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Determining the breast-feeding interruption schedule after administration of ^{123}I-iodide

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Radioactivity after administration of ^{123}I-sodium iodide was measured in breast milk samples obtained from a patient with postpartum thyroiditis. The breast milk was collected over 93 h during the infant's regular feeding times. The radioactivity in the breast milk was calculated with a ^{123}I capsule of the same lot number as the standard source. ^{123}I was excreted exponentially with an effective half-life of 5.5 h; 2.5% of the total radioactivity administered was excreted in the breast milk over the 93 h, 95% of which was excreted within the first 24 h, and 98.2% within 36 h.

The first milk sample collected at 7 h after administration of the radiopharmaceutical contained 48.5% of the total radioactivity excreted. We estimated the potential absorption of radioactivity to an infant's thyroid in uninterrupted breast-feeding to be 30.3 mGy. With a 24-hour interruption, the absorbed radioactivity would be 1.25 mGy; with a 36-hour interruption, it would be 0.24 mGy.

According to our calculations, breast feeding should be curtailed for 36 h to reduce the infant's exposure to ^{123}I radioactivity. By using a correction factor based on maximum radioactivity from another ^{123}I capsule of the same lot, we were able to ascertain the appropriate protocol for our patient and establish a measurement method that can be applied in similar clinical situations.

Key words: ^{123}I-sodium iodide, breast-feeding, calculation method, thyroid uptake, radiation exposure

INTRODUCTION

IT IS GENERALLY ACCEPTED that administration of radiopharmaceuticals to nursing mothers should be avoided if possible. When, however, nuclear medicine investigations must be performed, countermeasures must be taken to reduce exposure of the nursing child. Clinicians therefore advise the interruption of breast-feeding, and most measure the radioactivity excreted in the breast milk to determine when breast-feeding can be resumed.

In the literature to date, only case reports of one or a few patients have addressed the issue of radioiodine exposure in breast milk.[1–6] Many reports are about ^{131}I or ^{125}I, and there is one case report about ^{123}I sodium iodide.[7] We measured radioactivity in the breast milk of a patient who underwent thyroid gland imaging and an uptake test with ^{123}I sodium iodide to diagnose postpartum thyroiditis. The breast milk was collected for 5 days after administration of the radiopharmaceutical. To avoid exposing the infant to radioactivity, breast-feeding was interrupted during the collection period. We calculated the radioactivity in the excreted milk by using a correction factor based on ^{123}I capsule of the same lot number as the standard source.

PATIENT

A 23-year-old woman with suspected hyperthyroidism was referred for a thyroid scan and uptake test. The patient noticed swelling of the anterior collar region when she

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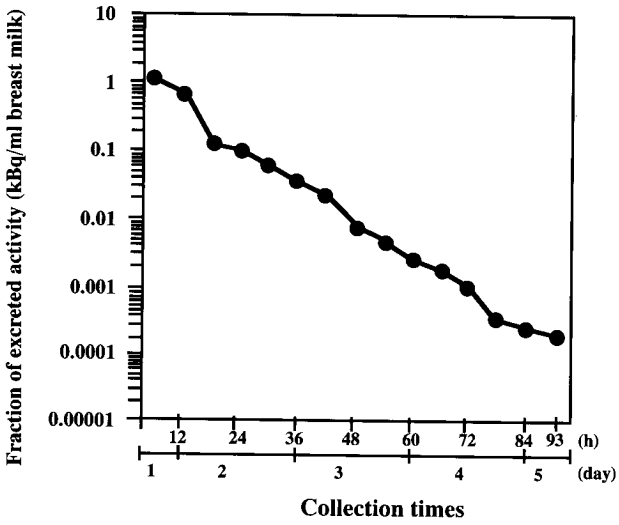

Fig. 1 Fraction of excreted activity per m*l* of breast milk after administration of ^{123}I.

