

Usefulness of per-rectal portal scintigraphy with Tc-99m pertechnetate for galactosemia in infants

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Galactosemia discovered by newborn screening is rarely caused by enzyme deficiency. It has recently been reported that among patients without enzyme deficiency portosystemic shunting may be a cause of galactosemia in some patients. We did per-rectal portal scintigraphy in patients with such galactosemia detected during screening of newborns to examine the usefulness of this method for the diagnosis of portosystemic shunts via the inferior mesenteric vein. The subjects were eight neonates with galactosemia without enzyme deficiency detected during screening. A solution containing technetium-99m pertechnetate was instilled into the rectum, and serial scintigrams were taken while radioactivity curves for the liver and heart were recorded sequentially. The per-rectal portal shunt index was determined by calculating the ratio for counts of the liver to counts for the heart integrated for 24 seconds immediately after the appearance of the liver time-activity curve. A portosystemic shunt was detected in both of the patients with a shunt index of 30% or more, but not in the six patients with a shunt index less than 30%. The blood galactose levels of these six patients later entered the reference range. This method is noninvasive and there is little exposure to the radionuclide. It seemed to be useful for the diagnosis of portosystemic shunt in newborns with galactosemia without enzyme deficiency.

Key words: galactosemia, portosystemic shunt, per-rectal portal scintigraphy

INTRODUCTION

DURING SCREENING of newborns for galactosemia, a few infants are found to have alimentary galactosemia without enzyme deficiency, of unknown cause.¹ One cause of galactosemia is a portosystemic shunt that prevents the conversion of galactose to glucose because the portal blood bypasses the liver, which contains the enzyme that catalyzes the conversion.² Per-rectal portal scintigraphy with Tc-99m pertechnetate enables noninvasive diagnosis of portosystemic shunts via the inferior mesenteric vein.³ We used this method in patients with galactosemia without enzyme deficiency to examine its usefulness.

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MATERIALS AND METHODS

Patients

Our subjects were 8 patients (6 boys and 2 girls, 1 month to 2 years old) with galactosemia without enzyme deficiency, detected by screening of newborns. Table 1 summarizes their clinical characteristics.

Methods

The subjects were not fed solid food after the last meal of the day on the day before the test. In the morning, the rectum was emptied by administration of a laxative. A polyethylene tube (Nélaton's catheter, French 11) was inserted 10 cm into the rectum, reaching the upper part. A large-field scintillation camera (Technicare-410S) was used to generate time-activity curves. The camera had a low-energy, multipurpose, parallel-hole collimator, and was interfaced with a digital computer (Sopha Simis 4). The camera was positioned over the patient's abdomen so

Table 1 Clinical features of patients with galactosemia without enzyme deficiency

Case no.	Age (months)	Sex	SI (%)	Diagnosis	Total bilirubin (mg/dl)	AST (IU/L)	Galactose (mg/dl)	Ammonia ($\mu\text{g/dl}$)	Total bile acid ($\mu\text{mol/L}$)
1	24	Female	62	CAPV	0.6	48	45.3	228	94
2	3	Male	33	Splenorenal shunt	4.2	13	5.9	90	92
3	12	Male	19	Infantile hepatitis	2.0	52	2.6	62	71
4	1	Male	18	Infantile hepatitis	6.7	37	48.1	140	273
5	4	Male	18	—	0.6	72	4.2	ND	12
6	3	Male	17	—	3.2	48	5.6	46	66
7	3	Male	14	—	0.7	21	15.6	42	9
8	2	Female	11	—	9.6	46	3.2	72	71

SI, shunt index; CAPV, congenital absence of portal vein; —, cause not identified; AST, aspartate transaminase, ND; not done.

that the field of view included the heart, liver, and spleen. First 111 MBq of Tc-99m pertechnetate (1 mL) was given through the tube, followed by 8 mL of air. Then time-activity curves for the areas of the liver and heart were obtained every 4 seconds. At the end of the 5-min examination, the 5-min summed image, displayed in color, was recorded. To evaluate the extent of the portosystemic shunt in terms of a shunt index, we calculated the ratio of counts for the liver to counts for the heart integrated for 24 seconds immediately after the appearance of the liver time-activity curve.³

RESULTS

Table 1 shows the shunt index, diagnosis and laboratory test results for the 8 patients. A portosystemic shunt was detected (see below) in the 2 patients with a shunt index of 30% or more. The 6 other patients, with a shunt index lower than 30%, were each examined by magnetic resonance imaging, abdominal ultrasonography and computed tomography, but portosystemic shunts were not detected. Two of these patients had neonatal hepatitis, but the cause of the galactosemia of the other 4 patients was not identified. The blood galactose levels of these 6 patients returned to within the reference range one month or more later.

