CONCLUSION

Our results with dynamic salivary scintigraphy in patients with reflux esophagitis showed that cisapride enhances salivary gland secretion during the postprandial phase. This indicates that cisapride improves both the gastroesophageal motor function and the salivary function and enhances esophageal acid clearance in patients with reflux esophagitis.

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Radioiodine Secretion in Tears

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Lacrimal secretion of radioiodine has been suspected from previous scintigraphic observations. We semiquantitated radioiodine secretion in the tears of a thyroid-ablated patient with an artificial eye while the patient was on thyroxine treatment. **Methods:** After an oral dose of 555 MBq (15 mCi) ^{123}I, 12 tear samples were collected over 24 hr by using Schirmer papers. Radioactivity in each sample was determined in a well counter 27 hr after radioiodine ingestion and was corrected for decay and counting efficiency. **Results:** Radioactivity was detectable at 15 min and at up to 24 hr after radioiodine ingestion and peaked at around 60 min (215 Bq/μl or 39×10^{-6} % of the administered dose/μl. Considering a tear-flow rate of 1 μl/min, the total radioactivity secreted in the first 4 hr was estimated to be 56 kBq, representing about 0.01% of the administered dose. **Conclusion:** An appreciable amount of ingested radioiodine could be secreted in tears. The potential damage of the lacrimal gland after high doses of ^{131}I treatment deserves further study.

Key Words: radioiodine secretion; tears; Schirmer test; thyroid cancer

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Several nonthyroidal tissues such as the gastric mucosa, intestine, choroid plexus, placenta and mammary, salivary and sweat glands have the ability to concentrate iodide (*1*). Radioiodine has been detected in fetal blood, breast milk, cerebrospinal fluid, sweat and salivary, gastric and nasopharyngeal secretions (*2*). Radioiodine uptake was observed in the lacrimal sac in a patient with dacrocystitis (*3*) and in the orbital cavity in a patient with an artificial eye (*3*).

We examined whether radioiodine is detectable in tear samples obtained after the ingestion of ^{123}I radioiodine.

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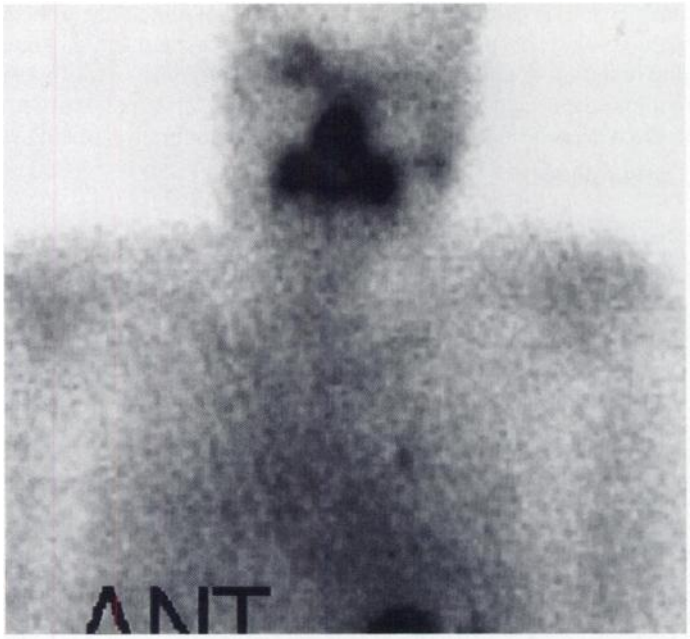

FIGURE 1. Anterior head and neck view of diagnostic ^{123}I radioiodine whole-body scan of patient on thyroxine treatment shows activity within right orbit representing radioiodine secretion in tears that accumulated behind prosthetic eye.

MATERIALS AND METHODS

A 44-yr-old-man who had previously undergone an enucleation of the right eye for choroidal melanoma was monitored for papillary thyroid carcinoma. Radioiodine uptake at the site of his prosthetic eye had been reported previously (*3*) and this stimulated our study for which informed consent was obtained. At the time of the study, the patient was on 150 μg thyroxine daily and had a thyroid-stimulating hormone (TSH) level of 0.1 milliunit/liter (normal range 0.35–5.5). Probing and syringing of the right nasolacrimal duct demonstrated a patent drainage system.

