Altered Body Distribution of [^{99m}Tc] Pertechnetate in Latrogenic Hyperaluminemia

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Failure of intravenously administered [^{99m}Tc] pertechnetate to leave the vascular space was observed in a patient with hyperaluminemia due to treatment with an antacid drug containing aluminum hydroxide. A repeat study 3 mo after discontinuing medication, when the plasma aluminum level had fallen, revealed normal in vivo distribution of pertechnetate. It was found that instant thin-layer chromatography, using pertechnetate and an 85% methanol system, can detect plasma aluminum levels as low as 50 μg/l.

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It has been reported that elevated plasma aluminum levels can alter the in vivo distribution of Tc-99m sulfur colloid (*1*) and of Tc-99m diphosphonate in experimental animals (*2*). The plasma aluminum concentration can be elevated by chronic ingestion of aluminum hydroxide preparation (*3*). We report studies of the in vivo distribution of [^{99m}Tc] pertechnetate in a patient (a) during a phase of hyperaluminemia coincident with treatment with an aluminum-containing antacid drug, and (b) during eualuminemia after withdrawal of medication.

CASE REPORT

A 38-year-old white woman with unexplained melena was referred for evaluation of possible Meckel's diverticulum. The patient had no history of hepatic or renal disease and had had no previous radionuclide studies. Her medications at the time of examination included an antacid containing aluminum hydroxide, which in the dosage prescribed caused ingestion of 7.2 g of aluminum hydroxide daily. To search for ectopic gastric mucosa, 15 mCi of pertechnetate was administered intravenously and images of the abdomen were obtained at intervals of up to 60 min postinjection. The study revealed *altered* distribution, with no evidence of localization in the stomach or bladder (Fig. 1). Other patients injected with material from the same preparation showed normal distribution of tracer, thus excluding faulty preparation as a cause of the unusual finding.

METHODS AND RESULTS

The following in vitro and in vivo tests were performed to determine the mechanism of the altered distribution of pertechnetate.

1. Because of reports linking altered distribution of Tc-99m-labeled compounds with high levels of serum aluminum (*1,2*) and because this patient had chronically ingested large quantities of aluminum

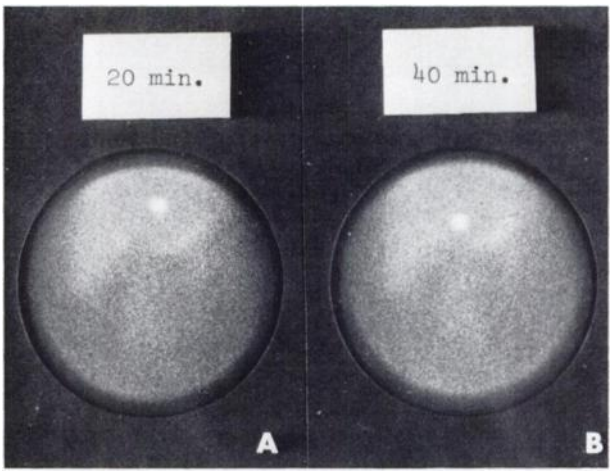

FIG. 1. During hyperaluminemia. Scintiphotos of abdomen at 20 (A) and 40 (B) min after i.v. administration of [Tc-99m] pertechnetate. Note absence of activity in stomach and bladder. Liver is faintly outlined by activity in its blood pool.

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hydroxide, her plasma and a pooled plasma sample were analyzed for aluminum content by atomic absorption spectrophotometry. The patient's plasma aluminum level was 65 μg/l, whereas that of the pooled plasma was 5.8 μg/l (Table 1). The normal plasma aluminum level is reported to be 3–11 μg/l (*3*).

2. The patient's red cells, plasma, and a sample of pooled plasma were mixed with pertechnetate and incubated at 37°C for 30 min. One drop of each sample was spotted on an instant thin-layer chromatography (ITLC) sheet and developed in an 85% methanol system and in saline. With the 85% methanol system, the *Rf* value of the patient's plasma was 0.90 and that of pooled plasma was 1.00. Both *Rf* values were 1.00 with the saline system (Table 2). These results showed that hyperaluminemic plasma alters the chemical or physiochemical characteristics of pertechnetate.