CASE REPORTS

Case 1

Newborn screening showed galactosemia in a patient brought to our hospital when she was 2 years old. The patient had been given lactose-free milk since infancy because the blood galactose level was still high (45 mg/dL) one month after birth. She was referred to the department of pediatrics at our hospital for further examination. A per-rectal portal scintigram done with Tc-99m pertechnetate showed high radionuclide activity in the heart, but liver image was not detected, and the pattern seen was that of portal hypertension (Fig. 1). The portal shunt index was 62%. Magnetic resonance venograms of the ascending circulation showed polysplenia, and the intrahepatic

portal vein was not visible (Fig. 2). These findings led to a diagnosis of congenital absence of the portal vein, complicated by a splenorenal shunt with flow of portal blood into the renal vein.

Case 2

Screening showed galactosemia in a newborn boy, referred to the department of pediatrics at our hospital for further examination when 3 months of age. A per-rectal portal scintigram done with Tc-99m pertechnetate showed high radionuclide activity in the heart, but no liver image was obtained. The pattern was of portal hypertension (Fig. 3). The portal shunt index was 33%. A splenorenal shunt was detected by abdominal ultrasonography (Fig. 4).

DISCUSSION

Galactosemia discovered by newborn screening is rarely caused by deficiency of the enzyme indispensable for metabolic pathways of galactose. Many patients with galactosemia have been found to have normal enzymatic activities engaged in galactose metabolism. It has recently been reported that among patients without enzyme deficiency portosystemic shunting may be a cause of galactosemia in some patients.⁴⁻⁶ A portosystemic shunt was found in 2 of the 8 patients with galactosemia without enzyme deficiency whom we examined, and one of them also had congenital absence of the portal vein. Congenital absence of the portal vein is rare; only a few cases have been reported,⁷⁻¹⁰ all in girls. In most cases, the portosystemic circulation forms a shunt to the inferior vena cava or left renal vein, with complicating malformation of other organs such as the heart, spleen and liver. Polysplenia, which we found in one patient, was found in 2 of the reported cases of congenital absence of the portal vein.⁸

The per-rectal approach for the measurement of portal circulation is a relatively noninvasive method. I-131,¹¹ Tl-201,^{12,13} and N-13 ammonia¹⁴ have been used as the radiopharmaceutical in this approach, but these nuclides are not absorbed well by the rectum, making it difficult to make a detailed analysis of the portosystemic shunt.

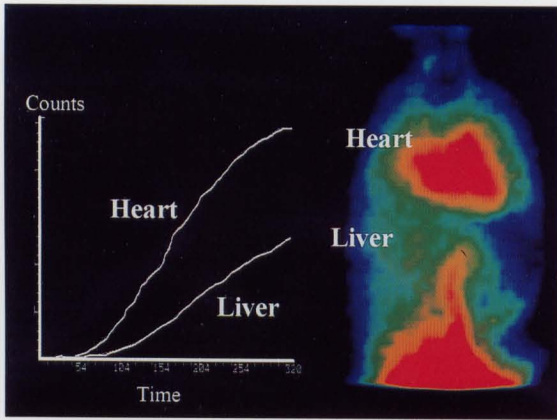


Fig. 1 Per-rectal portal scintigram and time-activity curves for the liver and heart, patient 1.

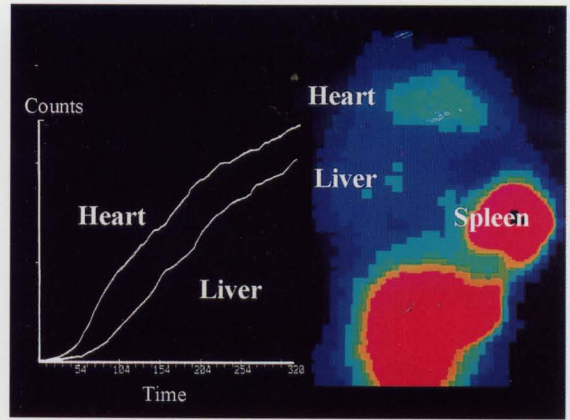


Fig. 3 Per-rectal portal scintigram and time-activity curves for the liver and heart, patient 2.

