Intrahepatic Venous and Portal Venous Aneurysms Examined by Color Doppler Flow Imaging

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Abstract: Thirteen cases with liver cystic lesions, which were suspected to communicate with intrahepatic vessels on the basis of ordinary sonography, were examined by color Doppler flow imaging. By this method, blood flow within the cystic lesion was detected in 5 of these cases, and the communication to the intrahepatic vessel confirmed. Information about the hemodynamics of aneurysms was obtained. Two of these lesions were diagnosed as an aneurysmal porta-hepatic venous fistula, another 2 as a portal venous aneurysm, and the remaining 1 as a hepatic venous aneurysm.

Indexing Words: Color Doppler flow imaging • Intrahepatic aneurysm • Venous aneurysm • Portal venous aneurysm • Aneurysmal porta-hepatic venous fistula

Aneurysmal porta-hepatic venous fistula is a rare disease with no more than 20 cases reported to date in the literature. Previously, it was diagnosed by autopsy or angiography, but subsequently a number of reports have described detection by CT or diagnosis by sonography. With ordinary sonography, it is not always easy to determine whether or not the intrahepatic cystic lesion communicates with neighboring vessels. In the present study, detailed examination by color Doppler flow imaging was performed on cases with an intrahepatic cystic lesion suspected to communicate with the intrahepatic vessel on the basis of ordinary sonography. By this method, the presence or absence of blood flow within the cystic lesion was clearly distinguished and an accurate diagnosis of aneurysm was made. Also, information not available by angiography, such as development of turbulent flow at the shunt site and changes in the flow velocity pattern, was obtained noninvasively.

SUBJECTS AND METHODS

The subjects of the present study were 13 patients in whom an intrahepatic cystic lesion was detected and suspected of communicating with the intrahepatic vessel on the basis of routine sonography. Of these 13 cases, 12 patients had chronic hepatitis or liver cirrhosis. There were no cases with hepatic encephalopathy, and none of them had a history of liver biopsy.

For the Doppler examination, a Toshiba SSA270A (Tokyo, Japan) with a 3.75 MHz sector probe and a Aloka SSD680 (Tokyo, Japan) with a 3.5 MHz convex probe were used.

The slowest blood flow velocity that theoretically could be shown in color was 3 cm/sec, and the frame rate employed was 3/sec to 5/sec.

A thorough examination was performed by ordinary sonography to elucidate the relationship of the cystic lesion to the intrahepatic vessel, followed by display of the blood flow by color Doppler flow imaging. Furthermore, using the upstream side of the inflow vessel to the aneurysm, inflow site, aneurysmal interior, outflow site, and downstream side of the drainage vessel as sampling points, the flow velocity pattern of the blood flow at each site was determined.
RESULTS

When thoroughly examined, the ordinary sonogram revealed an evident communication with the intrahepatic portal vein in 2 cases, communication with the hepatic vein in 1 case and an aneurysmal porta-hepatic venous shunt in 1 case. In 1 of the remaining 9 cases, the cystic lesion was revealed to be a localized dilatation of the intrahepatic bile duct, and communication with the blood vessel could be ruled out. In the other 8 cases, communication with the vein or portal vein running near the cystic lesion was suspected, but this was not evident.

In the examination using the Doppler technique, color display of the cystic lesion and a stable flow velocity pattern at that site was achieved in a total of 5 cases; that is, in 4 cases in which communication with the blood vessels was evident from the ordinary sonogram and in 1 of 8 cases in which a communication was suspected.

Aneurysmal Portahepatic Venous Fistula

A portal aneurysm accompanied by shunt to the hepatic vein was observed in 2 cases with liver cirrhosis.

Case 1 was an aneurysm, 5 cm in diameter, communicating with P₈ (the anterior-superior branch of portal vein) and the right hepatic vein. Because a liver tumor was suspected on the basis of a CT scan performed at an outpatient clinic, this case was referred to our hospital for detailed examination. Routine sonography revealed an evident communication with the portal vein and hepatic vein (Figures 1A and 1B). By color Doppler flow imaging, color display of the blood flow into the aneurysm from the branch of the P₈ was obtained and the turbulent flow within the aneurysm detected from a mixture of colors indicating blood flow toward and away from the probe (Figure 1C). Color display of the flow of blood from the aneurysm to the dilated hepatic vein (Fig. 1D) was also obtained.

In examining the flow velocity patterns, on the upstream side of the portal vein communicating with the aneurysm and at the inflow site, there was no constant waveform as is usually observed in the portal vein, but a biphasic wave pattern with 2 peaks during cardiac cycle was observed (Figures 1C and 1E). Furthermore, turbulent flow was noted within the aneurysm, but at the outflow site a laminar flow showing a normal flow velocity pattern of the hepatic vein was observed (Figures 1D and 1E).

