

The Usefulness of Iodine-123 Whole-Body Scans in Evaluating Thyroid Carcinoma and Metastases

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Objective: It is recognized that diagnostic doses of ^{131}I larger than 3 mCi will cause some cell injury to the tissue in which it concentrates and reduce subsequent uptake of ^{131}I administered therapeutically. Iodine-123 has been suggested as an alternate radiopharmaceutical to perform whole-body scans since its primary emissions are photons with minimal particulate radiation and it does not cause thyroid stunning and cell injury. The purpose of this study was to assess the effectiveness of ^{123}I for whole-body scans.

Methods: We examined 12 patients who had ^{123}I whole-body scans for known papillary/follicular thyroid cancer and 1 patient with Hürthle cell carcinoma, all with suspected metastases. All patients had undergone neck surgery and were given 0.8–1.0 mCi ^{123}I . Twenty-four hours later a whole-body image and static views of relevant areas were obtained. If abnormal uptake was noted, patients were treated with large doses of ^{131}I and then had whole-body ^{131}I scans 7–10 d post-therapy. These images were compared to ^{123}I whole-body scans.

Results: All 13 patients had abnormal ^{123}I scans and were treated with therapeutic doses of ^{131}I , followed by whole-body scans 7–10 d later. In 11 patients the activity seen on the ^{123}I scans correlated well with that seen on ^{131}I scans. In 1 patient, additional lesions were noted on the ^{131}I images. In another patient, neck activity was seen on the ^{123}I scan but not on the subsequent ^{131}I post-therapy scan. The ^{123}I activity was felt to represent esophageal lumen activity.

Conclusion: We found ^{123}I effective in demonstrating residual thyroid tissue, thyroid carcinoma and metastases, and recommend its use for whole-body iodine scans since it does not cause thyroid stunning.

Key Words: sodium iodine-131; sodium iodine-123; thyroid carcinoma; whole-body imaging; metastases

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Primary thyroid cancer is found most commonly in young women and is discovered usually as an asymptomatic lump in the neck (1). Five-year survival in properly treated patients is approximately 95% (2). About 80% of primary thyroid malignancies consist of well-differentiated cell types and almost all well-differentiated thyroid carcinomas demonstrate mixed papillary and follicular elements. Only rarely do these neoplasms consist of a pure papillary or follicular cell line (2). It is the follicular cells that concentrate iodine and this is the basis of ^{131}I therapy for metastases (3).

Generally when a primary thyroid cancer is discovered, a near-total thyroidectomy is performed. About 6 wk after thyroidectomy, and without thyroid hormone replacement, a diagnostic whole-body radioiodine scan is performed to detect residual thyroid tissue and/or functioning metastatic deposits. Alternatively, high-dose (30–150 mCi) ^{131}I therapy may be administered without a diagnostic scan. The rationale being that even if the diagnostic scan is negative, the high-dose therapy will eradicate any nonvisualized functioning micrometastases (2). The delay between surgery and radioiodine therapy or diagnostic scanning induces a hypothyroid state with elevated endogenous TSH levels. This increases radioiodine concentration by residual thyroid tissue and any functioning metastases.

It is important to maximize thyroid tissue radioiodine concentration to maximize therapeutic effect. Several investigators have shown decreased radioiodine concentration by thyroid tissue after ^{131}I administration (3). This has been referred to as the stunning effect and was first described by Rawson et al. in 1951 (4). They stated that “noncancericidal doses of ^{131}I markedly decreased the ability of thyroid carcinomas to concentrate the isotope for some time.” Currently it is thought that ^{131}I administration may cause decreased tumor radioiodine concentration by reducing tumor size or by killing those cells which concentrate radioiodine well (3). Therefore, it may be best to leave the most functional cancer cells unharmed until the tumor is exposed to therapeutic quantities of ^{131}I so that the maximum possible concentration of radioiodine per tumor volume is achieved. It is also possible that nontumoricidal radioiodine doses cause cellular damage with a subsequent decrease in radioiodine concentrating ability.

How can the thyroid stunning effect be avoided? Park et al. (5) suggest either using ^{123}I or a < 3-mCi dose of ^{131}I for diagnostic scans. Iodine-123, as opposed to ^{131}I , has no β emissions and delivers a much lower radiation dose to the thyroid gland. In post-thyroidectomy thyroid cancer patients,

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another option would be to proceed directly to a therapeutic dose of ^{131}I and eliminate the initial diagnostic scan (2). Also, alternative imaging agents may be used, such as ^{201}Tl chloride, $^{99\text{m}}\text{Tc}$ -sestamibi, ^{111}In -pentetreotide and ^{18}F -FDG. These agents have a lower specificity, however, than radioiodine (3). The other situation in which these agents may be of value is when the patient has elevated thyroglobulin levels and a negative diagnostic radioiodine scan. In addition, lithium carbonate given orally has been shown to retard release of ^{131}I from thyroid tumors and augment the delivered radiation (3). The production of recombinant human TSH in Chinese hamster ovary cells has been accomplished recently. If this is approved for use in humans by the FDA, it may increase therapeutic effectiveness by stimulating ^{131}I concentration by thyroid cancer cells (3).

