Splenoprtography in Idiopathic Splenomegaly
(So-called Banti’s Syndrome)

Toshio Sato, Kenji Koyama, Yasuo Suda and Kenichi Watanabe

Department of Surgery (Prof. T. Maki),
Tohoku University School of Medicine, Sendai

Splenoprtography obtained from 71 patients with idiopathic splenomegaly
(so-called Banti’s syndrome) was examined in relation to the portal pressure and
the extent of extrahepatic shunt. It was noted that in patients with increased
portal pressure, collateral channels were visualized; the splenic vein was curved
or tortuous; the sum of the length of the splenic vein and that of the portal trunk
was increased; the junction of the splenic vein with the portal vein was shifted to
the right; and visualization of intrahepatic branches of the portal vein was
impaired. It is therefore possible from the findings in splenoportography to
estimate the degree of portal hypertension.

Hepatofugal collateral channels consisted most often of ascending channels
through the both right and left gastric veins and the esophageal vein. In the
majority of patients in whom ascending collateral channels were demonstrated
in splenoportography, esophageal varices were detected in x-ray films with barium
meal. Extrahepatic shunt measured with RISA was correlated well with the
extent of collateral channels in splenoportography and proved to be useful in
quantitative evaluation of collateral circulation.

When the enlarged spleen in so-called Banti’s syndrome is thoroughly examin-
ed, it becomes readily conceivable, that there are many features which cannot be
accounted for by the notion that portal hypertension per se leads to splenomegaly.
In the presence of splenomegaly, there is seen proliferation of pulp cords and
sinuses, which cannot be explained as the result of congestion alone. It was also
shown in our experimental study on dogs as published previously1,2 that partial
constriction of the splenic vein failed to produce splenomegaly with proliferation of
pulp cords and sinuses. Moreover, there are cases in which portal hypertension is
not present but the spleen shows all the features similar to those seen in
splenomegaly with portal hypertension.3 These facts have led us to assume the
presence of an initial preparatory conditions in the spleen which induce spleno-
megaly by the aid of portal hypertension. The clinical condition with splenomegaly
thus produced has widely been called Banti’s syndrome in memory of Banti who
described the condition originally. The precise nature of preparatory conditions,
however, remains still obscure It would be, therefore, appropriate to designate
this type of splenomegaly as idiopathic splenomegaly.

It is generally accepted that splenoportography is one of the procedures that

Received for publication, November 13, 1968.

161
are of great help in diagnosis of hepatic and pancreatic diseases. In portal hypertension, it often plays a decisive role in diagnosing the disease and deciding the method of operation. It is the purpose of this paper to report on the results of splenoportography in patients with idiopathic splenomegaly (so-called Banti's syndrome), with special reference to findings of intra- and extrahepatic portal branches and their relations with the portal pressure and extrahepatic shunts.

**Materials and Methods**

Among the splenoportographic pictures taken from the patients with idiopathic splenomegaly, those obtained from 71 patients were satisfactory in quality and were selected for the present study.

1) *Method of splenoportography.* Through a needle inserted into the spleen at 9th or 10th intercostal space on the posterior axillary line of the patient in supine position, 40 ml of 76% Urokinol® or 80% Angio-Conray® was injected. Immediately before the termination of the injection, an anteroposterior roentgenogram was taken.

2) *Measurement of extrahepatic shunt.* Through a needle with a caliber of 0.5 mm inserted percutaneously into the spleen, 50 to 80 microcuries of RISA in 2 ml of normal saline was injected. For one minute after the injection, blood samples were taken from the femoral artery every 3 seconds. Radioactivity of 1 ml of each serum sample were measured with a well-type scintillation counter and plotted against time. Extrahepatic shunt was calculated by the method of Nakamura et al.4 from the curve of radioactivity obtained.

3) *Method of measurement of the portal pressure.* A catheter with a diameter of 2 mm was inserted through a branch of superior mesenteric vein into the portal trunk at the time of laparotomy and the portal pressure was measured using a water manometer.

**Results**

*Splenoportographic pictures*

1) *Visualization of intrahepatic portal branches.* The picture of intrahepatic portal branches differed considerably in each case. In some cases they were almost normal in the way of branching and in their courses, while in others abrupt narrowing or interruption of the branches were noted.