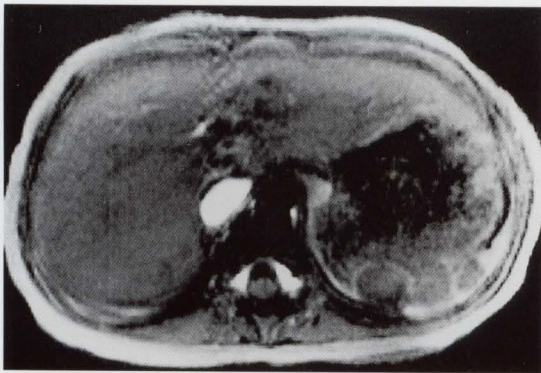


Fig. 2A

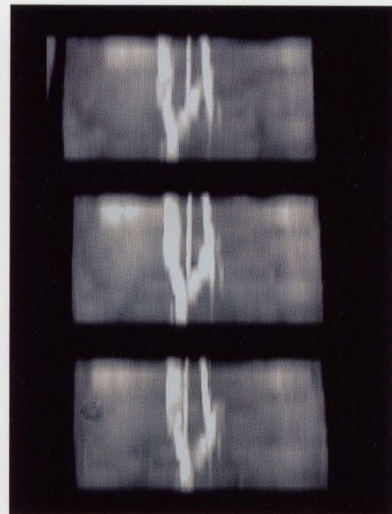
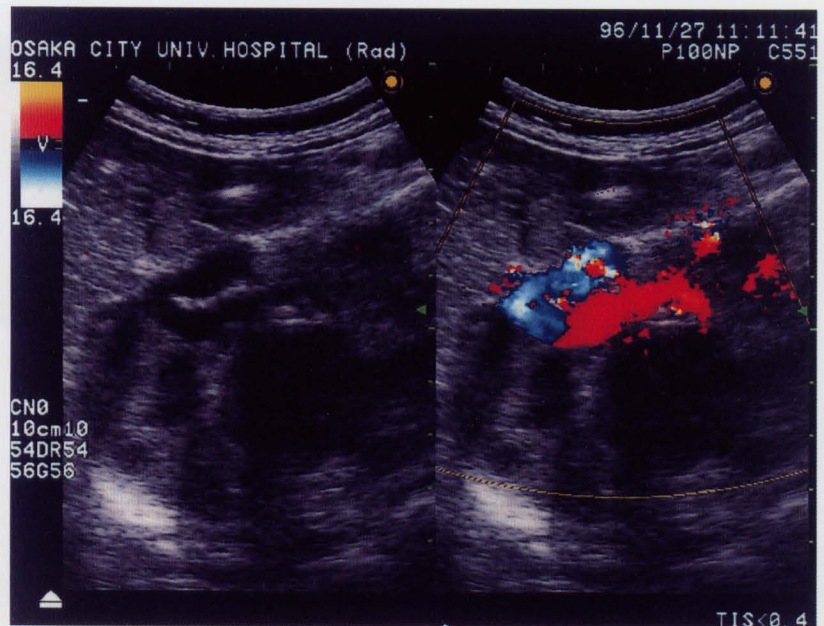


Fig. 2B

Fig. 2 A: Magnetic resonance image (patient 1) showing polysplenia and absence of the intrahepatic portal vein. B: Magnetic resonance angiography showing absence of the intrahepatic portal vein.

Fig. 4 Abdominal ultrasonography (patient 2) showing a splenorenal shunt.



Per-rectal measurement with Tc-99m pertechnetate^{3,15} or I-123 iodoamphetamine^{16,17} has been used in recent years. These radionuclides are absorbed well by the rectum,¹⁸ and, because their half-life is short, they can be used in large doses. We perform per-rectal portal scintigraphy with Tc-99m pertechnetate because I-123 iodoamphetamine is more expensive and harder to obtain than Tc-99m pertechnetate. When per-rectal portal scintigraphy is done in newborns, the patient must be given smaller amounts of radioisotope and air than would be used for an adult. Kato et al.¹⁹ reported doing per-rectal portal scintigraphy in a 2-year-old patient, but they used 37 MBq of I-123 iodoamphetamine, one-third the dose of 111 MBq for adults.^{16,17} In our study with Tc-99m pertechnetate, satisfactory images were obtained in patients 1–2 years old with 111 MBq, which is one-third the adult dose.³ For infants 1–3 months old, a dose of 37–74 MBq would probably have been adequate.

Although portosystemic shunt was detected in the 2 patients with a shunt index of 30% or more, it was not detected in 6 other patients with a shunt index lower than 30%. We reported that 195 of the 229 patients (85%) with a shunt index of 30% or more had esophageal varices but 10 of the 109 patients (9%) with a shunt index of less than 30% did not have the disease.¹⁵ The cumulative survival rate in the former group was much lower than in the latter group.¹⁵ Furthermore, children exhibit fatty degeneration of the liver resulting from malnutrition caused by portosystemic shunts, but it has been reported that liver function and fatty degeneration of the liver do not deteriorate during childhood if the shunt index is less than 30%.⁶

In conclusion, per-rectal portal scintigraphy with Tc-99m pertechnetate is noninvasive and the dose needed is small. This method was useful for the diagnosis of portosystemic shunts in newborns with galactosemia without enzyme deficiency.

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