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Patterns of radioiodine uptake by the lactating breast

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Abstract. Breast uptake of radioiodine, if not suspected, may be misinterpreted as thyroid cancer metastasis to the lung. To characterize the patterns of radioiodine breast uptake, we retrospectively studied 20 radioiodine scans that were performed within 1 week of cessation of breast feeding. Four patterns of uptake were identified: "full", "focal", "crescent" and "irregular". The uptake was asymmetric in 60% (left>right in 45%, right>left in 15%), symmetric in 25% and unilateral in 15% of cases. A characteristic full bilateral uptake was present in 40% of cases. In three cases with the irregular pattern, caused in part by external contamination with radioactive milk, the uptake closely mimicked lung metastases. Delayed images, obtained in one case, showed an apparent radioiodine shift from the breast to the thyroid, suggesting that the presence of breast uptake can modulate radioiodine uptake by thyroid tissue. In a case of unilateral breast uptake, a history of mastitis was obtained, which to our knowledge has not been previously reported. Breast uptake of radioiodine may take several scintigraphic patterns that are not always characteristic of the lactating breast and may affect the apparent extent of thyroid remnant/metastasis.

Key words: Radioiodine scan – Thyroid cancer – Breast uptake – Lung metastasis

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Introduction

Radioiodine uptake in the chest field can be suspected to be due to breast rather than lung uptake if the patient is known to be breast feeding. This can then be easily proven by obtaining lateral and/or posterior chest views. However, some women may have galactorrhoea in the absence of a recent history of pregnancy or breast feeding, in association with normal menses [1], a variety of drugs [2] or prolactinaemia [1, 2]. In addition, hypothyroidism, routinely induced in preparation for radioiodine scanning/treatment, can be associated with galactorrhoea with or without hyperprolactinaemia [1, 3]. Furthermore, about 70% of differentiated thyroid cancers occur in females of child-bearing age [4]. Thus an occasional patient with thyroid cancer may present with breast uptake on radioiodine scan without a history of breast feeding. In this case, unless the various patterns of breast uptake are well recognized, they may be misinterpreted as lung metastasis.

We had the opportunity to study the characteristics of 20 radioiodine scans obtained within 1 week after the discontinuation of breast feeding in 19 mothers with differentiated thyroid cancer.

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Materials and methods

About 650 females with thyroid cancer have been followed at King Faisal Specialist Hospital and Research Centre since 1975. Some patients were deemed by their treating physicians to need radioiodine treatment and/or scanning during lactation. All the scans in this study were performed within 1 week after cessation of breast feeding.

Whole-body radioiodine scans were performed after the withdrawal of thyroxine therapy for 4–6 weeks. Anterior and posterior spot images of the head and neck, chest, abdomen and pelvis were acquired for 300 000 counts or 10 min each. Diagnostic scans were performed 24h after the ingestion of a 185MBq iodine-123 capsule (local product of our Research Centre cyclotron containing <5% iodine-124 at calibration), using a large field of view gamma camera (GE400, Wisconsin, USA) mounted by a medium-energy collimator. Post-ablation scans were performed approximately 3 days after the administration of 3700–5550 MBq of iodine-131 (when the exposure rate is <1.8 mR/h at 3 ft.) or 24 h after the administration of 1037MBq of ^{131}I, using the same gamma camera mounted by a high-energy collimator. In patient 2, a repeat image at 96 h was also obtained.

Results

The characteristics of 20 radioiodine whole-body scans that were performed within 1 week after the cessation of breast feeding are summarized in Table 1. The various