Radioiodine Schirmer Test

The Schirmer test was performed after the ingestion of 555 MBq (15 mCi) ^{123}I radioiodine. Standardized sterile 5 × 35 mm Schirmer test strips (Visionex, Memphis, TN) were placed, without local anesthesia, at the junction of the middle and temporal thirds of the lower lid of the right orbit at 15, 30, 60, 105, 135, 195 and 235 min after removal of the prosthetic eye and at 24 hr without removal of the prosthetic eye. After 5 min, the strips were removed and evaluated by measuring the length of the moistened area using the millimeter scale imprinted on the strips. The ^{123}I radioactivity in each strip was determined (27 hr after radioiodine ingestion) for 2 min in a 3-in crystal well counter (1480 Wizard; Wallac, Turku, Finland). Counts were corrected for decay to time of administration (decay factor 0.2311) and counting efficiency of the well counter (83%) to obtain an estimate of the secreted radioactivity (Bq) that was collected on each strip. To obtain the concentration of ^{123}I in tears, the activity (Bq) was divided by the reading of the Schirmer paper in millimeters, multiplied by 0.64 [1 mm Schirmer = 0.64 μl tear (*4*)]. To obtain the total amount of radioiodine secreted in a given time period, a tear-flow rate of 1 μl/min was assumed (*5*), and the area under the curve was calculated using a linear trapezoid rule.

Radioiodine Imaging

Head and neck views were acquired 24 hr after the ingestion of ^{123}I using a MultiSPECT gamma camera (Siemens, Hoffman Estates, IL) and a medium-energy collimator. As shown in Figure 1, radioiodine uptake was seen only in the right orbit at the site of the prosthetic eye.

TABLE 1
Radioiodine Schirmer Test

Time* (min)	Schirmer test (mm)	Counts (cpm)	Activity† (Bq)	Concentration‡ (Bq/μl)	% of AD§ (μl^{-1})
15	12	272	24	3	0.6×10^{-6}
30	20	3,489	303	24	4×10^{-6}
60	21	33,223	2,887	215	39×10^{-6}
105	28	29,391	2,554	143	26×10^{-6}
135	10	11,699	1,017	159	29×10^{-6}
195	28	25,911	2,251	126	23×10^{-6}
235	20	15,645	1,360	106	19×10^{-6}
1,440	14	6,336	551	61	11×10^{-6}

*Time after radioiodine ingestion.
†Activity at time of administration corrected for 27-hr decay (0.2311) and counting efficiency (0.83).
‡Activity (Bq) divided by Schirmer strip volume (mm Schirmer × 0.64 μl/mm).
§Percentage of administered dose (555 × 10^6 Bq) that is secreted in 1 μl of tear.

RESULTS

The results of the radioiodine Schirmer test are shown in Table 1. The first tear sample, collected 15 min after radioiodine ingestion, contained the lowest concentration of radioactivity (3 Bq/μl), whereas peak radioidine secretion (215 Bq/μl) was reached by about 1 hr. The radioactivity was still detectable (61 Bq/μl) at 24 hr. The total amount of radioactivity secreted in the tears in the first 4 hr was about 56 kBq, representing 0.01% of the total ingested dose.

DISCUSSION

We had previously observed radioiodine uptake in the lacrimal sac of a patient with dacrocystitis (*3*) and in the right enucleated orbit of the current patient (*3*). This suggested that radioiodine might be secreted in tears. This study confirms that radioiodine is present in tears.

Lacrimal gland secretion of radioiodine is not unexpected. Radioiodine is secreted by several nonthyroidal glands such as the salivary, sweat and mammary glands (*1,2*). However, the lacrimal glands, tear film and drainage system normally are not visualized on radioiodine whole-body imaging. This is most likely due to the low uptake and small size of the lacrimal gland, coupled with the small volume of the tear film and the low tear-flow rate, as well as the high turnover rate of the tear film and the patent lacrimal system. Basal tear flow measures 1 μl/min. The volume of the tear film averages about 7 μl, and the continuous drainage of tears in the lacrimal system results in a turnover rate of the tear film of approximately 12%–16%/min (*6*). On the other hand, the proper position of the eyelids against the globe, continuous blinking and the location of the puncta in relation to the lacrimal strips must prevail for the capillary attraction to move tears from the lacrimal strip into the canaculi (*7*). Impairment of these mechanisms may explain the accumulation of radioiodine in the right enucleated orbit of our patient. In addition, the amount of ^{123}I secreted in the tears of this patient may be higher than usual since his thyroid gland had been ablated, which allows a much larger fraction of the administered radioiodine to be available for lacrimal gland uptake.

Radioiodine is likely to be present in the middle, thick aqueous layer that constitutes 98% of the tear film (*8*) and is where other electrolytes are secreted (*8*). It is presumably in the inorganic form, free or protein bound, similar to its form of secretion in other extrathyroidal tissues (*9*).