Table 1 Radioactivity excreted in breast milk

Day	Volume (m*l*)	Excreted activity (kBq)	Excretion ratio* (%)
1	198	1.98×10^{2}	2.10
2	390	3.41×10	3.68×10^{-1}
3	415	1.77	1.91×10^{-2}
4	448	10.32×10^{-2}	1.10×10^{-3}
5	161	5.0×10^{-3}	5.50×10^{-5}
	1161	2.33×10^{2}	2.49

$$\text{*Excretion ratio} = \frac{\text{Excreted activity}}{\text{Administrated activity}}$$

Table 2 Absorbed dose to the infant's thyroid

Interrupted breast-feeding period (h)	Excreted activity (kBq)	Absorbed dose* (mGy)
0	2.22×10^{2}	2.88×10
24	9.27	1.19
36	1.79	2.30×10^{-1}
48	4.33×10^{-1}	5.6×10^{-3}

*Absorbed dose calculated by Hedrick's method

was about 17 years of age, but she did not have it examined. On January 20, 1995, she delivered a healthy girl by natural childbirth. The patient was aware of general fatigue, dullness, palpitation, tachycardia and excessive sweating right after childbirth, and these symptoms progressed.

On February 22, she noticed pressure-pain in the right thyroid gland, and she visited the Fourth Department of Medicine at Kurume University Hospital on February 24. Physical examination revealed a diffusely enlarged, soft and tender thyroid gland but no exophthalmos. Thyroid function tests were performed on an outpatient basis with the following results: FT3, 17.5 pg/m*l* (normal 2.7–4.5 pg/m*l*); FT4, 6.8 ng/d*l* (normal 1.08–1.86 ng/d*l*); TSH, < 0.1 μU/m*l* (normal 0.3–3.9 μU/m*l*); T.Chol, 111 mg/d*l* (normal 100–220 mg/d*l*); antimicrosomal antibodies, 1 : 400 (−100). Basedow's disease was suspected. The patient was hospitalized on March 9 for detailed examination and treatment.

She was 48 days postpartum and was breast-feeding. Test results on admission were as follows: FT3, 12.0 pg/m*l*; FT4, 5.44 ng/d*l*; TSH, < 0.1 μU/m*l*; T.Chol, 102 mg/d*l*; Tg, 35 ng/m*l*; antimicrosomal antibodies, 1 : 400; TBII 3.7% (< 10); TSAb 131% (< 180).

Thyroid gland scintigraphy with I-123 (9.2 MBq) sodium iodide was performed. The 5-h and 24-h uptake values were low, 1.74% and 0.22%, respectively, and the patient's thyroid gland could not be imaged. The thyroid hormone level decreased during bed rest; hence, temporary thyrotoxicosis after childbirth (postpartum thyroiditis) was suspected.

Biopsy of the thyroid gland was performed on March 30 and revealed Hashimoto's disease but no subacute thyroiditis or acute exacerbation of Hashimoto's disease, so that the diagnosis of postpartum thyroiditis was confirmed.

METHODS

The breast milk was collected twice on the first day, with the first milk sample collected 7 h after administration of the radiopharmaceutical. Beginning on the second day, breast milk was obtained five times per day at the infant's regular feeding times of 7 : 00, 10 : 00, 13 : 00, 16 : 00, and 20 : 00. The last milk sample was obtained at 7 : 00 (93 h after administration) on day 5. As for the collection of breast milk, the patient manually expressed as much milk as possible herself, without an apparatus.

The collection of breast milk and the measurement of radioactivity were done as follows.

1. Nursing was prohibited after taking of 2 capsules (total 9.2 MBq) of ^{123}I sodium iodide.
2. Breast milk was collected at the infant's regular feeding times for 5 days (until 93 h after ^{123}I administration).
   a. The volume of each milk sample was measured, and the radioactivity per m*l* of milk was measured in a gamma-ray counter.
   b. A 3.9 MBq ^{123}I capsule with the same lot number was dissolved in 100 m*l* of hot water in order to calculate the maximum radioactivity of a 1 m*l* milk sample and establish a correction factor for clinical measurement of excreted radioactivity.
   c. At the time of collection, excreted activity was calculated by multiplying the corrected radioactivity per m*l* by the volume of each milk sample.
   d. The excretion ratio was determined by dividing the calculated radioactivity in the milk sample by the

total radioactivity administered.

RESULTS

Figure 1 gure shows the radioactivity levels in the breast milk at each collection point, indicating a steadily decreasing fraction per m*l* of milk. ^{123}I was excreted exponentially with an effective excretion half-life of 5.5 h.

