

## LIVER PATHOPHYSIOLOGY, REGENERATION, CYTOKINES

### Altered intrahepatic pathway of para-umbilical vein in portal hypertension

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**Abstract** The object of this study was to determine the frequency and characteristics of altered para-umbilical vein in the hepatic parenchyma, developed from portal hypertension, using computed tomography (CT). Two hundred and ninety-two patients who presented with portal hypertension from 1986 to 1996 were studied retrospectively. The pathway of the dilated para-umbilical vein was demonstrated by contrast-enhanced CT. Thirty-one (11%) patients had a dilated para-umbilical vein arising from the left portal vein into the falciform ligament. In 24 (77%) of these patients, the para-umbilical vein followed the expected route, passing through the fissure of ligamentum teres hepatis. The remaining seven patients (23%) displayed the unusual pathway, with the vein arising from the left branch of the portal vein and passing into the hepatic parenchyma. In these seven patients, four had one collateral vein, and three patients had two collateral veins in the liver parenchyma. The dilated para-umbilical vein frequently passes through the hepatic parenchyma in patients with portal hypertension.

**Key words:** intrahepatic pathway, para-umbilical vein, portal hypertension.

## INTRODUCTION

Numerous portosystemic collateral pathways have been found in patients with portal hypertension.<sup>1–4</sup> The vessel in the falciform ligament frequently developed in portal hypertension is traditionally presumed to be a recanalized umbilical vein,<sup>5</sup> but this shunt vein is probably more accurately referred to as a para-umbilical vein.<sup>6</sup> Accordingly, we have used the term para-umbilical vein in this study.

The pathway of the para-umbilical vein is clearly demonstrated by radiological imaging studies such as contrast-enhanced computed tomography (CT)<sup>3,7,8</sup> and colour Doppler sonography.<sup>9,10</sup> The para-umbilical vein usually arises from the umbilical portion of the left portal vein and passes through the fissure of ligamentum teres hepatis. Few reports have demonstrated the collateral shunt vein having an altered pathway in the hepatic parenchyma and draining into para-umbilical vein in falciform ligament,<sup>7,9</sup> but the frequency of the altered pathway and the findings of contrast-enhanced CT are not well documented. The aim of this study was

to determine the frequency and characteristics of altered para-umbilical vein in hepatic parenchyma, developed by portal hypertension, using contrast-enhanced CT.

