Visualization of Suppressed Thyroid Tissue by Technetium-99m-Tertiary Butyl Isonitrile: An Alternative to Post-TSH Stimulation Scanning

P. Ramanathan, R. B. Patel, N. Subrahmanyam, U. N. Nayak, S. S. Sachdev*, and N. Ramamoorthy*

Radiation Medicine Centre, (B.A.R.C.), Tata Memorial Centre Annexe, Parel, Bombay, India

The autonomously functioning thyroid nodule (AFTN) is a discrete, nodular structure which operates independently of pituitary control and without relation to the remaining thyroid tissue. Presently, for the visualization of a suppressed thyroid lobe, a patient has to undergo the thyrotropin (TSH) stimulation test, which has several disadvantages. In this study we have used tertiary butyl isonitrile (^{99m}Tc-TBI), well known as a myocardial imaging agent, for visualization of the suppressed lobe. Thirteen of fourteen patients studied demonstrated a contralateral lobe on a ^{99m}Tc-TBI scan which was not visualized with a $^{99m}TcO_4$ or ^{131}I scan. Although it is not possible to demonstrate the autonomous nature of the hyperfunctioning thyroid nodule using ^{99m}Tc-TBI, we conclude that it is feasible to use this agent to visualize the lobe without the TSH test.

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With conventional thyroid imaging using iodine-131 (^{131}I), ^{123}I, or technetium-99m- (^{99m}Tc) pertechnetate (*1*), only a portion of an autonomously functioning thyroid nodule (AFTN) is visualized, the rest is suppressed. The patient may be euthyroid or hyperthyroid, or suffering from a thyroid anomaly such as hemiagenesis. If the suppressed tissue can be visualized, a diagnosis of AFTN is far more likely.

Presently the thyrotropin (TSH) stimulation test is used to visualize suppressed tissue during an iodine scan (*2*). There are, however, several disadvantages to TSH stimulation: bovine proteins may induce systemic or local allergic reactions (*3*); the release of thyroxine into the body is potentially dangerous; and the investigation is necessarily time-consuming because of the need for intramuscular injections. Furthermore, the TSH test is also not readily available in many countries.

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For reprints contact: P. Ramanathan, Radiation Medicine Centre (B.A.R.C.), Tata Memorial Centre Annexe, Jerbai Wadia Rd., Parel, Bombay 400 012, India.

* Current Address: Radiopharmaceutical Division, Bhabha Atomic Research Centre, Bombay, India.

Recently, thallium-201- (^{201}Tl) chloride thyroid imaging has been studied for use in the visualization of suppressed thyroid tissues in an autonomous nodule (*4*, *5*). The low energy of ^{201}Tl results in significant scatter and attenuation, impairing image quality and lesion contrast. In addition, the slow clearance of ^{201}Tl from the body and its long physical half-life limit the permissible injection dose, resulting in count-deficient images.

As ^{99m}Tc-TBI is readily available in our laboratory (*6*), Tc-TBI scintigraphy has been attempted in order to visualize the suppressed thyroid in patients presenting with a hot nodule on ^{131}I and or ^{99m}Tc scans.

MATERIALS AND METHODS

Three investigations were carried out in each of 14 patients, all of whom were on iodine-free diets. If a patient had been on antithyroid medication, it was stopped at least seven days prior to participating in the study.

Iodine-131 Scan. Twenty-four hours after oral administration of 0.925 MBq of ^{131}I, scans were obtained in the anterior position using a rectilinear scanner (Picker) with a high-energy collimator.

Technetium-99m-pertechnetate Scan. Four hours after oral administration of 74-111 MBq of [^{99m}Tc]pertechnetate, scans were obtained in the anterior position using a gamma camera (GE 400AT) and magna scanner (Picker MAGNA 1000).

Technetium-99m-TBI scan. Forty minutes and also 4 hr after intravenous administration of 148–185 MBq ^{99m}Tc-TBI scintigraphy was performed in the anterior position using the same gamma camera and magna scanner.

Preparation of ^{99m}Tc-TBI

Technetium-99m-TBI was obtained by the reaction of Tc-pertechnetate in 0.2 ml, 0.9% saline solution with TBI in 50% ethanol at 100°C., using stannous chloride as the reducing agent. The reaction mixture was heated in a boiling water bath at 100°C. for 20 min. A continuous flow of sterile air was used for evaporating the reaction mixture and the vial was allowed to cool to room temperature. Subsequently, sterile 25% ethanol in saline was added (*6*,*7*).