In the present study, visualization of the intrahepatic portal branches was divided into the following 6 grades: In Grade 0, the intrahepatic portal branches were not at all or only faintly visualized (Fig. 1). In Grade 1, the first branches were clearly visualized but the second branches were abruptly narrowed to less than 1 mm in diameter or disappeared completely (Fig. 2). In Grade 2, the second branches were clearly visualized but the third branches were narrowed abruptly to less than 1 mm in diameter or disappeared completely (Fig. 3). Depending upon the visualization of the fourth, fifth and sixth branches, they were graded as Grade 3, 4 and 5 respectively (Figs. 4–6).

When the pictures obtained in 67 patients were graded according to the above criteria, visualization of grade 3 was most frequent (in 24 cases) as is shown in Table 1, followed by that of Grade 4 in 12 patients. Namely, in idiopathic splenomegaly, abrupt narrowing or non-visualization of the 4th and 5th
Fig. 1. Grade 0 of visualization. Intrahepatic portal branches are only faintly visualized, and the collateral channel in the gastric vein is demonstrated. Portal pressure, 380 mm H$_2$O.

Fig. 2. Grade 1 of visualization. The second branches of intrahepatic portal vein disappear completely. Portal pressure, 340 mm H$_2$O.

Fig. 3. Grade 2 of visualization. The third branches of intrahepatic portal vein narrow abruptly, and the collateral channel in the umbilical vein is demonstrated. Portal pressure, 410 mm H$_2$O.
Fig. 4. Grade 3 of visualization. The fourth branches of intrahepatic portal vein are not demonstrated. Portal pressure, 380 mm H₂O.

Fig. 5. Grade 4 of visualization. The fifth branches of portal vein narrow abruptly, and no collateral circulation is demonstrated. Portal pressure, 290 mm H₂O.

Fig. 6. Grade 5 or visualization. The fifth branches of intrahepatic portal vein are demonstrated clearly. Portal pressure, 300 mm H₂O.
Fig. 7. Shape of splenic vein, 'straight' type. No collateral channel is demonstrated. Portal pressure, 200 mm H₂O.

Fig. 8. Shape of splenic vein, 'bending' type. Umbilical vein is demonstrated as a collateral channel. Portal pressure, 240 mm H₂O.

Fig. 9. Shape of splenic vein, 'tortuous' type. Collateral channel is demonstrated in the umbilical vein. Portal pressure, 350 mm H₂O.
Fig. 10. Ascending collateral channel is demonstrated in the gastric and esophageal vein (arrow). Portal pressure, 500 mm H₂O.

Fig. 11. Descending collateral channel is demonstrated in the umbilical vein (arrow). Portal pressure, 320 mm H₂O.

Fig. 12. Descending collateral channel is demonstrated in the vein to the retroperitoneum (arrow). Portal pressure, 320 mm H₂O.
intrahepatic portal branches was frequently demonstrated in splenoportography.

2) *Pattern of splenic vein.* The pattern of visualized splenic vein varied considerably in each case. They were, however, divided into the following 3 groups. In the first group, straight type, the splenic vein was almost straight or curved only slightly (Fig. 7); in the second group, bending type, it showed a sharp turn and the upper edge of the vein of the splenic side crossed over to the lower edge of the hepatic side (Fig. 8) and in the 3rd group, tortuous type, an arcuate or more complicated pattern of splenic vein was included (Fig. 9). In 70 patients studied, the 3rd group was most often and the first group was seen in only 5 patients (Table 2).

3) *Collateral circulation.* The hepatofugal collateral circulations were demonstrated in splenoportography in 52 of 71 patients. The number of the patients in whom the collateral circulation in each location was demonstrated are presented in Table 3. Collateral circulation in the right and left gastric veins was most common and was observed in 39 patients, and the esophageal vein was visualized in 15 patients among them (Fig. 10). The descending collateral circulation in the umbilical vein and retroperitoneum was observed in 13 patients (Figs. 11 and 12).

