeping with brown adipose tissue (BAT). No other site of discordant ^{99m}Tc-sestamibi activity was identified to suggest hyperfunctioning parathyroid tissue. Subsequent neck ultrasound to exclude parathyroid hyperplasia or adenoma was also unremarkable. Remaining investigations for consideration include 4D-CT and fluorocholine PET-CT.

DISCUSSION

^{99m}Tc-sestamibi is taken up by mitochondria-rich cells including hyperfunctioning parathyroid tissue, myocardial cells, salivary glands, hepatocytes and malignant cells [1-4]. In hyperfunctioning parathyroid tissue, ^{99m}Tc-sestamibi activity relates to oxyphil cell content, although there is variability in uptake due to factors including vascular supply, calcium levels and protein expression including P-glycoprotein [4]. ^{99m}Tc-sestamibi initially concentrates in thyroid tissue, thyroid adenomas and parathyroid hyperplastic tissue/ adenomas. Thyroid activity decreases rapidly over time while parathyroid adenomas generally retain activity on delayed imaging [5,6].

BAT is a metabolically active tissue which aids in thermoregulation in response to cold exposure [7]. Abundant in children, BAT remains present in adults but decreases with age [3,8-10]. It is highly vascular, has a high density of mitochondria and can accumulate ^{99m}Tc-sestamibi [3,8-10]. Common sites of BAT include the neck, supraclavicular region and paraspinal adipose tissues [3,10].

TEACHING POINT

This case demonstrates false positive ^{99m}Tc-sestamibi uptake within BAT in the neck during dual-isotope parathyroid imaging and illustrates the value of SPECT-CT in differentiating BAT from parathyroid activity.

QUESTIONS

1) Which of the following statements is true regarding ^{99m}Tc-sestamibi?

a) Uptake is specific for parathyroid adenomas
b) It can accumulate in non-parathyroid tissues with high mitochondrial activity (applies)
c) It cannot be taken up by adipose tissue
d) It has renal excretion only
e) Uptake is not influenced by serum calcium

Explanation: ^{99m}Tc-sestamibi is uptake not specific to parathyroid adenomas and can be seen in other mitochondria-rich tissue. It is excreted in urine and through faeces. Sestamibi uptake can be influenced by serum calcium.

2) Which of the following can accumulate ^{99m}Tc-sestamibi?

a) Brown adipose tissue (applies)
b) Salivary glands (applies)
c) Myocardial cells (applies)
d) Hepatocytes (applies)
e) Skeletal muscle

Explanation: ^{99m}Tc-sestamibi can accumulate in mitochondria-rich tissue, such as brown adipose tissue, myocardial cells, salivary glands, hepatocytes and malignant cells.

3) Which of the following is a common site for brown adipose tissue in adults?

a) Pelvis
b) Liver
c) Supraclavicular region (applies)
d) Groin
e) Thighs

Explanation: Common sites of brown adipose tissue include the neck, supraclavicular region and paraspinal adipose tissues.

4) What is the advantage of using dual-isotope imaging over single-tracer techniques in parathyroid localisation?

a) Lower radiation dose
b) Reduced imaging time
c) Improved diagnostic accuracy (applies)
d) Elimination of motion artifacts
e) Allows omission of pinhole scintigraphy

Explanation: Dual-isotope imaging can improve diagnostic accuracy by facilitating better differentiation of thyroid and parathyroid tissue. The ^{99m}Tc-pertechnetate (thyroid) planar image can also be subtracted from the ^{99m}Tc-sestamibi (parathyroid) planar image

5) Which is true regarding ^{99m}Tc-sestamibi uptake on dual-timepoint imaging?

a) Parathyroid adenomas usually demonstrate more rapid ^{99m}Tc-sestamibi washout than thyroid tissue
b) Thyroid tissue demonstrates no ^{99m}Tc-sestamibi uptake on early or delayed imaging
c) Both thyroid tissue and parathyroid adenomas usually washout ^{99m}Tc-sestamibi at a similar rate
d) Parathyroid adenomas often retain ^{99m}Tc-sestamibi longer than thyroid tissue (applies)
e) Neither thyroid tissue nor parathyroid adenomas usually retain ^{99m}Tc-sestamibi

Explanation: Parathyroid adenomas most commonly demonstrate retention of ^{99m}Tc-sestamibi on delayed images, while thyroid tissue washes out ^{99m}Tc-sestamibi more rapidly.

Literature indicates that 60% of adenomas show sestamibi retention [11]. Conversely, thyroid retention is occasionally seen, particularly in thyroid nodules [12].