Over the 5 days, 233 kBq was excreted in the breast milk, which was equivalent to about 2.5% of the total activity (9.2 MBq) administered to the mother: 2.1% on the first day, 0.368% on the second, 0.0191% on the third, 0.0011% on fourth, and 0.000055% on the fifth. Most importantly, 125.2 kBq of the 198.01 kBq in the breast milk collected on the first day was excreted in the first sample. This amount was equivalent to 48.5% of the total radioactivity for the 5 days (Table 1).

The potential dose absorbed dose by the infant's thyroid gland was calculated according to the method of Hedrick.[7] If the nursing had been continued over the 5 days, the absorbed dose could have been 30.3 mGy. Resumption after a 24-h interruption would have resulted in a 1.25 mGy absorbed dose. With 36-h and 48-h withdrawals, the absorbed dose would have been 0.24 mGy and 0.0059 mGy, respectively (Table 2).

DISCUSSION

The best possible approach should be taken to avoid exposure of a child to breast milk containing radioactivity after radiopharmaceutical administration to a lactating mother. With that purpose in mind, the quantity and time-course of radioactivity excreted in breast milk should be measured.

In the literature, many authors do not describe in detail the method for measuring radioactivity. Hedrick et al.[7] measured the radioactivity in breast milk with a calculation system calibrated to a ^{57}Co standard by applying a correction for different emission frequencies, and the measured activity was corrected for decay in order to determine the activity at the time of collection. We, however, used a ^{123}I capsule of the same lot number as that administered to the patient as the standard. The differences between radioactivity in the ^{123}I capsule and that shown on the label of the radiopharmaceutical should be examined. The ^{123}I capsule administered to the patient was marketed with about a +5.4% difference between actual radioactivity in the capsule and that specified on the label.[8] And the difference in radioactivity between capsules was ±0.2%.[8] We therefore considered that any capsule with the same lot number can be used as the standard radiation source. This is very convenient.

As to the study of radiopharmaceutical defluxion in breast milk, there are many case reports. Comparing the reports to date regarding defluxion in breast milk raises some distressing concerns because the collection methods and the activity determination methods vary across reports. In addition, even with similar administration and collection methods, the results differ widely. Therefore, establishing a clinical protocol for preventing infant exposure is difficult. In 1989, Mountford and Coakley[4] established four interruption protocols for lactating mothers based on their quantitative analysis of radioactivity in breast milk: interruption not essential, interruption for a defined period, interruption with measurement, and total cessation. Rubow et al.[5] recommended a fifth protocol: restriction of close contact between the mother and infant. ^{123}I-sodium iodide is classed in the interruption with measurement protocol.

In other reports, the total excreted radioactivity in the milk was usually calculated by using the activity per m*l* and assuming the standard breast milk output to be 850 m*l* per day,[10] but we calculated the total radioactivity by using the total volume of the collected milk samples (about 400 m*l*/day on average in this study). A large difference in total excreted milk volume was noted between Hedrick's[7] study and ours, but the percentage of total excreted activity was very similar: 2.6% in Hedrick's and 2.5% in ours. The effective excretion half-life was also similar: 5.8 h and 5.5 h respectively. These findings suggest that excreted activity correlates with administered radioactivity rather than excreted milk volume.[5]

As for the absorption of ^{123}I, the thyroid gland is the most sensitive organ, followed by the stomach wall; absorption is quite decreased in other organs. In a 1-year-old child, thyroid absorption is 56 mGy/MBq, and stomach wall absorption is 0.36 mGy/MBq.[11] Accordingly, exposure to the thyroid gland is of chief concern.

The potential absorbed doses for ^{123}I excretion were calculated in our study as if the tracer was pure, but contaminations of ^{124}I and ^{125}I have been reported, and the relative absorption must be taken into account.[2,4,12] Between 23 and 106 days' interruption of breast-feeding has been recommended after administration of 3.7 MBq ^{123}I,[14] 1.5 to 3 days' interruption after administration of currently available ^{123}I that contains contaminating ^{124}I and ^{125}I.[13]