Table 1. Scintigraphic appearance of the lactating breast

Patient	Age (yrs)	Tracer (MBq)	Thyroid remnant	Breast appearance	Distribution
1	50	^{131}I (1073)	Absent	R Full L Full	R<L
2	42	^{131}I (1073)	Present	R Full L Full	R<L
			Increased [a]	R Full L Full	R=L
3	35	^{123}I (185)	Absent	R Absent L Focal	Unilateral
4	24	^{123}I (185)	Present	R Crescent L Full	R<L
5	28	^{123}I (185)	Present	R Irregular L Irregular	R<L
6 [b]	21	^{131}I (5550)	Present	R Irregular L Irregular	R=L
7	32	^{131}I (1073)	Absent	R Full L Full	R=L
8	28	^{123}I (185)	Absent	R Focal L Focal	R<L
9	40	^{123}I (185)	Present	R Absent L Full	Unilateral
10	43	^{131}I (1073)	Absent	R Absent L Full	Unilateral
11	30	^{131}I (1073)	Absent	R Irregular L Focal	R>L
12	29	^{131}I (1073)	Present	R Full L Full	R=L
13	35	^{131}I (1073)	Present	R Full L Full	R<L
14	29	^{131}I (1073)	Present	R Full L Full	R>L
15	29	^{131}I (1073)	Present	R Focal L Full	R<L
16	35	^{131}I (3700)	Present	R Focal L Full	R>L
17	36	^{123}I (37)	Absent	R Irregular L Full	R<L
18	26	^{131}I (1073)	Present	R Crescent L Crescent	R=L
19	37	^{123}I (185)	Absent	R Full L Full	R<L

[a] A repeat image 96 h after dose administration
[b] Breast milk contained 1.2 and 0.05 MBq/ml, 18.5 and 80 h, respectively, after the administration of the tracer

patterns of breast uptake of radioiodine are depicted in Figs. 1–5.

The "full" pattern (Figs. 1, 2 a) was the most common and was present in 20/38 breasts (53%). The "focal" (Figs. 2 b, 3), "crescent" (Fig. 4), "irregular" (Fig. 5) and absent patterns were present in 16%, 8%, 16% and 8% of breasts, respectively.

That the uptake is indeed breast uptake was clear from reviewing the anterior chest views only in most of the cases (patients 1, 2, 7, 8, 12–16, 18, 19). However, in some cases other views and previous or subsequent scans had to be reviewed to establish the exact location of the uptake. The chest uptake in the scans of patients 5 (Fig. 5) and 6 is not likely to have been due to lung metastasis

because in patient 5, a posterior view of the chest showed minimal shine-through activity, a chest x-ray was normal and a follow-up ^{123}I diagnostic scan after 5 weeks showed only a faint focal breast uptake, while patient 6 had a normal chest X-ray and low thyroglobulin level together with a follow-up ^{123}I diagnostic scan after 11 weeks that showed disappearance of the chest uptake despite the persistence of the thyroid remnant. Whether the "irregular" breast uptake in patients 6, 11 and 17 was due to irregularity within the breast or to the coexistence of breast uptake and skin/clothing contamination is not clear, since post-cleaning images were not obtained in these patients. However, in patient 5 the irregular pattern of breast uptake partially disappeared after cleaning, while in patient 4, the focal area of uptake above the left breast that mimicked lung metastasis proved to be due to skin contamination (likely by milk that contained radioiodine) because it was superficial on lateral views and disappeared on post-cleaning scans.

The left unilateral breast uptake in patients 3 (Fig. 3), 9 and 10 was distinguished from residual radioiodine activity in the stomach by its appearance (patients 9 and 10) and by the coexistence of clear stomach activity (patients 3, 9 and 10). Further, in patient 3 (Fig. 3), external markers were placed on the breasts and xiphoid to confirm the anatomical location of the uptake.

In patient 2 (Fig. 2 b), the 96-h image showed a relative increase in thyroid uptake (in relation to breast uptake) as compared to the 24-h image. Unfortunately, the actual uptakes in the breast and in the thyroid were not obtained. Thus, whether the increase in the ratio of the thyroid to breast uptake is due to a relative decrease in breast uptake or to a relative increase in thyroid uptake or both cannot be determined.