As demonstrated by the radioiodine Schirmer test, peak

radioiodine concentration (215 Bq/μl) was reached by 1 hr and was presumably related to peak plasma concentration (*10*). A fraction of radioiodine secreted in tears accumulated behind the prosthetic eye, as shown in the 24-hr image, and another fraction drained in the patent nasolacrimal duct accounted for some of the nasal activity. The status of the patient, being hypothyroid or hyperthyroid (on thyroxine suppression), did not appear to significantly affect radioiodine accumulation in the orbit (Fig. 1) (*3*). This is in agreement with a previous study on radioiodine uptake by extrathyroidal tissues that did not demonstrate any response to TSH stimulation (*2*).

We estimated that about 0.01% of the administered radioiodine dose is secreted in tears (in each eye) during the first 4 hr. The clinical significance on the function of the lacrimal gland of radioiodine secretion in tears, when repeated large doses of ^{131}I are given, or on the lens when the nasolacrimal ducts are blocked, is not known and needs further study. It is of interest that the parotid and lacrimal gland functions were reduced in a thyroid cancer patient who had undergone thyroidectomy and treatment with radioiodine (*11*). However, it was suggested that hormonal and metabolic derangements, rather than the direct effect of ^{131}I on the glands, were responsible for the glandular dysfunction.

CONCLUSION

Although the mechanism(s) of radioiodine lacrimal uptake remain(s) unclear, it is unrelated to TSH levels. Further studies are needed to calculate the amount of radioiodine secretion in patients with normal thyroid glands and eyes and to calculate the radiation dose delivered to the lacrimal glands as well as to explore the prevalence of dry eye in thyroid cancer patients who have received multiple high doses of radioiodine treatments.

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Gallium-67-Citrate Scanning of Renal Parenchymal Malacoplakia

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The purpose of this article is to review the potential role of nuclear medicine scanning, especially with ^{67}Ga, in the presumptive diagnosis and clinical management of patients with renal parenchymal malacoplakia (RPMP), a rare disease associated with coliform bacterial infection of the kidney and characterized by chronic unresolving inflammatory infiltrates containing von Hansemann macrophages in the renal parenchyma. **Methods:** Published cases of RPMP were collected from the archival literature by searching the MEDLINE database and by reviewing bibliographic references contained in articles on malacoplakia. Data on the clinical features and radiographic evaluation of patients with RPMP were extracted from the clinical case reports. **Results:** Forty-three cases of RPMP published over the past 20 yr were identified. Ten of the 43 patients (23%) had ^{67}Ga scanning as a component of their diagnostic evaluation. In all 10 patients, renal uptake of ^{67}Ga was classified as intense. Two of those 10 patients had serial ^{67}Ga scanning performed to assess response to antibiotic treatment; both patients exhibited decreased uptake or complete resolution of abnormal renal uptake over time, a finding also exhibited by our patient. **Conclusion:** Intense renal uptake of ^{67}Ga, typically in the clinical setting of fever, progressive renal failure and nephromegaly, strongly supports a diagnosis of RPMP. In those patients receiving prolonged antimicrobial therapy for RPMP, resolution of abnormal ^{67}Ga uptake over time may provide an objective endpoint for treatment.

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Key Words: malacoplakia; nephromegaly; gallium-67 scanning; acute renal failure

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Malacoplakia, a rare inflammatory disorder of uncertain etiology associated with coliform bacterial infection, most commonly involves the genitourinary tract, particularly the bladder and ureters (*1–4*). Renal parenchymal malacoplakia (RPMP), a severe form of genitourinary tract malacoplakia, frequently mimics pyelonephritis and may be quite difficult to diagnose, especially since ultrasound and CT often demonstrate only nephromegaly (*2–6*). The diagnostic test of choice for RPMP is renal biopsy with histopathological identification of pathognomonic Michaelis-Gutmann bodies within von Hansemann macrophages (*2,3*). However, the decision to pursue renal biopsy, a potentially morbid procedure, is often difficult. A noninvasive diagnostic study that might predict which patients with unresolved pyelonephritis should be biopsied to exclude RPMP would be clinically useful.

Optimal therapy for RPMP has not been well defined. Although surgical resection was previously the preferred management for RPMP (*2,3,7*), recent literature emphasizes the emerging role of prolonged antimicrobial therapy in management (*2,3,8*). The duration of effective therapy for RPMP has varied from weeks to months with relapse after inadequate treatment a well-recognized problem (*2–5*). Some authors have