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Evaluation of persistence of ductus venosus with Tc-99m DTPA galactosyl human serum albumin liver scintigraphy and I-123 iodoamphetamine per-rectal portal scintigraphy

Tomohiro KIRA,* Shinji IKEDA,** Yoshihisa SERA,** Seiji TOMIGUCHI,* Mutsumasa TAKAHASHI,* Takako UCHINO*** and Fumio ENDO***

*Departments of *Radiology, **Pediatric Surgery and ***Pediatrics, Kumamoto University School of Medicine*

Tc-99m DTPA galactosyl human serum albumin (Tc-99m GSA) hepatic scintigraphy was performed in two patients with patent ductus venosus before and after operation. To evaluate the portosystemic shunt flow, per-rectal portal scintigraphy with I-123 N-isopropyl-p-iodoamphetamine (IMP) was undergone in the same period. The portosystemic shunt indices (PSS index) were decreased from 67.9% to 7.3% in the patient 1, and from 77.3% to 22.7% in the patient 2, respectively. Quantitative indices of Tc-99m GSA hepatic scintigraphy improved dramatically in both patients. Under microscopic examination, nearly all the hepatic cells showed signs of severe fatty degeneration. After the operation, the severe fatty degeneration was alleviated and all the hepatic cells appeared normal. I-123 IMP per-rectal portal scintigraphy and Tc-99m GSA hepatic scintigraphy were useful in evaluating the quantitative shunt flow of the persistent ductus venosus and its hepatic functional reserve.

Key words: persistence of ductus venosus, Tc-99m DTPA galactosyl human serum albumin, per-rectal portal scintigraphy, I-123 iodoamphetamine

INTRODUCTION

THE DUCTUS VENOSUS is the continuation of the umbilical vein. It extends from the left portal vein to the inferior vena cava. During fetal life, the ductus venosus provides a bypass of the portal venous system for blood returning through the umbilical vein.[1] Both the ductus venosus and umbilical vein are usually obliterated and become fibrotic cords during early life.[2] Although various types of congenital portosystemic anastomosis have previously been reported,[3] there are few with a patent ductus venosus.[3–5]

We describe 2 patients with congenital portosystemic venous shunt due to a patent ductus venosus. To evaluate the changes in hepatic functional reserve and shunt flow caused by the treatment, Tc-99m GSA hepatic scintigraphy and I-123 IMP per-rectal scintigraphy were performed before and after surgery.

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For reprint contact: Tomohiro Kira, M.D., Department of Radiology, Kumamoto University School of Medicine, 1–1–1 Honjou, Kumamoto 860–8556, JAPAN.

PATIENTS AND METHODS

Two brothers who had a patent ductus venosus were studied. Patient 1 was a 3-year-old boy with hyperammonemia and unconsciousness.[6] So far he had developed well without any symptoms. Tc-99m GSA hepatic scintigraphy and per-rectal portal scintigraphy with I-123 IMP were performed before and 4 months after the operation. Patient 2 was a boy aged 5 months, who did not show any clinical symptoms. Tc-99m GSA hepatic scintigraphy and per-rectal portal scintigraphy were performed before and 1 month after the operation.

Tc-99m GSA hepatic scintigraphy

The patients were made to food fast before the test, and received 3 mg of Tc-99m GSA in 1 m*l* saline intravenously. After injection of 185 MBq Tc-99m GSA, sequential imaging was performed with the patient in the

Table 1 Changes of blood laboratory data before and after operation

	Patient 1			Patient 2	
	before	1 month	6 months	before	1 month
Blood ammonia (μmol/l)	94	37	39	66	31
GOT (u/l)	80	40	25	50	29
GPT (u/l)	52	37	15	17	11
Cholinesterase (u/l)	98	133	160	100	122
Platelets (counts/μl)	17.6	26.3	17.6	27.1	31.6

supine position under a large field-of-view gamma camera equipped with a low-energy high-resolution parallel-hole collimator (Toshiba GCA 90 B, Tokyo, Japan). The acquisition parameters included a 20% energy window and a peak at 140 keV. Sequential anterior abdominal images (64 × 64 matrix) including the heart and liver were acquired at 30 second intervals for 16 minutes. Digital data were collected in an on-line computer (Toshiba GSM 550U, Tokyo, Japan) simultaneously.