Discussion

Breast uptake of radioiodine can be classified into four patterns according to its scintigraphic appearance. The full pattern represents marked intense uptake over the breast area that may be homogeneous (Fig. 1) or inhomogeneous (Fig. 2 a, right breast). Uptake that is more concentrated centrally in the subareolar region gives a focal pattern (Figs. 2 b, 3), whereas uptake that is more intense peripherally gives a crescent pattern (Fig. 4, right breast). A scintigraphic appearance similar to the full pattern has been reported on ^{123}I scan of a lactating breast [5], whereas an uptake similar to the crescent pattern has been reported on gallium-67 and ^{99m}Tc-pertechnetate scans in a non-lactating breast [6]. The underlying cause(s) of these various patterns is not known. The focal and the crescent patterns may represent radioiodine in the collecting duct and breast tissue, respectively, whereas the full pattern may be the sum of both. Thus recent emptying of breast milk may result in a crescent pattern, whereas a generalized decrease in the activity of the mammary gland may result in a focal pattern. Alternatively, the various patterns may simply reflect the positioning of the breast in relation to the camera and the intensity of the uptake.

The fourth pattern of breast uptake (Fig. 5), the irregular pattern, may closely mimic lung metastasis. Most likely it represents a combination of breast uptake and external contamination with expressed milk that contains radioiodine [7, 8]. It has been reported that between 1.4% and 26.8% of the administered dose of ^{131}I can appear within 24 h in breast milk [9].

Although in the majority of cases, breast uptake is bilateral, it is usually asymmetric. As shown in Fig. 1, in patient 1, in whom both breasts showed a full pattern, the uptake was much greater in the left than in the right breast. The asymmetric pattern of breast uptake was noted in a previous study and was attributed to infant preference of selective breast feeding from one side [10]. Interestingly, in our study, 70% of the cases with asymmetric uptake (45% of all cases) showed higher uptake in the left breast.

Three patients (3, 9 and 10) had unilateral left breast uptake (Fig. 3). None of them had mastectomy. Howev-

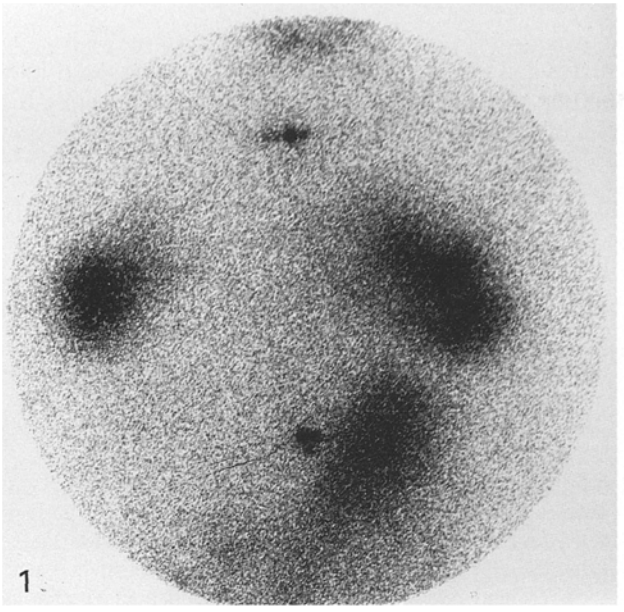
Fig. 1. Asymmetric full homogeneous pattern. Anterior view of the chest on a 1073MBq ^{131}I scan in a 50-year-old female (patient 1) demonstrating asymmetrical full pattern of breast uptake (right<left)

Fig. 2 a, b. "Shifting" of radioiodine from breast of thyroid. Full inhomogeneous pattern. Anterior view of the chest on a 1073MBq ^{131}I post-ablation scan in a 42-year-old female (patient 2). **a** Twenty-four hour image. *Arrows* demonstrate full intense activity in the breasts bilaterally. Note that the uptake in the right breast is inhomogeneous. *Open arrow* delineates thyroid remnant. **b** Ninety-six hour image. *Arrows* demonstrate an apparent decrease in breast uptake that now shows a mild focal pattern. *Open arrow* delineates apparently increased uptake by the thyroid remnant, causing septal penetration

Fig. 3. Unilateral focal pattern. Anterior view of the chest on a 185MBq ^{123}I diagnostic scan in a 35-year-old female (patient 3), demonstrating focal intense uptake in the left breast. Note that there is a marker on the right breast that does not demonstrate any activity. A 185MBq ^{123}I diagnostic scan 4 years later showed bilateral, focal breast uptake (right>left)