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FIGURES

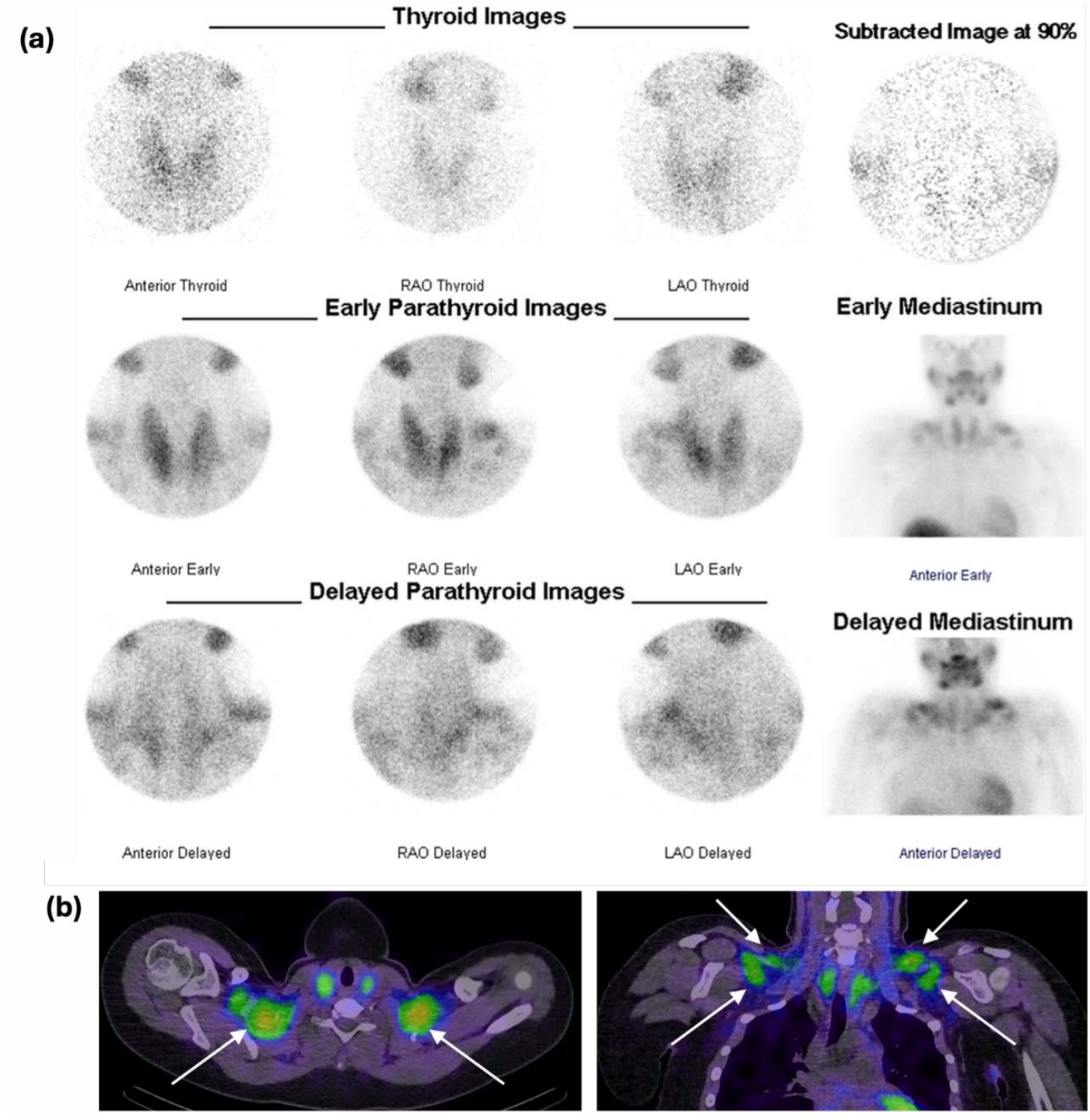

Figure 1: (a) Early and delayed pinhole and planar scintigraphy demonstrating homogenous ^{99m}Tc-pertechnetate activity throughout the thyroid and discordant ^{99m}Tc-sestamibi activity within the bilateral supraclavicular regions; **(b)** representative early axial and coronal SPECT-CT imaging with arrows indicating sites of intense ^{99m}Tc-sestamibi activity within supraclavicular brown adipose tissue (BAT).

KEYWORDS

Brown adipose tissue; parathyroid scan; pinhole; SPECT-CT; technetium-99m sestamibi

ABBREVIATIONS

SPECT-CT = SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY - COMPUTED TOMOGRAPHY
BAT = BROWN ADIPOSE TISSUE
4D-CT = 4-DIMENSIONAL COMPUTED TOMOGRAPHY
PET-CT = POSITRON EMISSION TOMOGRAPHY – COMPUTED TOMOGRAPHY

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