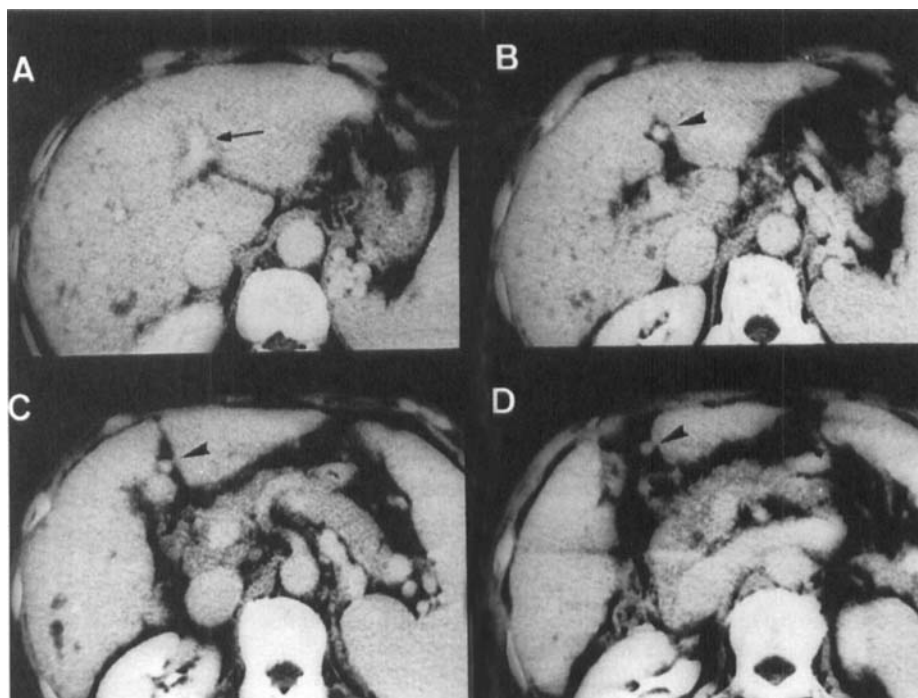
## METHODS

### Subjects

All patients with chronic liver diseases who were admitted to Asahikawa Medical College Hospital from April 1986 to December 1996, were retrospectively studied. Diagnosis of diffuse liver disease was obtained by laparoscopic and histological findings of the liver as described previously<sup>11</sup> and diagnosis of portal hypertension was obtained by the presence of splenomegaly and thrombocytopenia. Patients with haematological disorders were excluded from the study. Hepatocellular carcinoma (HCC) was diagnosed by angiographic findings and by elevated levels of serum tumour markers,  $\alpha$ -fetoprotein (AFP) and/or protein induced by vitamin K absence or antagonism II (PIVKA-II).

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**Figure 1** Contrast-enhanced computed tomography (CT) findings of the typical route of the para-umbilical vein. (a) The para-umbilical vein (arrowhead) arising from the left portal vein (arrow) runs through (b–d) the fissure of the ligamentum teres hepatis. The underlying disease was viral liver cirrhosis with polycystic liver.

Two hundred and ninety-two patients, 181 men and 111 women with a median age of 54 years (range 32–83 years) had been diagnosed with portal hypertension. Of these patients, 135 had HCC associated with liver cirrhosis, 102 had liver cirrhosis (LC), 14 had idiopathic portal hypertension (IPH) and 41 had primary biliary cirrhosis (PBC). Gastro-oesophageal varices, one of the signs of portal hypertension, were evident in 46 patients with HCC (34%), 32 with LC (31%), 16 with PBC (39%), and 13 with IPH (93%).

Patients were examined by plain and contrast-enhanced CT. Scans were obtained from the dome of the diaphragm, through the liver to the umbilicus. Either a 10 mm, 8 mm or 4 mm collimator was used for scanning.

The dilated para-umbilical vein was identified as a tubular structure which showed contrast enhancement at the portal phase by CT. Serial sections showed that the para-umbilical vein connected to the umbilical portion of the portal vein. In this study, a para-umbilical vein  $\geq 3$  mm in diameter was required for detection. Contrast enhancement did not clarify para-umbilical veins with a diameter  $< 3$  mm.

## RESULTS

In 292 patients with portal hypertension, 31 patients (11%), 18 men and 13 women, had a visible para-umbilical vein arising from the umbilical portion of the left portal vein. The underlying liver diseases in these patients were HCC (six), LC (20), IPH (three) and PBC (two). Seventeen patients (55%) had gastro-oesophageal varices and six (19%) had other portosystemic shunt veins.

In 24 of these 31 patients (77%), the para-umbilical vein followed a typical route, with the vein originating

from the umbilical portion of the left portal vein and passing through the fissure of ligamentum teres hepatis into the falciform ligament towards the umbilicus (Fig. 1). The mean diameter of para-umbilical veins with this typical route was 8 mm (range 3–18 mm).

In contrast, the para-umbilical vein in the remaining seven patients (23%) had an altered pathway (Table 1). In these patients, the para-umbilical vein arose from the umbilical portion of the left portal vein, but did not run through the fissure of ligamentum teres hepatis. Instead, a collateral vein ran into the hepatic parenchyma of the medial segment and reached to the ventral surface of the liver, connecting with the para-umbilical vein in the falciform ligament (Figs 2–4). The diameter of altered para-umbilical veins was 7–15 mm (Table 1). There was no difference in size between altered and classical para-umbilical veins.

In the seven patients with an altered para-umbilical vein, four patients had one collateral vein (Fig. 2) and three patients had two collateral veins (Figs 3,4) in the hepatic parenchyma. In patients 6 and 7, the two collateral veins both originated from the left portal vein, passed through the medial segment and connected together within the same segment, making a single para-umbilical vein (Fig. 3). The para-umbilical vein in patient 5 followed a rare pathway: one collateral vein arose from the left portal vein into the medial segment and the other originated from the right portal vein and towards the medial segment (Fig. 4). These two collaterals joined together in the medial segment and formed one para-umbilical vein.