MATERIALS AND METHODS

We studied 12 patients on whom ^{123}I whole-body scans were performed after thyroidectomy for papillary/follicular carcinoma. One additional patient had Hürthle cell carcinoma. These scans were performed 24 h after an oral dose of ^{123}I . The administered activity ranged from 0.8–1.0 mCi. All of these patients then received a therapeutic dose of ^{131}I and a whole-body scan was performed 7 to 10 d later. Iodine-131 therapeutic doses ranged from 29.9–250 mCi. All scans were performed on a dual-head gamma camera. We selected patients whose initial scan showed residual thyroid tissue or metastases or both. The post-therapy scans were considered our gold standard for the presence or absence of residual thyroid tissue or metastases. We used 2 independent observers who visually compared the ^{123}I whole-body scan to the post-therapy ^{131}I images. We evaluated the number of lesions, their locations, their relative intensities and visual detectabilities.

RESULTS

There was excellent scan correlation in 11 of 13 patients (Fig. 1). In 1 patient (Fig. 2) lung lesions on the ^{123}I scan had lower uptake intensity when compared with the ^{131}I scan. In this case, however, lung activity definitely was visualized on the ^{123}I scan and would not have been missed. Another patient demonstrated a focus of neck activity on the ^{123}I scan and the post-therapy ^{131}I scan was negative for residual neck activity or metastases. Presumably, the abnormality seen on the ^{123}I scan represented activity within the proximal esophageal lumen. This false-positive finding and subsequent ^{131}I therapy may have been avoided by having the patient drink a glass of water before performing the ^{123}I scan.

DISCUSSION

We found good correlation between the ^{123}I and ^{131}I whole-body scans with exceptions noted above. To further compare ^{123}I and ^{131}I , we took samples of known activity of each isotope and placed them in an acrylic thyroid phantom. We counted the samples on a camera for 10 min using the collimators that we routinely used for whole-body scanning. We used a low-energy,

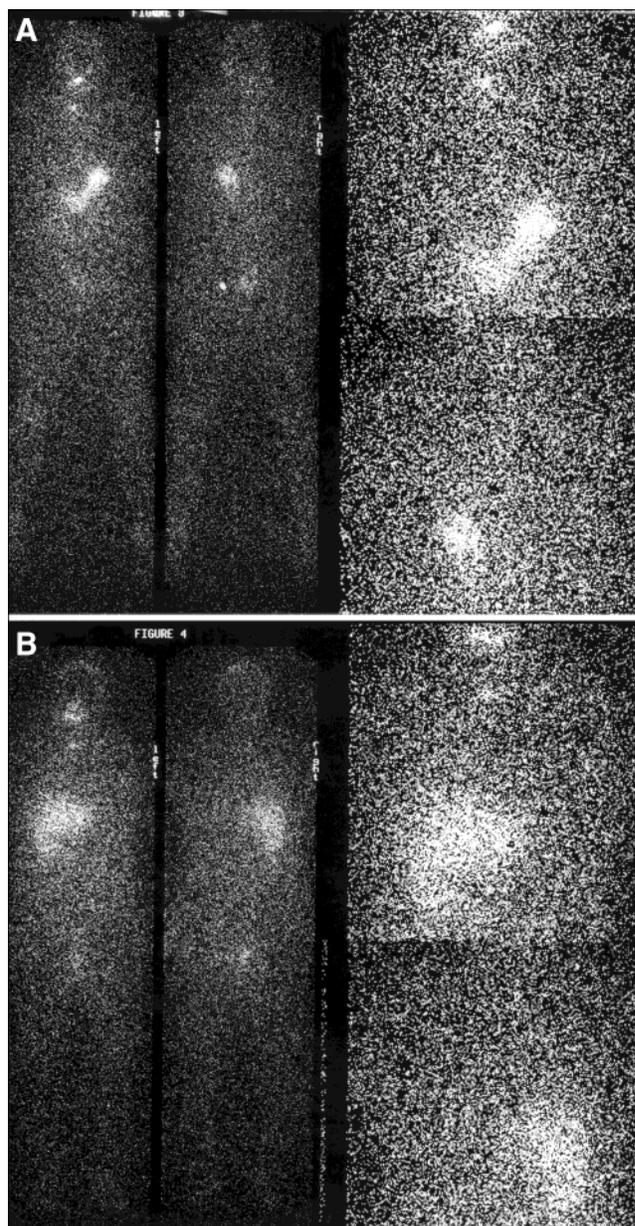


FIGURE 1. (A) Whole-body scan following 1 mCi ^{123}I demonstrates a focus of thyroid tissue in the neck. Note left buttock contamination. (B) Post-therapy whole-body scan following 150 mCi ^{131}I on the same patient confirms findings on prior ^{123}I scan and demonstrates no evidence of further thyroid tissue or metastases.

high-resolution, parallel-hole collimator for ^{123}I and a high-energy, all-purpose, parallel-hole collimator for ^{131}I . We obtained 353,000 cts/mCi/min with ^{123}I and we obtained 152,000 cts/mCi/min with ^{131}I . We conclude that photons arising from ^{123}I are detected more easily than the higher energy photons from ^{131}I , since photon emission abundance from each radioisotope is roughly equal. This may, in part, make up for the lower administered ^{123}I activity (compared with ^{131}I) used in whole-body scanning. Also, ^{123}I photon detection would improve further with a low-energy all-purpose collimator.