Fig. 4. Crescent pattern. Anterior view of the chest on a 185MBq ^{123}I diagnostic scan in a 24-year-old female (patient 4), demonstrating crescent uptake in the right breast. *Open arrow* delineates a focus of skin contamination above the full pattern of the uptake in the left breast. This focus was superficial on the lateral view and disappeared on a post-cleaning scan

Fig. 5. Irregular pattern. Anterior view of the chest on a 185MBq ^{123}I diagnostic scan in a 28-year-old female (patient 5). *Arrows* demonstrate bilateral breast uptake. *Open arrows* demonstrate external contamination by milk. The combined picture mimicked lung metastasis. A posterior view of the chest of the same scan showed minimal shine-through activity. A follow-up ^{123}I diagnostic scan after 5 weeks showed very faint focal breast uptake bilaterally



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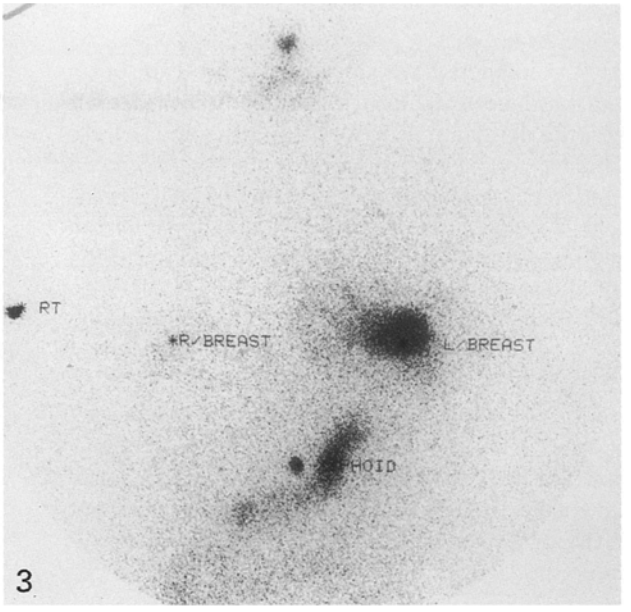

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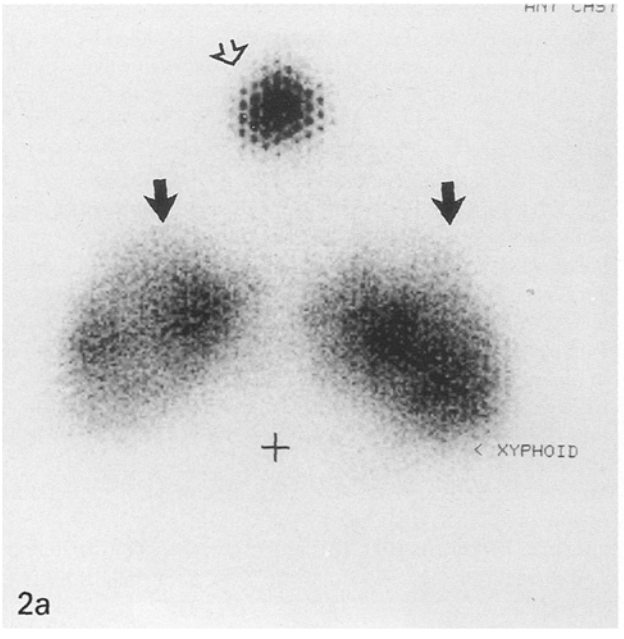