Radiochemical purity was confirmed by ascending paper chromatography using Whatman filter paper No. 3, and pure methanol as solvent. The Rf of ^{99m}Tc-TBI was found to be 0.9 to 1.0; that of [^{99m}Tc]pertechnetate and $^{99m}TcO_2$ 0.3–0.4 and 0.0, respectively. The radiochemical purity of ^{99m}Tc-TBI

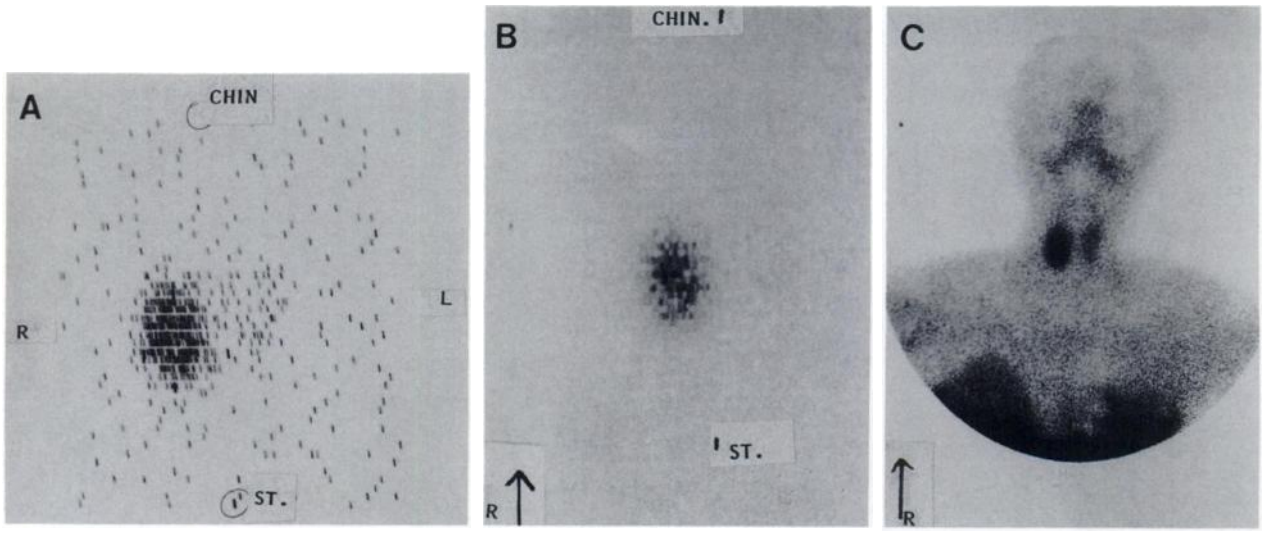

FIGURE 1
A 53-yr-old woman with a right thyroid nodule. T4 was >20 μg/dl (normal 4.2–13), T3 of 41 ng/dl (normal 70-200), and TSH of 0.01 uu/ml (normal 0–9). Her ^{131}I (A) and $^{99m}TcO_4$ (B) scans showed the right lobe nodule and a portion of the left lobe. The ^{99m}Tc-TBI scan (C) revealed the entire left lobe.

was found to be more than 95% free pertechnetate and $^{99m}TcO_2$ was found to be less than 5%.

RESULTS

In all 14 patients, the ^{131}I scan and [^{99m}Tc]pertechnetate scan revealed a hot nodule. Mean size of the nodule was 27.6 cm^3. All of the patients with the autonomous nodule were female, a circumstance that has been previously reported (*1*). Biochemical manifestations of hyperthyroidism were present in 10 of 14 patients.

The presence of a contralateral lobe and the visibility of the upper pole of the ipsilateral lobe (not seen in either the ^{131}I or the [^{99m}Tc]pertechnetate scans) were considered to be evidence of visualization of suppressed thyroid tissue. In 13 patients, the contralateral lobe could be visualized on the ^{99m}Tc-TBI scan (Figs. 1–3).

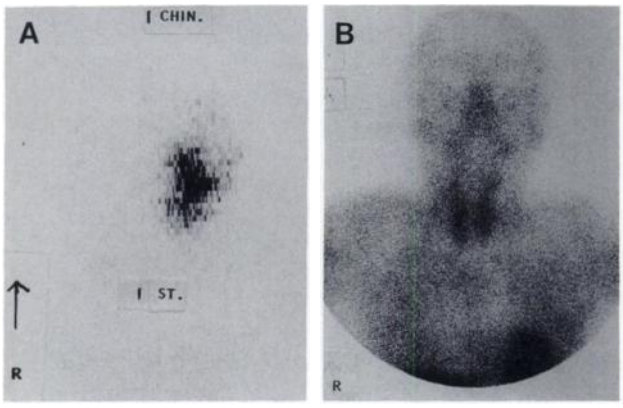

FIGURE 2
A 55-yr-old woman with a 7 cm × 4 cm nodule of the left lobe. T4 was 15.9 μg/dl. T3 371 ng/dl, and TSH was 0.8 uu/ml. Only the left lobe nodule was visualized on the $^{99m}TcO_4$ (A) scan. A ^{99m}Tc-TBI scan (B) demonstrated concentration in both lobes.

