Radioiodine Uptake in the Chest

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CASE REPORT

A 60-yr-old woman was diagnosed to have papillary thyroid cancer 15 yr ago. She had a thyroidectomy followed by two doses of 100 mCi (3700 MBq) of ^{131}I within 1 yr, after which she entered into remission as evidenced by negative follow-up whole-body scans and undetectable thyroglobulin levels.

She presented to the outpatient clinic for her regular follow-up complaining of productive cough with white sputum of several days duration. Her physical examination was unremarkable. Laboratory work up showed a white blood cell count of 12.9 × 10^9/liter (nl, 4–11) with normal differential, TSH level of 32 mIU/liter (nl, 0.2–5), FT4 level of 3.7 pmole/liter (nl, 12–30) and thyroglobulin level of <5 ug/liter (nl, 2–70). Sputum culture showed normal flora. A chest radiograph was normal. A 3-mCi (111-MBq) ^{131}I diagnostic whole-body scan showed hilar and lobar deposition of radioiodine on the 24 hr anterior and posterior chest views (Fig. 1A, B). Delayed images acquired at 48 hr demonstrated no significant change. A 5-mCi (185-MBq) ^{123}I diagnostic scan performed after 10 days of antibiotic treatment (500 mg ampicillin orally every 6 hr) showed complete clearance of the abnormal chest uptake (Fig. 1C, D).

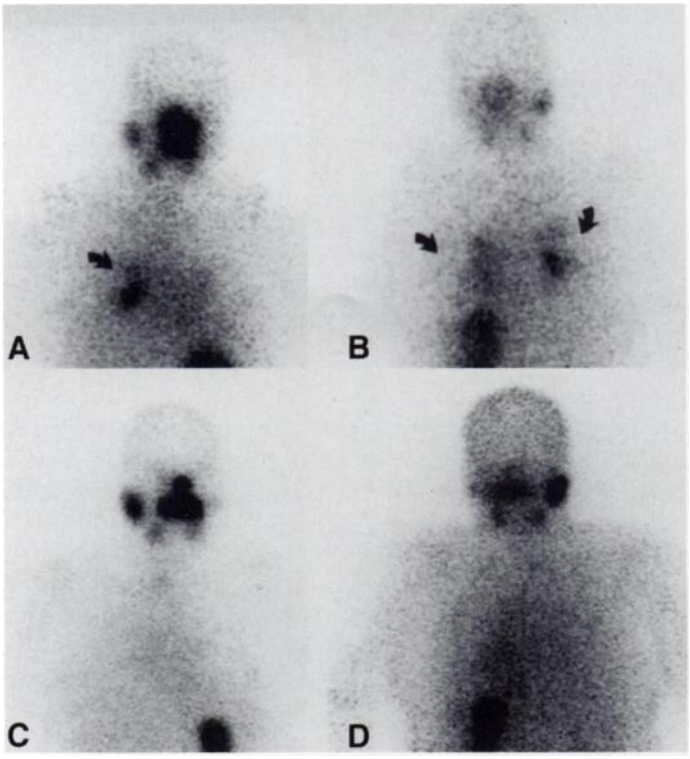

FIGURE 1. Hilar/lobar deposition of radioiodine. (A) Anterior and (B) posterior views of the chest of a 3-mCi (111-MBq) diagnostic ^{131}I whole-body scan. Arrows demonstrate focal uptake in the right hilum anteriorly and lobar uptake in the left lower lobe posteriorly. The findings were associated with symptoms of acute respiratory tract infection and closely mimicked lung metastases. (C) Anterior and (D) posterior views of the chest of a follow-up diagnostic ^{123}I whole-body scan, performed 10 days later, showing disappearance of the chest activity.

DISCUSSION

The detection of uptake on chest views of radioiodine whole-body scans in thyroid cancer patients usually indicates the presence of pulmonary, skeletal, hilar or mediastinal lymph node metastases and prompts the administration of therapeutic radioiodine doses (*1*). Therefore, it is essential to recognize the pathological conditions and artifacts that can cause false-positive radioiodine scans.

Radioiodine Uptake in the Lung

The focal uptake in the left lower lobe and in the right hilum seen in this patient during acute respiratory tract infection could have been easily misdiagnosed as pulmonary metastasis. However, as expected, the uptake was transient as it was not seen on repeat scanning after 10 days. This is in contrast to radioiodine uptake that is caused by chronic pulmonary inflammation, as bronchiectasis, that causes diffuse and persistent pulmonary uptake, even after radioiodine treatment (*2*).