In the Case 2, a shunt was observed between P₆ (the posterior-inferior branch of portal vein) and the right hepatic vein, with 3 aneurysms, 1 cm in diameter, near the surface of the right lobe of the liver. The diagnosis of this case had been confirmed by angiography, and a case report presented previously, but sonography of this case was ordered for follow-up observation. By routine sonography, a communication with only the dilated right hepatic vein was detected (Figures 2A and 2B), but color Doppler flow imaging permitted color display of the blood flow from the branch of P₆ to the aneurysm, turbulence of the blood flow within the aneurysm, and the flow into the right hepatic vein (Figures 2C and 2D). The flow velocity pattern at each site is shown in Figure 2E. As in Case 1, on the upstream side of the portal vein and at the inflow site into the aneurysm, laminar flow showing a biphasic velocity pattern was noted. Within the aneurysm, turbulent flow was observed and on the venous side or outflow, a laminar flow representing a normal hepatic vein wave pattern was seen.

Intrahepatic Venous Aneurysm

In 1 patient (Case 3) who entered our hospital for a thorough medical examination, an intrahepatic venous aneurysm without shunt was observed. A part of the left hepatic vein protruded like a diverticulum, 1 cm in diameter. Ordinary sonography was unable to confirm the communication with the hepatic vein (Figure 3A). CT failed to detect any localized lesion. By color Doppler flow imaging, a continuous color display of the left hepatic vein and only during the diastolic phase, of the cystic lesion was obtained. The presence of a venous aneurysm thus became evident. Furthermore, the flow velocity pattern of the left hepatic vein was an ordinary venous pattern at all points upstream and downstream from the aneurysm (Figure 3B).

Intrahepatic Portal Aneurysm

There were 2 cases of intrahepatic portal aneurysm without shunt, 1 case with liver cirrhosis and another with chronic hepatitis. The location and diameter of the aneurysms were 2.5 cm at P₆ (Case 4) and 2 cm at P₇ (posterior-superior branch of the portal vein) (Case 5). In both cases communication with the portal vein was evident by ordinary sonography (Figure 4A); also in both cases the cystic space was visualized with plain CT scanning and enhanced by contrast. The former case was diagnosed as a portal aneurysm,
FIGURE 1. Aneurysmal porta-hepatic venous fistula (Case 1). (C) Color Doppler imaging revealed the blood flow that runs straight into the aneurysm and is turbulent within the aneurysm. (A: aneurysm.)

FIGURE 2. Aneurysmal porta-hepatic venous fistula (Case 2). The blood flow that runs into the aneurysm from the branch of \( P_\alpha \) (C) and the turbulent flow within the aneurysm (D) are shown by color Doppler flow imaging. (P: portal branch.)

FIGURE 3. Intrahepatic venous aneurysm (Case 3). (B) On color flow imaging, both the cystic lesion and mid-hepatic vein are shown in color.

FIGURE 4. Intrahepatic portal aneurysm (Case 5). Color Doppler flow imaging reveals the circulating wave within the aneurysm (B) and fine outflow paths (arrows) (C). (P: portal branch.)
FIGURE 1. Aneurysmal porta-hepatic venous fistula (Case 1). A cystic lesion that communicates with the portal branch (A) and the right hepatic vein (B) is shown on ordinary sonograms. (A: aneurysm, P: portal branch, RHV: right hepatic vein.)
FIGURE 1. Aneurysmal porto-hepatic venous fistula (Case 1). (D) Blood flow runs out to the dilated hepatic vein from the aneurysm (see Fig. 1C).
(E) Schematic presentation of flow velocity pattern. (A: aneurysm, RVH: right hepatic vein.)
FIGURE 2. Aneurysmal porta-hepatic venous fistula (Case 2). Three cystic lesions about 1 cm in diameter are visualized near the surface of the right lobe of the liver (A). These cystic lesions definitely communicate with the dilated right hepatic vein (B), but the communication with the portal branch cannot be clearly visualized (A) by ordinary sonography. (P: portal branch, RHV: right hepatic vein.)
while the latter case was misread with CT as a section of the hepatic vein.

The findings of the color Doppler flow imaging in both cases were as follows: a directional color display of the flow into the aneurysm from the proximal portal vein was observed. When the flow reached the contralateral wall of the aneurysm, the direction changed to make it flow along the wall and flow out to the portal branches, indicating a circular flow (Figure 4B). It was possible to make a color display of the minute portal branches corresponding to the outflow paths, which could not be visualized by ordinary sonography (Figures 4B and 4C). In examining the flow velocity pattern (Figure 4D), a constant wave pattern such as is usually seen in the portal vessel was observed at all points of the inflow, within the aneurysm, and in the outflow.

Others

In the 8 remaining cases, including the localized bile duct dilatation case, blood flow through the cystic lesions could not be detected with the Doppler apparatus.