<table>
<thead>
<tr>
<th>Table 3. <em>Collateral channels demonstrated in splenoportography</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Collateral channel</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Right or left gastric vein</td>
</tr>
<tr>
<td>Esophageal vein</td>
</tr>
<tr>
<td>Umbilical vein</td>
</tr>
<tr>
<td>Short gastric vein</td>
</tr>
<tr>
<td>Vein to retroperitoneum</td>
</tr>
</tbody>
</table>
Table 4. Ascending collateral channels and esophageal varices

<table>
<thead>
<tr>
<th>Splenoportography Barium swallow</th>
<th>Ascending collateral channels (+)</th>
<th>Ascending collateral channels (−)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophageal varices (+)</td>
<td>34</td>
<td>6</td>
</tr>
<tr>
<td>Esophageal varices (−)</td>
<td>9</td>
<td>22</td>
</tr>
</tbody>
</table>

As is shown in Table 4, the majority of patients who had evident ascending collateral circulation in splenoportography had also esophageal varices demonstrated in x-ray films with barium meal, while the esophageal varices were not demonstrated in the majority of patients in whom ascending collateral circulation was not demonstrated.

Relationship between the splenoportographic picture and portal pressure

It is quite reasonable to assume that the morphology of intra- and extrahepatic branches of the portal vein is influenced by the portal pressure. The relationship between them was investigated in terms of the following factors.

1) Visualization of intrahepatic branches of the portal vein and the portal pressure. The relationship between visualization of intrahepatic branches of the portal vein graded according to the criteria described above and the portal pressure is presented in Fig. 13. There is no significant difference in the portal pressure

![Fig. 13. Grade of visualization of intrahepatic portal branches in relation to portal pressure.](image-url)
between the group of grade 2 visualization and that of grade 3 visualization. In the group of 4 to 5 grade visualization, however, the portal pressure was appreciably reduced. It can be concluded, therefore, that in patients in whom visualization of the intrahepatic portal branches is poor, the portal pressure is elevated.

2) **Relationship between the length of the splenic vein plus that of the portal trunk and the portal pressure.** The sum of the length of the splenic vein and that of the portal trunk was measured on the splenoportographic picture in 60 patients. As is shown in Fig. 14, a significant positive correlation was found between the value of length and the portal pressure at 5% level and it can be expressed by a linear regression, \( y=129.275 +0.17908 \times x \), in which \( x \) is the portal pressure and \( y \) is the sum of the length of the splenic vein and that of the portal trunk.

3) **Relationship between the portal pressure and the site of the junction of the splenic vein with the portal trunk.** As is illustrated in Fig. 15, four equidistant lines were drawn in such a way as to divide the width of the vertebral body into 3 equal parts and designated as L₁, L₂, L₃ and L₄ from left to right. Another line was added 1 cm to the right of the L₄ and designated as L₅, and the distance between Lₙ and Lₙ₊₁ was expressed by Sₙ.

The relation of the site of the junction of the splenic vein with the portal trunk expressed by this reference system to the portal pressure is presented in Fig. 15. It can be noted that the splenic vein tends to join the portal trunk at the site further to the right as the portal pressure increases.

4) **Relationship between the portal pressure and the type of the splenic vein.** As is shown in Fig. 16, the portal pressure tended to be low in patients of straight and bending pattern, and high in those of tortuous.
5) Portal pressure and collateral circulation. As is shown in Fig. 17, the portal pressure was relatively low in the majority of 19 patients without collateral circulation, while it had tendency toward high in the 59 patients with collaterals.
The lowest portal pressure in the patients who had collateral circulation was 240 mm H$_2$O, and the highest one in the patients without collaterals was 310 mm H$_2$O. In the majority of the latter group it did not exceed 240 mm H$_2$O.

Furthermore, the relation of the portal pressure to the diameter of intra- and extrahepatic branches of the portal vein, to that of the splenic vein trunk, to the angles of branching of the intrahepatic portal veins and to the angle between the splenic and portal vein were examined, but no significant correlations were found between them.

3) Relationship between the extrahepatic shunt and the splenoportographic pattern

Extrahepatic shunt was measured in 12 cases of idiopathic splenomegaly. The values obtained in relation to the presence of collateral circulation and the portal pressure are presented in Table 5. In patients in whom there were appreciable extrahepatic shunts, collateral circulation was evident in splenoportography, while in those in whom the shunt circulation was of a small proportion, collateral channels were not always demonstrated in splenoportography.