## DISCUSSION

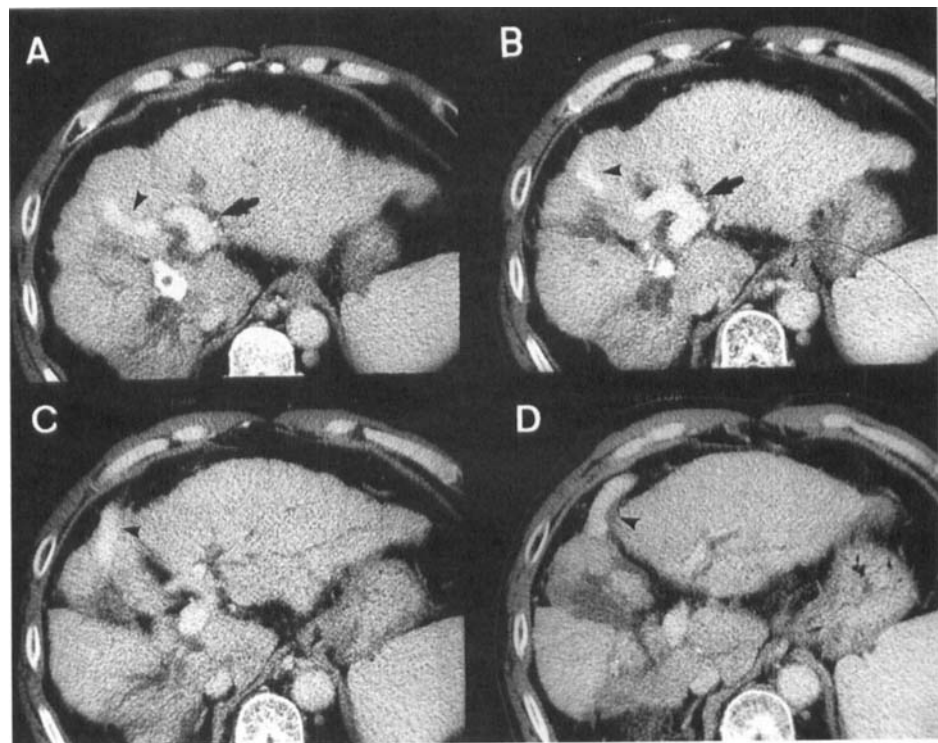
In the present study, 11% of the patients with portal hypertension had a visible para-umbilical vein as

**Table 1** Patients who had an altered para-umbilical vein

| Patient | Age/sex | Underlying liver disease | Stage of liver disease* | Number | Para-umbilical vein Location | Diameter (mm) |
|---------|---------|--------------------------|-------------------------|--------|------------------------------|---------------|
| 1       | 62/M    | HCC, C-LC                | B                       | 1      | S4                           | 10            |
| 2       | 35/M    | B-LC                     | B                       | 1      | S4                           | 15            |
| 3       | 61/M    | C-LC                     | B                       | 1      | S4                           | 15            |
| 4       | 47/M    | HCC, B-LC                | B                       | 1      | S4                           | 7             |
| 5       | 50/F    | HCC, C-LC                | B                       | 2      | S4, S4                       | 10            |
| 6       | 48/F    | PBC                      | A                       | 2      | S4, S4                       | 7             |
| 7       | 62/M    | C-LC                     | A                       | 2      | S4, S4                       | 10            |

HCC, hepatocellular carcinoma; C-LC, hepatitis C virus-positive liver cirrhosis; B-LC, hepatitis B virus-positive liver cirrhosis; PBC, primary biliary cirrhosis; S4, medial segment.

\* According to Child-Pugh's classification.