Data analysis was conducted by setting a region of interest (ROI) on both the liver and heart and then their time-activity curves were generated. Two ROIs were placed on the entire liver and on the entire heart in the sequential images. The following quantitative indices were calculated from the time-activity curves:

Blood clearance index, defined as the uptake ratio of the heart at 15 minutes to that at 3 minutes (HH15); and the hepatic accumulation index, defined as the uptake ratio of the liver to liver plus heart at 15 minutes (LHL15).

I-123 IMP per-rectal portal scintigraphy

With the patient in the left lateral decubitus position, a 10 Fr. catheter was inserted about 10–15 cm into the upper part of the rectum, and a 37 MBq of I-123 IMP was administered through the catheter. The residual I-123 IMP in the catheter was flushed out with air. The patient was placed in the supine position and the liver and lungs were included in the imaging field. Images were obtained by means of a gamma camera (Toshiba GCA-7200A, Tokyo, Japan), with a low-energy general-purpose parallel-hole collimator, 30 minutes after tracer administration. It took five minutes to obtain an image. Patients' data were collected and analyzed by means of an on-line computer (Toshiba GMS-5500A/DI, Tokyo, Japan). Three ROIs were placed on the whole liver and both lungs (Fig. 1). Another ROI was also placed on the mediastinum to measure background counts. The portosystemic shunt index (PSS index) was obtained by means of the following formula;

$$\text{PSS index} = C^*LU/(C^*LU + C^*LI) \times 100\ (\%)$$
$$C^*LU = CLU - CBG \times PLU/PBG$$
$$C^*LI = CLI - CBG \times PLI/PBG,$$

where CLU, CLI and CBG represent counts within ROIs of the lungs (CLU), liver (CLI) and background (CBG), respectively. PLU, PLI and PBG are the number of pixels in ROIs of the lungs (PLU), liver (PLI) and background (PBG), respectively.[7] If the border of the lung and liver was obscure, the border was defined with a Tc-99m GSA hepatic image.

Table 2 Changes of PSS index and Tc-99m GSA data

	Patient 1		Patient 2	
	before	6 months	before	1 month
PSS index (%)	67.9	7.3	77.3	22.7
HH15	0.661	0.357	0.627	0.460
LHL15	0.853	0.972	0.850	0.928

RESULTS

Blood laboratory data are shown in Table 1. The serum ammonia value was reduced after the operation in both patients. The hepatic transaminase value was also reduced, and the cholinesterase value and the number of platelets increased in both patients. The PSS index decreased from 67.9% to 7.3% in patient 1, and 77.3% to 22.7% in patient 2 (Table 2). The scintigraphic images of patient 1 are shown in Figure 2. Quantitative indices of Tc-99m GSA hepatic scintigraphy were greatly improved in both patients. HH15 decreased from 0.661 to 0.357 in patient 1 and from 0.627 to 0.460 in patient 2. LHL15 increased relatively from 0.853 to 0.972 in patient 1 and from 0.850 to 0.928 in patient 2 (Table 2). The Tc-99m GSA scintigraphic image of patient 1 is shown in Figure 3. The Tc-99m GSA scintigram showed improvement in liver accumulation and an increase in liver volume after the operation. Under microscopic examination, nearly all the hepatic cells showed signs of severe fatty degeneration before the operation. The hepatic architecture was normal, and there was no evidence of fibrosis or inflammation. After the operation, the severe fatty degeneration disappeared and all the hepatic cells appeared normal.

DISCUSSION

Patent ductus venosus is an infrequent anomaly observed in children. The diagnosis of this anomaly can be made with ultrasonography or portal angiography,[8] but it is difficult to quantify the rate of shunt flow and hepatic functional reserve. We reported two brothers with persis-