<table>
<thead>
<tr>
<th>No. of cases</th>
<th>Collateral channel</th>
<th>Portal pressure (mmH$_2$O)</th>
<th>Extrahepatic shunt (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gastric vein</td>
<td>350</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>Gastric vein</td>
<td>290</td>
<td>79</td>
</tr>
<tr>
<td>3</td>
<td>Gastric vein</td>
<td>440</td>
<td>73</td>
</tr>
<tr>
<td>4</td>
<td>Umbilical vein</td>
<td>320</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>Gastric vein</td>
<td>240</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>Retroperitoneum</td>
<td>300</td>
<td>54</td>
</tr>
<tr>
<td>7</td>
<td>Gastric vein</td>
<td>260</td>
<td>54</td>
</tr>
<tr>
<td>8</td>
<td>Gastric vein</td>
<td>380</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>(−)</td>
<td>380</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>(−)</td>
<td>275</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>(−)</td>
<td>260</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>(−)</td>
<td>240</td>
<td>0</td>
</tr>
</tbody>
</table>

Discussion

It is generally recognized that portal hypertension followed by rupture of esophageal varices which constitute one of the collateral channels frequently occurs in idiopathic splenomegaly. It is readily conceivable, therefore, that evaluation of the portal pressure and the extent of collateral circulation is of great importance in diagnosis as well as in surgical indication of this disease. It is also of great benefit, if the site of obstruction of portal blood flow can be identified. The present study on 71 patients of idiopathic splenomegaly has made it clear that splenoportography offers important information about the portal pressure and location of collateral circulation.

The following 4 features in splenoportographic pictures are important in relation to the portal pressure: The radiological pattern of the splenic vein, the
length of splenic vein plus that of portal trunk, the site of the junction of the splenic vein with the portal trunk and visualization of intrahepatic portal branches.

Doehner et al.,\(^5\) studying portography taken in cadavers, classified the pattern of the splenic vein in normal subjects into 10 types, namely, straight type, undulated type, upward convex curve, upward knee curve, etc. They concluded, however, that it was more or less straight in general. In his splenoportographic studies, Shimizu\(^6\) found that the splenic vein was almost straight or showed sharp turns in individuals with normal portal pressure.

In the present study of patients with idiopathic splenomegaly, it was found that the splenic vein was sometimes straight or bending, but most often tortuous. It was further demonstrated that portal hypertension was milder in patients in whom the splenic vein was straight or nearly so, than in those it was tortuous, the portal pressure exceeding 240 mm H\(_2\)O in all of the latter group. It seems therefore justified to assume portal hypertension exceeding 240 mm H\(_2\)O when curving or tortuosity of the splenic vein is demonstrated in splenoportography.

For the study of the site of the splenoportal junction, a method similar to that of Doehner et al.\(^5\) was used. According to them, the junction was located at S\(_1\) in 16 (32\%) cases, at S\(_2\) in 15 (30\%) cases, at S\(_1\) in 14 (28\%) cases, and in none of their cases it was found at S\(_4\) or S\(_5\).

In the present study it was revealed that in patients with idiopathic splenomegaly, the junction tended to be displaced more to the right, namely, it was at S\(_1\) in 24 (34\%) cases and at S\(_5\) in 19 (27\%) cases. There was also a correlation between the rightward shift of the junction and portal pressure.

In the present study it was also revealed that the sum of the length of the splenic vein and that of the portal trunk tended to be increased in correlation with elevation of the portal pressure. In some patients, however, in whom there was an extensive formation of collateral circulation, the sum of the length of these vessels was not increased in proportion to the elevation of portal pressure. This discrepancy may be explained by assuming that the collateral channels had developed already at the time when portal hypertension was not so remarkable.

The observation that visualization of intrahepatic portal branches decreases as the portal pressure increases may be accounted for as the result of obstruction of portal branches. Obstruction of intrahepatic branches of the portal vein is considered to be the cause of impairment of portal blood flow in idiopathic splenomegaly,\(^7,8\) and it seems that decreased visualization of the branches reflects the extension of obstruction of the branches.