DISCUSSION

It can be inferred from our observations that suppressed thyroid tissue in patients with autonomous nodules can be visualized by ^{99m}Tc-TBI scintigraphy, without the disadvantages associated with TSH stimulation. Systemic or local allergic reactions from TSH can be avoided altogether. Another advantage of ^{99m}Tc-TBI is that it can be performed without discontinuation of antithyroid drug therapy. Moreover, a therapeutic dose of ^{131}I can be given immediately after a ^{99m}Tc-TBI scan, as iodine uptake in the extranodular tissue has not been stimulated.

Recent reports have suggested that 2-methoxy isobutyl isonitrile (MIBI) is a superior agent, compared to TBI, for myocardial imaging (*8*). Proponents note its better myocardial-to-liver uptake ratio, and the simplicity of the procedure required to obtain the administered form (*9*). We do not have any experience with MIBI, but believe that it might also be useful for visualizing the suppressed thyroid tissue in AFTN.

The clear visualization of the contralateral lobe in patients with low serum concentrations of TSH suggests that TSH control is not a major factor in ^{99m}Tc-TBI uptake. The actual mechanism, however, remains unclear.

We conclude that ^{99m}Tc-TBI scintigraphy is an alternative to ^{131}I or [^{99m}Tc]pertechnetate imaging after TSH stimulation in patients with hot nodule on preliminary ^{99m}Tc or ^{131}I scintigraphy.

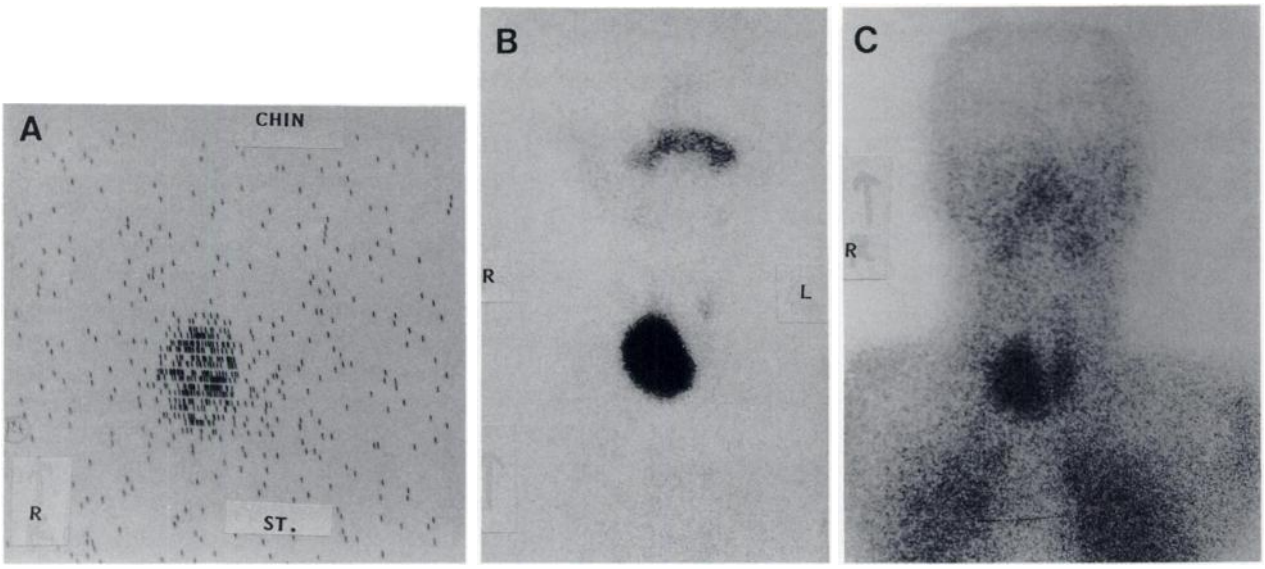

FIGURE 3
A 41-yr-old female had a sudden increase in the size of her neck over 6 mo. Her T4 was >20 μg/dl, T3 249 ng/dl. TSH was not done. Only the right lobe nodule was seen on the ^{131}I (A) and $^{99m}TcO_4$ scans. (B) Both lobes were clearly seen on ^{99m}Tc-TBI scan (C).

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