The mechanism(s) of radioiodine uptake in bronchopulmonary infection/inflammation is unknown. A possible explanation is increased concentration of iodide salt due to hyperemia of the inflamed mucosa (*2*). Other potential mechanisms include leakage of radioiodine into the bronchial tree/lung parenchyma due to increased permeability, and accumulation of tracheobronchial secretions due to decreased clearance. The possibility of the aspiration of nasal or salivary secretions is unlikely as the patient was alert and had no breathing difficulties.

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Pulmonary fungal infection has been described in association with false-positive uptake in the lung parenchyma (*3*), although primary lung tumor is the most commonly reported cause (*4–8*).

Radioiodine Uptake in the Mediastinum

Mediastinal lymph node metastases are usually associated with pulmonary metastases (*9*). However, false-positive mediastinal uptake has been proven to be due to a hyperplastic (*10*) or normal thymus (*11,12*), a metastatic salivary gland tumor (*13*) or displaced gastric mucosa (*14–17*). In other cases, it was presumed to represent ectopic foci of thyroid tissue (*18*), a normal variant (*19*) or increased blood-pool activity (*20*). Esophageal retention of salivary secretions by an apparently normal esophagus has been recently shown to be present on 1.5% of ^{123}I radioiodine scans, representing the most common cause of false-positive mediastinal uptake (*21*).

Sites of Radioiodine Uptake

Thirty different conditions have been reported to cause false-positive radioiodine uptake in the chest area mimicking metastases to the lungs and mediastinum (Table 1). The site of uptake can be in:

TABLE 1
Reported Cases* of False-Positive Radioiodine Uptake in the Chest Area

Lung	Primary papillary adenocarcinoma (*4*)†
	Tubular adenocarcinoma (*5*)
	Squamous cell carcinoma (*6*)
	Large cell undifferentiated bronchial carcinoma (*7*)*
	Small cell undifferentiated bronchial carcinoma (*8*)
	Severe bronchiectasis (*2*)
	Fungal infection (*3*)
	Acute respiratory tract infection (present case)
Breast	Lactation (*19,22–24*)
	Postpartum (*25*)†
	Nonlactating female (*26,27*)
Heart	Pectus excavatum (*28*)
	Pericardial effusion (*29,30*)
	Pleuropericardial cyst (*31*)
Thymus	Normal (*11,12*)
	Hyperplastic (*10*)
Trachea	Tracheostomy (*32*)
Esophagus	Retained saliva in normal esophagus (*21,33*)
	Benign stricture (*34*)
	Colon graft (*35*)
	Achalasia (*36*)†
	Zenker's diverticulum (*37*)
Spinal cord	Papillary meningioma (*38*)†
Mediastinum	Metastatic salivary gland tumor (*13*)†
	Ectopic thyroid tissue (*29*)‡
Stomach	Hiatal hernia (*14,15*)
	Gastric pull-up (*16*)
	Disseminated gastric adenocarcinoma (*17*)†
Hair	Contaminated braided hair (*39*)
Skin	Contamination by body secretions (*40–45*)
Garment	Contaminated handkerchief (*45*)

*Some references are single case reports and some represent more than one case.
† The patient was found to not have primary thyroid cancer.
‡ The uptake is presumed to be due to benign ectopic thyroid tissue.

1. Tissues that are normally present in the chest (lung, breast, rib cage, thymus, heart, trachea, esophagus, spinal cord, skin).
2. Tissues that are not normally present in the chest (ectopic thyroid, metastatic salivary gland tumor, displaced gastric mucosa, colonic graft).
3. Contaminated braided hair and garments.

Mechanism of Radioiodine Uptake

The causes of false-positive radioiodine uptake in the chest can be classified according to the underlying mechanism into four categories (Table 2):

1. Physiological uptake (breast, thyroid, blood-pool activity, gastric and colonic mucosa).
2. Pathological activity (lung, pleura, pericardium, thymus, meninges).
3. Internal retention of body secretions (esophagus, trachea).
4. External contamination (skin, hair, garment).

Physiological Uptake. Radioiodine can be taken up by the lactating (*24*) and the nonlactating breast (*27*). Four different patterns of breast uptake: full, focal, crescentic and irregular have been described (*24,27*). The uptake may be symmetrical, asymmetrical or unilateral. It may or may not be associated with expressible galactorrhea and/or elevated prolactin levels (*27*). The irregular and unilateral uptake, in particular, can mimick lung metastases (*24,27*). A posterior or lateral view can help differentiate breast from lung uptake in difficult cases. The estimated prevalence rate of radioiodine uptake by the nonlactating breast on whole-body scans is about 6% (*27*).