Now a question arises as to the mechanism by which the changes in the pattern, the length and the site of junction of the splenic vein are brought about. An increase in blood flow through the splenic vein and elevation of portal pressure cause elongation and expansion of the splenic vein resulting in tortuosity of the vein and a further shift of its junction with the portal vein to the right. When the blood flow through the splenic vein is small and the portal pressure is low, there is no appreciable elongation or expansion of the splenic vein. In this
case, the splenic vein would show a sharp turn when the rightward shift of the junction is slight, and a straight course when the shift is of an appreciable degree. Thus it would seem that the pattern of the splenic vein and the site of the junction with the portal trunk are more dependent upon the factors such as an increase in splenic blood flow itself rather than backward pressure from the liver. Passive congestion of the portal system alone may result in a decrease in splenic blood flow, and consequently in a shift of the junction of the splenic vein with the portal vein to the left rather than to the right. In a previous report we have repeatedly pointed out an increase in splenic blood flow in idiopathic splenomegaly and discussed its bearing upon the portal pressure. The results of the present splenoportographic study also suggest an active role of the spleen in the development of portal hypertension.

New development and increase of hepatofugal collateral channels are important accompaniment of portal hypertension. In general, ascending collateral channels, mainly right and left gastric veins including esophageal vein, develop most frequently and are of greater importance in the aspect of treatment, than descending channels through retroperitoneal or umbilical veins which are rather to be preserved than to be removed at the time of operation. In deciding upon the type of operation, it is recommended, therefore, to demonstrate the collateral channels which is possible only by means of splenoportography. In our 71 patients, ascending collateral channels were demonstrated in 62 while descending channels through the umbilical and retroperitoneal veins were shown only in 13. These collaterals developed in patients who showed an elevation of the portal pressure to above 240 mm H₂O. In 60% of patients in whom collateral channels were not demonstrated, the portal pressure was below 240 mmH₂O, while the maximum portal pressure was 310 mmH₂O in patients without collateral circulation. It can be inferred, therefore, that collateral channels make their appearance when portal pressure is elevated to an level around 300 mmH₂O. It is a matter of controversy if the portal pressure is reduced to an appreciable degree by the development of collateral circulation. Düx et al. has stated that the portal pressure is not influenced by the presence of collateral circulation. But our observation that ligation of both right and left gastric veins following splenectomy frequently results in an elevation of portal pressure about 20 mm H₂O points to effectiveness of collateral circulation in reducing portal pressure. In a previous reports, we have described the observation of a case in which portal hypertension was of a minor degree of 250 mm H₂O in spite of a three-fold increase in splenic blood flow to 1,000 ml/min. Extrahepatic shunt having been 60% in this case, the failure of remarkable portal hypertension to develop can be explained by the fact that 600 ml/min out of 1,000 ml/min of splenic blood flow was shunted away from the liver through the collateral channels. Burchell et al. have reported on many cases in which the portal trunk could not be clearly visualized even though it was patent, because the contrast medium injected into the spleen extensively went into developed collateral channels. It can be surmised in such cases that portal hyper-
tension would have been considerably high but for the collateral circulation. Therefore, the presence of collateral circulation would greatly contribute towards the reduction of portal pressure.

X-ray study with barium meal and esophagoscopy are used for detecting esophageal varices. In 80% of cases in which either splenoportography demonstrated the ascending collateral channels or the esophagogram with barium meal showed the presence of esophageal varices, the positive finding was obtained in both of the procedures, and in remaining 20% of cases only one of the two procedures gave the positive finding.

Measuring of the extrahepatic shunts in an attempt for quantitating the collateral circulation which can be qualitatively demonstrated in splenoportography. The values obtained reflect the proportion of splenic blood flow which passes through extrahepatic shunts when collateral channels originate from the splenic vein and that of portal blood flow through extrahepatic shunts when they arise from the portal trunk. This procedure is a useful adjunct to splenoportography and makes possible a quantitative evaluation of collateral circulation demonstrated by splenoportography, since it is simple to perform and less injurious than splenoportography.

References