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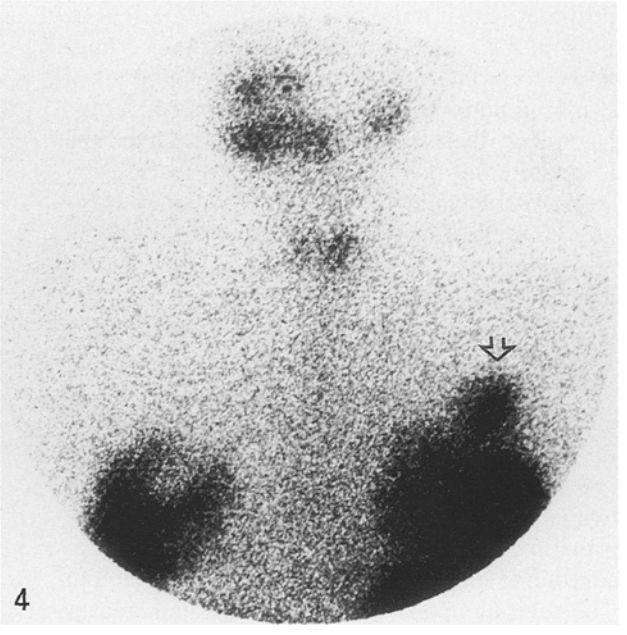

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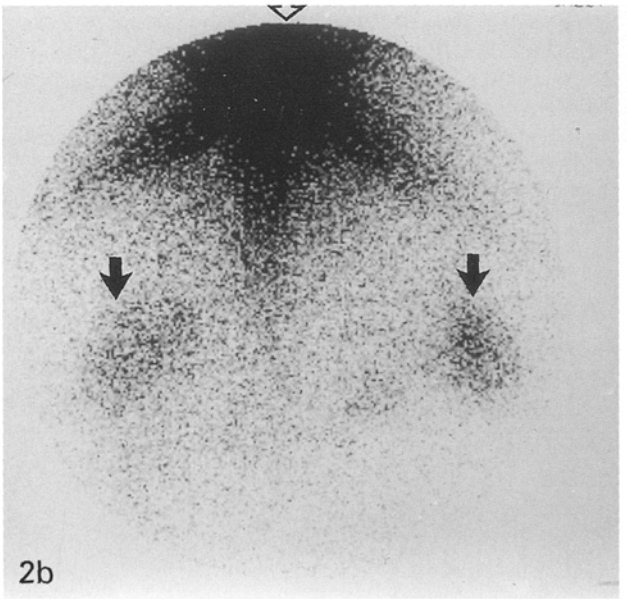

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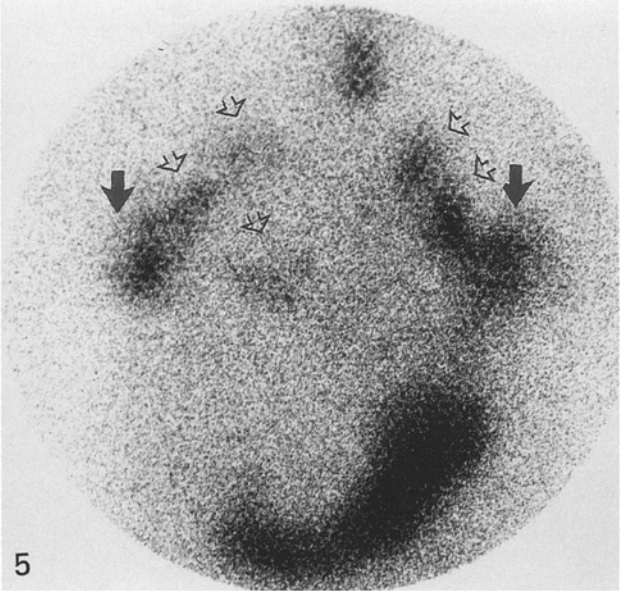

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er, patient 9 volunteered a history of mastitis and of an inability to produce milk from the right breast. To our knowledge, the association between mastitis and the absence of breast uptake on radioiodine scan has not been reported before. It is of note that in patient 3, a diagnostic ^{123}I scan 4 years later showed bilateral focal breast uptake (right>left), indicating the transient nature of the absence of breast uptake.