3. To determine the level of hyperaluminemia that detectably alters the distribution of pertechnetate, pooled plasma was mixed with known concentrations of aluminum hydroxide: 15, 35, 50, 75, 100, and 150 μg/l. These preparations were subjected to ITLC as described above. At plasma aluminum levels of 50 μg/l and above, with the 85% methanol system, the *Rf* values were 0.90; below that level the *Rf* values were 1.00 (Table 3). This showed that aluminum levels about 50 μg/l are detectable by alteration of the *Rf* value for pertechnetate on ITLC with an 85% methanol system.

TABLE 1. ANALYSIS OF ALUMINUM LEVELS IN PLASMA

Date	Patient's plasma	Pooled plasma
10/20/76	65 μg/l	5.8 μg/l
11/1/77	15 μg/l	5.8 μg/l

TABLE 2. ITLC DATA OF MIXTURE OF [^{99m}Tc] PERTECHNETATE WITH PATIENT'S AND POOLED PLASMA

	Rf value				
Solvent system	Patient's plasma	Pooled plasma	$^{99m}TcO_4^-$	Patient's red cells	Pooled red cells
Saline	1.00	1.00	1.00	1.00*	1.00*
85% methanol	0.90	1.00	1.00	1.00*	1.00*

ITLC (instant thin-layer chromatography, SG type).
* Tailing.

TABLE 3. ITLC DATA OF MIXTURES OF [^{99m}Tc] PERTECHNETATE, POOLED PLASMA AND ALUMINUM HYDROXIDE

	Rf value						
Solvent system	Pooled plasma	15 μg/l	35 μg/l	50 μg/l	75 μg/l	100 μg/l	150 μg/l
85% methanol	1.00	1.00	1.00	0.90	0.90	0.90	0.90

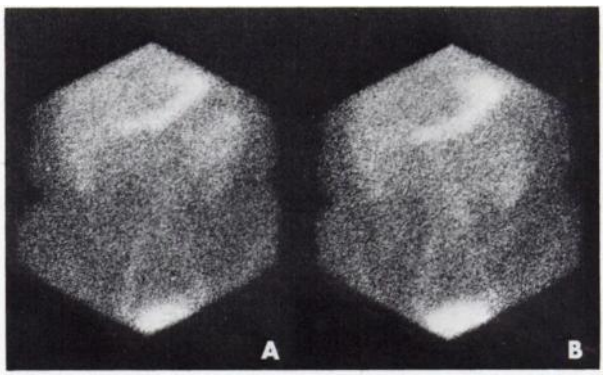

FIG. 2. During eualuminemia. Scintiphotos of abdomen at 20 (A) and 40 (B) min show normal localization of pertechnetate in gastric mucosa.

4. Finally, to determine whether in our patient the abnormal in vivo distribution of pertechnetate would persist after restoration of normal plasma aluminum levels, a restudy with i.v. pertechnetate was done 3 mo after discontinuation of Mylanta®, at which time the patient's plasma aluminum level had fallen to 15 μg/l (Table 1). Normal distribution of pertechnetate was observed (Fig. 2). Repeat ITLC of the patient's plasma and pooled plasma with pertechnetate gave identical *Rf* values of 1.00.

DISCUSSION

These show that, during hyperaluminemia, intravenously administered pertechnetate failed to leave the vascular space. When the plasma level of aluminum approached the normal range, normal in vivo distribution of the tracer returned. The mechanism by which hyperaluminemia alters the body distribution of pertechnetate is not understood.

Aluminum hydroxide is absorbed from the gastrointestinal tract (*3*) and is excreted by the kidneys, but little else is known about its metabolism. Appropriate metabolic studies have been hampered by the absence of suitable radioisotopes of aluminum for

tracer studies, and until recently by the lack of sensitive analytical methods for measuring aluminum levels in blood and tissues (*4*).

Aluminum is known to be toxic to animals (*5*), but its effects in humans are not well known (*6*). It seems advisable to identify patients potentially at risk, such as those on dialysis or on chronic antacid treatment for gastrointestinal disorders. Altered pertechnetate distribution in vivo should alert the physician to the possibility of hyperaluminemia. Our results indicate that ITLC studies with pertechnetate can be used to detect plasma aluminum levels of 50 μg/l and above.

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