Radioiodine uptake by ectopic thyroid tissue is traditionally classified under false-positive uptake in the setting of the diagnosis of thyroid cancer, since it mimicks metastatic disease. Radioiodine uptake in tissues that are considered normal distribution, such as gastric and colonic mucosa, can be classified as physiological even when present in aberrant locations in the chest (*14–16*).

Pathological Activity. In the majority of patients, false-positive radioiodine uptake in the chest area represents an artifact, the recognition of which is important only to differentiate it from thyroid cancer metastases. However, in some cases the uptake is due to unrelated pathology that requires specific management. The most commonly reported causes of false-positive uptake in this category are tumors, including primary lung cancer (*4–8*), gastric adenocarcinoma (*17*), metastatic salivary gland tumor (*13*) and papillary meningioma (*38*). Upper respiratory tract infection (present case), fungal infection (*3*), severe bronchiectasis (*2*), pericardial effusions (*29,30*), pleuropericardial cyst (*31*) and hyperplastic thymus (*10*) could also be classified under this category.

TABLE 2
False-Positive Radioiodine Uptake in the Chest Area According to Underlying Mechanism and Relative Frequency

Frequency	Physiological uptake	Pathological activity	Internal retention	External contamination
Common	Nonlactating breast Lactating breast		Esophagus (normal)	Skin Garment Hair
Uncommon and rare	Thyroid (ectopic) Blood-pool activity (displaced) Gastric mucosa (displaced) Colonic activity (grafted) Thymus (normal)	Tumor: Primary lung tumor Papillary meningioma Metastatic salivary gland tumor	Esophagus (abnormal): Achalasia Esophageal stricture Zenker's diverticulum	
		Infection/inflammation: Fungal infection Bronchiectasis Acute respiratory tract infection	Trachea: Tracheotomy tube	
		Miscellaneous: Pericardial effusion Pleuropericardial cyst Thymus (hyperplasia)		

Internal Retention. Esophageal retention is not always linear or diffuse to suggest its origin. In about 80% of the cases, the uptake is focal and difficult to differentiate from mediastinal lymph node or spinal metastasis (*21*). The uptake is transient and usually disappears or changes in configuration on delayed images after eating and drinking. In most cases, saliva is retained in a clinically normal esophagus (*21*). Salivary retention could also occur in an abnormal esophagus due to decreased esophageal motility, mechanical obstruction or pooling of saliva in the posterior pharyngeal pouch, secondary to achalasia (*36*), esophageal stricture (*25*) and Zenker's diverticulum (*37*), respectively. Tracheal retention of nasopharyngeal secretions has also been reported at the site of a tracheostomy tube (*32*).

External Contamination. External contamination with body secretions may mimick lung or bone metastases (*43,45*) with an estimated prevalence of about 0.4% (*45*). Radioiodine-containinig salivary, nasopharyngeal, tracheo-bronchial secretions or sweat (*39–45*) can contaminate the skin and/or garment by coughing, sneezing, perspiring and tobacco chewing (*40*).

Previous Classifications

Several reviews focusing on different aspects of false-positive radioiodine uptake have been reported (*19,29,36,46,47*). However, some were not inclusive of all reported cases (*46*), some included theoretical rather than documented causes (*17,45*) and some mixed technetium with radioiodine scans (*29,46*).

Greenler et al. (*19*), in an excellent review, classified the cases of false-positive radioiodine uptake under four categories: body secretions, pathological transudate and inflammation, nonspecific mediastinal uptake and neoplasm of nonthyroidal origin. Since the publication of that review, new cases or causes have been reported. Furthermore, we have recently provided evidence that most of the nonspecific mediastinal uptake is likely due to esophageal retention of salivary secretions (*21*) and documented radioiodine breast uptake in nonlactating women (*27*). Therefore, the classification outlined above may be more useful and complete.

CONCLUSION

False-positive radioiodine uptake in the chest area can be classified into four categories:

1. Physiological uptake (breast, thyroid, blood-pool activity, gastric and colonic mucosa).
2. Pathological activity (tumor, infection/inflammation, etc.).
3. Internal retention (esophageal, tracheal).
4. External contamination (skin, hair, garment).

The most common reported causes are physiological uptake by the nonlactating breast, esophageal retention of salivary secretion by an apparently normal esophagus and external contamination by body secretions. A high degree of suspicion, coupled with careful history and physical examination, is needed for proper interpretation of positive radioiodine scans.

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