The ^{123}I-sodium iodide administered to our patient was made by decay of ^{123}Cs and ^{123}Xe, which are produced by irradiating ^{124}Xe with a proton beam.[13] The preparation produced by this method contains 99.7% ^{123}I and 0.3% or less ^{121}Te, and does not contain ^{124}I, ^{126}I, ^{130}I, ^{131}I or ^{24}Na.[11] Because the target organ of ^{121}Te is not the thyroid, the dose absorbed by the thyroid gland does not increase significantly. Even if this radionuclide is disseminated through the whole body, the exposure dose can be ignored, but if ^{123}I produced by proton-irradiated-^{127}I is administered, the level of ^{125}I contamination should be measured.[15]

Mountford[4] recommended that for ^{123}I, in which the fractional ingestion is less, although mothers can be advised before injection that feeding can be resumed

within a few days, each patient should be instructed to interrupt feeding while milk samples are expressed and analyzed. Because the acquisition of milk samples is difficult with out-patients, a list of interruption periods for various radiopharmaceuticals has been used,[3] but ^{123}I is not listed.

Because ^{123}I-sodium iodide was administered before assay time in our case, the patient absorbed more radioactivity (9.2 MBq) than usual. The thyroid gland could not be imaged scintigraphically. The 5-h and 24-h uptake ratios were 1.74% and 0.22%, respectively. Accordingly, the decrease in thyroid gland uptake adversely increased the excreted radioactivity in breast milk.[7] Nevertheless, the dose absorbed by the thyroid gland of the infant after a 36-h interruption in feeding would have been acceptably low (0.24 mGy).

Based on our calculations in this case, it appears that breast-feeding should be curtailed for 36 h with the administration of ^{123}I sodium iodide. Further group studies should be performed to confirm this as the appropriate ^{123}I protocol.

REFERENCES

1. Wyburn JR. Human breast milk excretion of radionuclides following administration of radiopharmaceuticals. *J Nucl Med* 14: 115–117, 1972.
2. Romney BM, Nickoloff EL, Esser PD, Alderson PO. Radionuclide administration to nursing mothers: mathematically derived guidelines. *Radiology* 160: 549–554, 1986.
3. Rose MR, Prescott MC, Herman KJ. Excretion of iodine 123-hippuran, technetium-99m-red blood cells, and technetium-99m-macroaggregated albumin into breast milk. *J Nucl Med* 31: 978–984, 1990.
4. Mountford PJ, Coakley AJ. A review of the secretion of radioactivity in human breast milk: Data, quantitative analysis and recommendations. *Nucl Med Commun* 10: 15–27, 1989.
5. Rubow S, Klopper J, Wasserman H, Baard B, van Niekerk M. The excretion of radiopharmaceuticals in human breast milk: additional data and dosimetry. *Eur J Nucl Med* 21: 144–153, 1994.
6. Ahlgren L, Ivarsson S, Johansson L, Mattson S, Nosslin B. Excretion of radionuclides in human breast milk after the administration of radiopharmaceuticals. *J Nucl Med* 26: 1085–1090, 1985.
7. Hedrick WR, Di Simone RN, Keen RL. Radiation dosimetry from breast milk excretion of radioisotope and pertechnetate. *J Nucl Med* 27: 1569–1571, 1986.
8. Nihon Medi-Physics Co., Ltd. private communication.
9. ICRP. Report of the Task Group on Reference Man. International Commission for Radiological Protection Publication 23, Oxford, England, Pergamon Press, 1975.
10. Loevinger R, Berman M. A schema for absorbed dose calculation for biologically-distributed radionuclides. MIRD pamphlet No. 1, New York, The Society of Nuclear Medicine, 1968.
11. ICRP. Radiation dose to patients from radiopharmaceuticals. International Commission for Radiological Protection Publication 53, Annals of the ICPR 18: 266, 1987.
12. Blue PW, Dydek GJ, Ghaed N. Radiation dosimetry from breast milk excretion of iodine-123. *J Nucl Med* 28: 544–545, 1987.
13. Hedrick WR, DiSimone RN, Keen RL. Reply. *J Nucl Med* 28: 544–545, 1987.
14. Blue PW, Dydek GJ. Excretion of radioiodine in breast milk. *J Nucl Med* 30: 127–128, 1989.
15. The Japan Radioisotope Association. Sodium iodide capsule. *Radiopharmaceuticals Hand Book. 4th ed.* Japan Radioisotope Association, Tokyo, pp. 52–53, 1991.