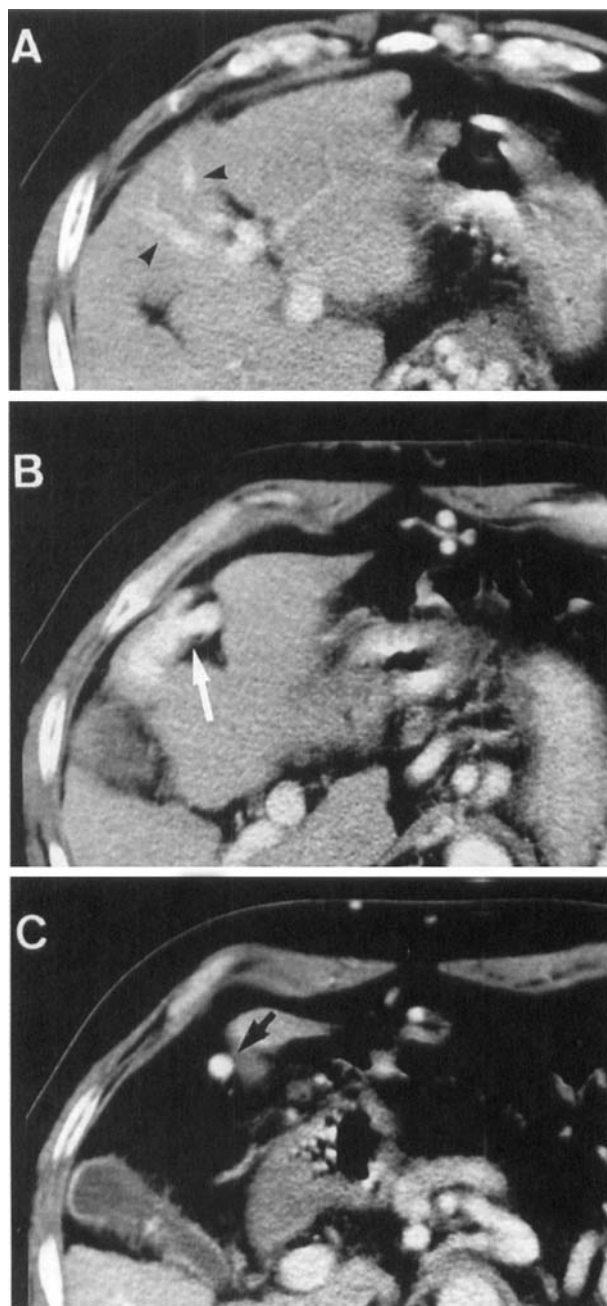
**Figure 2** Contrast-enhanced computed tomography (CT) findings of case 1. (a,b) Single collateral vein (arrowhead) originating from the left portal vein (arrow) passes through the medial segment of the liver and (c,d) reaches to the hepatic surface without passing through the fissure of ligamentum.

demonstrated by contrast-enhanced CT. This result is compatible with previous reports that a dilated para-umbilical vein is recognized in 10–29% of the patients with portal hypertension.<sup>1–3,5,10</sup> This portosystemic collateral vein usually pass through the fissure of ligamentum teres into the falciform ligament. Some recent reports have shown that the abnormal para-umbilical vein is located in the hepatic parenchyma, not in the fissure of ligamentum teres.<sup>7,9</sup> Several imaging techniques, including contrast-enhanced CT and colour Doppler sonography can detect collateral blood flow in the hepatic parenchyma. Colour Doppler sonography is a good technique with high sensitivity for detecting small amounts of blood flow in the liver.<sup>9,10</sup> However, the proficiency of the operators may affect the frequency of detection of altered para-umbilical veins. Therefore, in this study, we used contrast-enhanced CT

performed by special technicians from the Radiology Unit, Asahikawa Medical College to locate the para-umbilical vein.

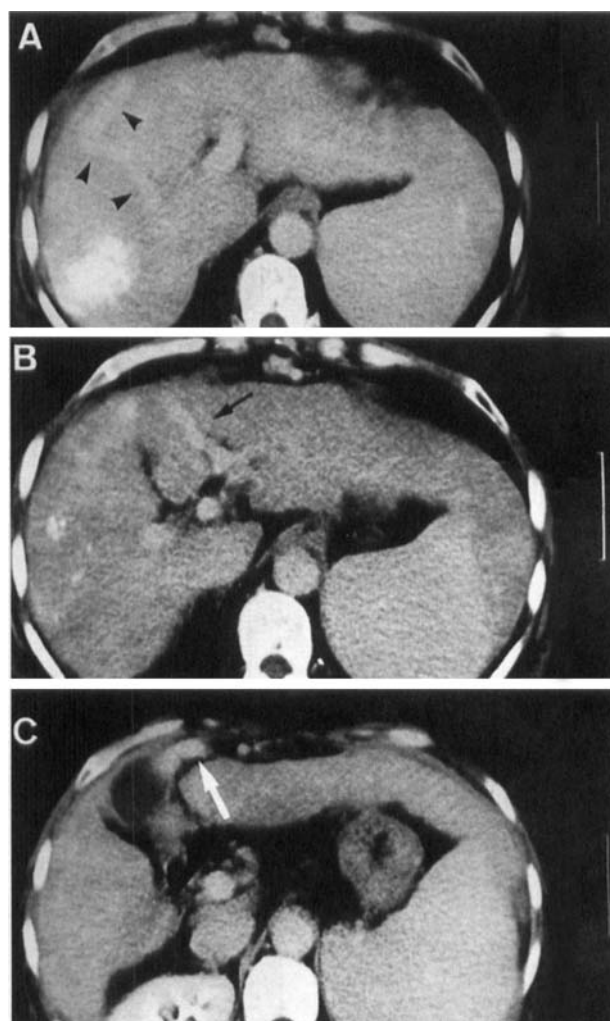
We demonstrated that the para-umbilical vein followed a classical pathway in 24 of the 31 patients in whom the para-umbilical vein was detected (77%). The para-umbilical vein followed an unusual intrahepatic route in the remaining seven cases (23%) in which it was detected. In previous reports, the intrahepatic para-umbilical vein was mostly located in the medial segment<sup>7,9</sup> except for one case in which the altered vessel passed through the lateral segment.<sup>10</sup> In the present cases, all portosystemic collaterals were found in the medial segment.