By CT, 4 of these lesions were visualized as nonenhanced, low-density areas and diagnosed as simple cysts. In the remaining 4 cases, no localized lesion was detected by CT.

**DISCUSSION**

Cystic lesions of the liver are often encountered, and for the treatment of liver cyst, an ultrasonically guided ethanol injection is sometimes carried out. However, rarely, a case with intrahepatic aneurysm may be treated in this manner. In the present study, 5 of 13 cases with intrahepatic cystic lesion were diagnosed as so-called aneurysm with communication to intrahepatic vessels. It is necessary to rule out communication with a blood vessel by color Doppler flow imaging before the injection of a drug into the cystic lesion, because communication with blood vessels cannot always be ruled out by ordinary sonography.

There have been few reports on intrahepatic venous aneurysm. Perhaps this is because the pathological significance of this vascular disturbance is low and because hepatic venography is a rare examination performed only in detailed studies of other diseases. In the present investi-
Intrahepatic venous aneurysm (case 3). (A) A cystic lesion 1 cm in diameter is shown near the gallbladder. (MHV: mid-hepatic vein.)

In the 2 cases of intrahepatic portal aneurysm, it was relatively easy to confirm the communication with the portal vessel by sonography, but it was not possible to obtain a tomogram along the fistula by CT. In one case an erroneous interpretation was made regarding the image of this program to be a section of the hepatic vein. The blood flow within the portal aneurysm circulated along the aneurysmal wall, but the flow velocity pattern was the same as that observed in the normal portal vein without any flow turbulence. Since observation of circulating flow within a portal aneurysm is difficult even by portography, it was hardly ever been reported in the literature.

In the present study, aneurysmal portohepatic venous fistula, which is considered a rare disease, was encountered in 2 cases. There are some reports\textsuperscript{6,9–11,13} of diagnosis of this disease by ordinary sonography. In our experience, in the case of aneurysms as large as 5 cm in diameter, the fistula can be visualized easily by ordinary sonography, but in the case of relatively small aneurysms of 1 cm in diameter, it is difficult to visualize the communication. Takayasu et al.\textsuperscript{5} have reported a case of aneurysmal portohepatic venous shunt diagnosed by dynamic CT, which was first suspected to be a liver tumor by plain and enhanced CT. In our first case, a liver tumor was also suspected on the basis of a CT scan conducted at an outpatient clinic. Hypervasculaity is readily detected by CT through contrast enhancement. However, it can be said that sonography is superior for differentiating the aneurysm from a solid tumor and visualizing the fistula by making a tomogram along the vessel.

By color Doppler flow imaging, turbulent flow was observed within the aneurysm with P-V shunt in both of the cases. In cases of venous aneurysm and portal venous aneurysm without a shunt examined in the present study, no turbulent flow was detected. It is, therefore, considered that turbulent flow is a finding suggestive of the presence of a shunt.

On the portal vein side of the inflow site of the aneurysm, a biphasic wave flow velocity pattern...
FIGURE 4. Intrahepatic portal aneurysm (Case 5). (A) Communication of the branch of B, to the cystic lesion is clearly visualized by ordinary sonography. (A: aneurysm, P: portal branch.) (D) Schematic presentation of the flow velocity pattern.
was commonly observed in 2 cases. This specific flow velocity pattern probably resulted from the mutual effects of intraluminal pressure of the portal vein and hepatic vein. This flow velocity pattern observed on the portal vein side resembles the pulsating flow seen in the hepatic vein rather than the constant flow usually noted in the portal vein, suggesting that the effect of the hepatic vein flow is greater. Ikeda et al.\textsuperscript{13} reported that, in the case of an intrahepatic portohepatic venous shunt, constant flow was observed both in the portal vein at the inflow site and in the hepatic vein at the outflow site. However, since the internal pressure difference during the cardiac cycle is larger in the hepatic vein than in the portal vein, it is reasonable to assume that the effect of the hepatic vein is larger when the communication is adequate.

With the development of color Doppler flow imaging scanners for exclusive use in the abdominal region, it has become possible to obtain a color display of even minute blood vessels with relatively slow flow and to apply this technology to the diagnosis of small tumors of the liver such as hepatocellular carcinoma and hemangioma.\textsuperscript{14} However, it cannot be said that the function of the present scanners permits a consistently stable display of minute tumorous blood vessels. Nonetheless, for the blood vessel abnormalities examined in the present study, it was possible to make an adequate color display of the blood flow in the lesion and to ascertain the hemodynamics from the flow velocity pattern. In particular, aneurysms with shunt are clearly visualized by color Doppler because the flow velocity at the shunt is relatively high even with a fine fistula. The procedure is extremely useful since it permits us to obtain, noninvasively, far more physical information than can be obtained by angiography.

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REFERENCES