We compared the cost of each iodine isotope. Our radiopharmacy charges \$200 for 1 mCi ^{123}I and \$80–\$96 for doses of 1–3 mCi ^{131}I . We feel that the higher cost of ^{123}I is justified to avoid

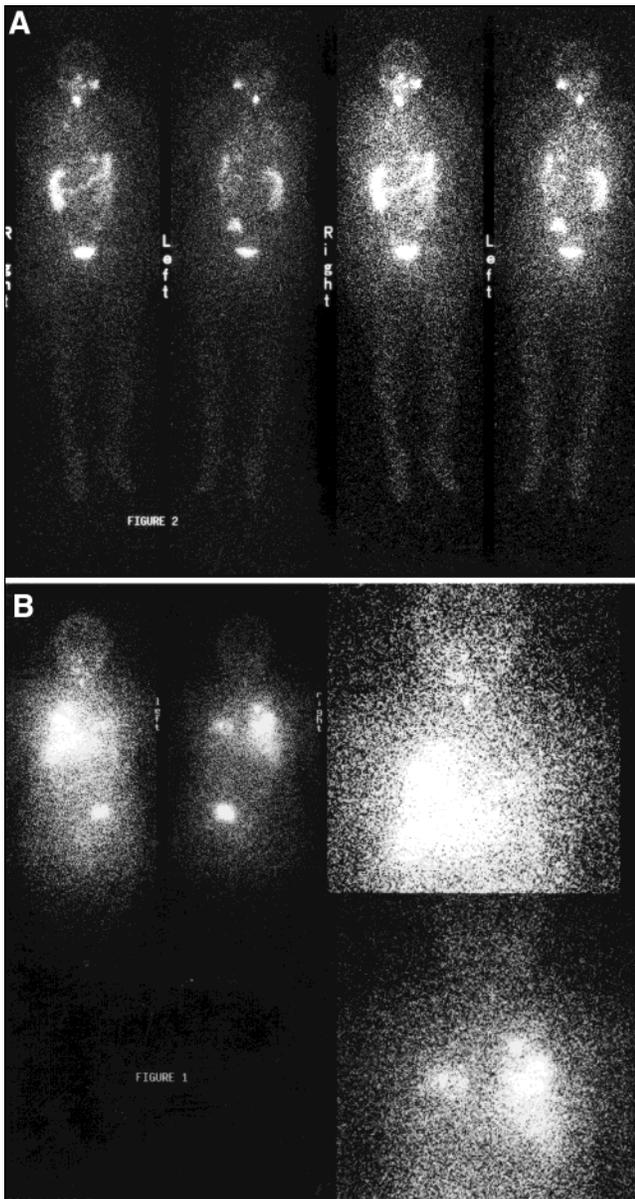


FIGURE 2. (A) Whole-body scan following 1 mCi ¹²³I demonstrates metastases in the neck, lungs and left iliac bone. Lung metastases are less well-visualized, when compared with the ¹³¹I scan, but are definitely present. (B) Post-therapy whole-body scan following 250 mCi ¹³¹I on the same patient demonstrates papillary/follicular thyroid carcinoma metastases in the neck, lung and left iliac bone.

thyroid stunning and maximize radioiodine therapeutic effectiveness.

A potential disadvantage of ¹²³I is that imaging must be performed 24 h later due to its shorter half-life, compared with ¹³¹I. Delayed images of 48 h or 72 h can be performed with ¹³¹I and this may allow thyroid cancer metastases time to concentrate higher levels of ¹³¹I and, thus, increase detectability.

CONCLUSION

Papillary/follicular thyroid carcinoma is a relatively common neoplasm with an excellent prognosis if treated properly. The basis of treatment is surgical thyroidectomy with ¹³¹I radioiodine therapy. Maximizing effectiveness of radioiodine therapy is important and is influenced in several ways. These include induction of a hypothyroid state with elevated endogenous TSH levels and minimizing or eliminating tumor exposure to nontumoricidal doses of ¹³¹I. This can be done by using ¹²³I or alternative imaging agents for diagnostic scans. In addition, lithium carbonate and recombinant human TSH administration may become a part of thyroid cancer treatment by maximizing ¹³¹I effectiveness.

We compared ¹²³I diagnostic scans to post-therapy ¹³¹I scans and conclude that ¹²³I is effective in demonstrating residual thyroid tissue and thyroid carcinoma metastases. Iodine-123 eliminates exposure to nontumoricidal doses of ¹³¹I before high-dose ¹³¹I therapy, therefore avoiding the thyroid stunning effect.

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