In most cases, only one para-umbilical vein was found,<sup>1–6</sup> although some patients had plural shunt veins. Sugiura *et al.*<sup>9</sup> observed that 34% of 41 patients with



**Figure 3** Contrast-enhanced computed tomography (CT) findings of case 7. (a) Two collaterals (arrowhead) from the left portal vein pass through the medial segment of the liver (b) and join together in the hepatic parenchyma (white arrow), (c) forming a single para-umbilical vein (black arrow).

dilated para-umbilical vein had multiple collateral veins in the hepatic parenchyma. In this study, three patients (43%) had two intrahepatic collateral veins. In patients 6 and 7, two collateral veins arose from the left portal vein and passed through the medial segment. Patient 5 had one collateral vein, which originated from the right portal vein, although the other para-umbilical vein arose from the left portal vein. This finding has not been previously reported in the literature. In these three cases,



**Figure 4** Contrast-enhanced computed tomography (CT) findings of case 5. (a) Unusual intrahepatic collateral vein originating from the right portal vein (arrowhead) runs antero-medially in the hepatic parenchyma. (b) This shunt vein joins with the collateral vein from the left portal vein (black arrow) in the medial segment of the liver (c) and forms one para-umbilical vein (white arrow).

the two collateral veins connected together in the medial segment and formed a single para-umbilical vein which appeared at the hepatic ventral surface and progressed towards the umbilicus.

There is, as yet, no reasonable embryological or other aetiological mechanism to explain the development of the altered para-umbilical vein in the hepatic parenchyma. From an histological study, Lafortune *et al.*<sup>6</sup> showed that the dilated vein in portal hypertension was a para-umbilical vein rather than a reopened umbilical vein in the falciform ligament. They demonstrated that the normal falciform ligament contained one to three tiny collapsed para-umbilical veins and that the number and calibre of the para-umbilical veins increased in the presence of portal hypertension.<sup>6</sup> We suggest that a similar mechanism is responsible for the formation of the altered para-umbilical vein in hepatic

parenchyma. Embryologically residual veins in the hepatic parenchyma, such as a tiny para-umbilical vein in the ligamentum teres hepatis, may form the collateral veins which pass through the hepatic parenchyma. The paired umbilical vein is observed in the early stage of the embryo and the right umbilical vein disappears during normal development.<sup>12</sup> The para-umbilical vein arising from the right portal vein detected in patient 5, may be formed by the embryologically residual vein around the atrophied right umbilical vein.

A para-umbilical vein passing through the hepatic parenchyma is recognized as an abnormal tubular structure by radiological imagings such as CT and sonography. In the liver, however, the portal and hepatic veins demonstrate tubular structures containing blood flow under normal conditions and dilated bile ducts and other shunt veins are observed in pathological states.<sup>13-15</sup> Therefore, differential diagnosis is required to distinguish the para-umbilical vein from other tubular structures. It is necessary to consider the possibility of the presence of the para-umbilical vein in hepatic parenchyma and to detect the connection with the portal vein by radiological methods such as CT and sonography.

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