Figure 2 reveals an interesting aspect of radioiodine kinetics. The ratio of the thyroid to breast uptake increased markedly between 24h and 96h after radioiodine administration. Whether this was due to a relative decrease in breast uptake, a relative increase in thyroid uptake or both cannot be determined from our study, since the actual uptake in the breast or thyroid areas was not obtained. However, it has been shown that the concentration of radioiodine in breast milk of a hypothyroid patient was about 2% of the administered dose and declined over time, with a biological half-life of 12 h [11]. Further, most of the radioiodine in the breast is in a non-protein-bound form [12], suggesting that it can be taken up by the thyroid upon its release from the breast. If this is indeed possible, then the breast may have played the role of a "radioiodine reservoir", effectively increasing the radioiodine pool available to the thyroid and thus increasing thyroid uptake of radioiodine over time. On the other hand, the breast, favoured by its mass, may have competed with the thyroid for radioiodine and thus decreased (at least initially) the radioiodine uptake by the thyroid. However, due to the organification of iodine by the thyroid gland (but not the breast), thyroid content of radioiodine increased, whereas that of the breast decreased on later images. In fact, in a lactating mother thyroid uptake at 24h increased from 18% to 36%, 8 weeks after cessation of lactation [13]. It therefore appears that the interaction between breast and thyroid uptake of radioiodine may be time dependent, and although the ratio of thyroid uptake to breast uptake increases over 96 h, final thyroid uptake may not necessarily be higher in the presence of breast uptake than in its absence.

In summary, four patterns of radioiodine uptake by the lactating breast could be identified. The recognition of these patterns should help in differentiating uptake by the breast from that due to thyroid cancer metastasis to the lung, particularly if a recent history of breast feeding is missing. Further, the presence of breast uptake may affect the accuracy of radioiodine scan in estimating the extent of normal and/or malignant residual thyroid tissue in a time-dependent manner.

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References

1. Kleinberg DL, Noel GL, Frantz AG. Galactorrhea: a study of 235 cases, including 48 with pituitary tumors. *N Engl J Med* 1977; 296: 589–600.
2. Vance ML, Thorner MO. Prolactin: hyperprolactinemic syndromes and management. In: DeGroot LJ, ed. *Endocrinology, 2nd end.* Philadelphia: W.B. Saunders; 1990: 408–418.
3. Edwards CRW, Forsyth IA, Besser GM. Amenorrhoea, galactorrhoea, and primary hypothyroidism with high circulating levels of prolactin. *Br Med J* 1971; 111: 462–464.
4. McConahey WM, Hay ID, Woolner LW, Heerden JA, Taylor WF. Papillary thyroid cancer treated at the Mayo Clinic, 1946 through 1970: initial manifestations, pathologic findings, therapy, and outcome. *Mayo Clin Proc* 1986; 61: 978–996.
5. Duong RB, Fernandez-Ulloa M, Planitz MK, Maxon HR. I-123 breast uptake in a young primipara with postpartum transient thyrotoxicosis. *Clin Nucl Med* 1983; 8: 35–36.
6. Richman SD, Brodey PA, Frankel RS, de Moss EV, Tormey DC, Johnston GS. Breast scintigraphy with ^{99m}Tc-pertechnetate and ^{67}Ga-citrate. *J Nucl Med* 1974; 16: 293–299.
7. Romney B, Nickoloff EL, Esser PD. Excretion of radioiodine in breast milk. *J Nucl Med* 1989; 30: 124–126.
8. Rubow Sietske, Klopper J. Excretion of radioiodine in human milk following a therapeutic dose of I-131. *Eur J Nucl Med* 1988; 14: 632–633.
9. Weaver JC, Kamm ML, Dobson RL. Excretion of radioiodine in human milk. *JAMA* 1960; 173: 872–875.
10. Greenler DP, Klein HA. The scope of false-positive iodine-131 images for thyroid carcinoma. *Clin Nucl Med* 1989; 14: 111–117.
11. Spencer RP, Spitznagle LA, Karimeddini MK, Hosain F. Breast milk content of ^{131}I in a hypothyroid patient. *Int J Radiol Appl Instrum B, Nucl Med Biol* 1986; 13: 585.
12. Miller H, Weetch RS. The excretion of radioactive iodine in human milk. *Lancet* 1955; II:1013.
13. Nurnberger CE, Lipscomb A. Transmission of radioiodine (I^{131}) to infants through human maternal milk. *JAMA* 1952; 150: 1398–1400.