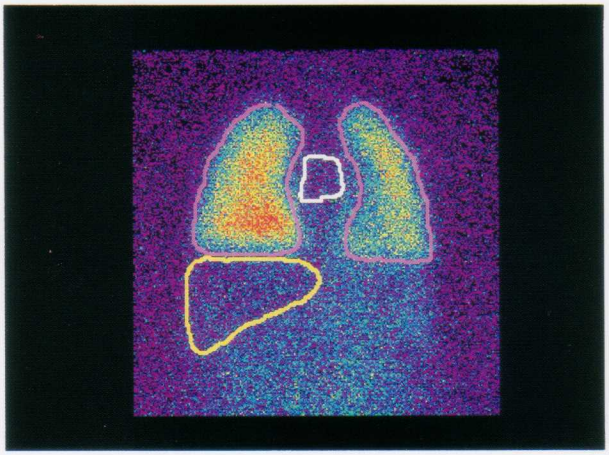

Fig. 1 Three ROIs were placed on the whole liver (yellow line), bilateral lungs (pink line). Another ROI was also placed on the mediastinum (white line) for measuring background counts.

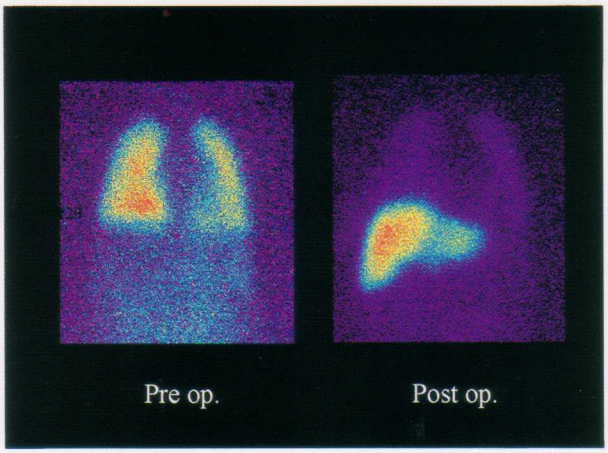

Fig. 2 ^{123}I-IMP per-rectal portal scintigraphy before and after operation in the patient 1. The radioactivity in the liver was very low and the border of the liver was obscure in pre-operation image (left). PSS index was 67.9%. In post-operation image, the radioactivity in the liver increased to almost normal level (right). PSS index was 7.3%.

tent ductus venosus, and evaluated the changes in shunt flow and hepatic functional reserve before and after the operation by means of noninvasive scintigraphic techniques.

PSS indices were reduced to normal after the operation in patient 1. In patient 2, the PSS index (22.7%) was not reduced as much as in patient 1, probably because ligation of the ductus venosus was incomplete, and gradual obstruction of the duct would continue. Per-rectal portal scintigraphy in patient 2 was undergone 1 month after the operation. Therefore, it may be too early to confirm the effect of the operation in patient 2.

Tc-99m GSA hepatic scintigraphy showed a moderate reduction in hepatic functional reserve in both patients

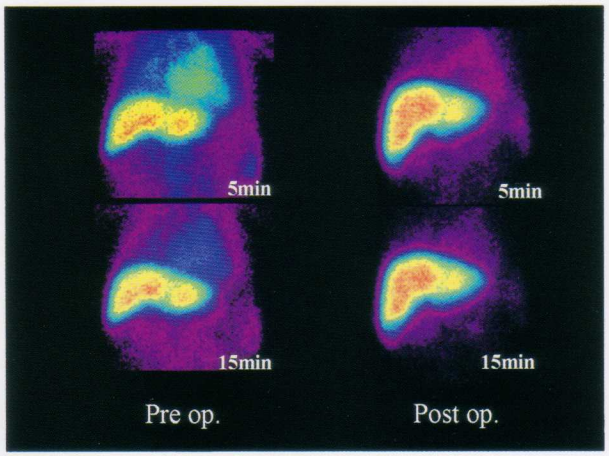

Fig. 3 ^{99m}Tc-GSA scintigraphic images before and after operation in the patient 1. The ^{99m}Tc-GSA scintigram showed improvement in liver accumulation and increase in liver volume after operation.

before the operation, and restoration to normal after the operation. Histological findings were consistent with the scintigraphic results. All the hepatic cells were normal even in patient 2 who was operated on only one month earlier. We could confirm the increase in hepatic volume in Tc-99m GSA scintigraphic images after the operation. We thought it was caused by the improvement in portal blood flow in the liver.

In conclusion, I-123 IMP per-rectal portal scintigraphy and Tc-99m GSA hepatic scintigraphy were useful to evaluate the quantitative shunt flow in persistent ductus venosus and its hepatic functional reserve.

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