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Per-rectal Portal Scintigraphy with Technetium-99m Pertechnetate for Esophageal Varices

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ABSTRACT

Per-rectal portal scintigraphy is a non-invasive method in which a radioisotope is used for imaging of the portal collaterals. Per-rectal portal scintigraphy with 99m-technetium pertechnetate ($^{99m}TcO_4^-$) was performed in 42 subjects to evaluate the portal hemodynamics. Ten healthy controls, 13 cases of liver cirrhosis without esophageal varices, 15 cases of liver cirrhosis with esophageal varices, and 4 cases of portal systemic shunt were included in this study. Moreover, in 4 patients who underwent transabdominal esophageal transection, per-rectal portal scintigraphy was repeated one month postoperatively. Portosystemic shunt index was calculated by the following equation. Shunt Index (%) = ($^{99m}TcO_4$ Counts of Heart/$^{99m}TcO_4$ Counts of Liver and Heart) × 100. The results, expressed as shunt index (SI) were: 8.8 ± 5.2 in controls, 21.2 ± 8.0 in cirrhotic patients without esophageal varices, 31.0 ± 18.5 in cirrhotic patients with esophageal varices, and 49.0 ± 6.9 in patients with portosystemic shunt. After transabdominal esophageal transection, the shunt indices were decreased in all four cases. Morphological improvements of the esophageal varices were also observed. These results suggest that the shunt index measured by perrectal portal scintigraphy may be useful for assessment of portal collaterals, especially for patients with esophageal varices.

Key words: *Per-rectal portal scintigraphy, Esophageal varices, Transabdominal esophageal transection*

Abnormal portosystemic shunt, i.e., esophageal varix, is often seen in chronic liver disease and more specifically in liver cirrhosis. A number of methods have been proposed to detect the abnormal portal collaterals. The per-rectal approach with technetium-99m pertechnetate is especially advantageous since it is a non-invasive measurement of the portal circulation. This approach has been widely used for various examinations[2,4,5] and significant findings have been reported regarding the relationship between the portal hemodynamics and the degree of esophageal varices[4,8], their ruptures, or the effect of the endoscopic injection sclerotherapy[1,6]. In this paper, we present the relationship between the degree of esophageal varices and the portal hemodynamics, and the changes of the shunt index after transabdominal esophageal transection.

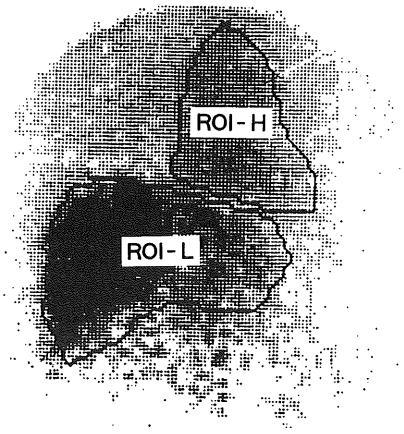
PATIENTS AND METHODS

Forty-two patients were included in this study: 10 healthy controls, 13 and 15 liver cirrhosis patients without and with esophageal varices respectively, and 4 cases of portosystemic shunt.

In four of the 32 patients who underwent transabdominal esophageal transection, per-rectal portal scintigraphy was also performed one month after operation. The age of the subjects ranged from 26 to 79 years (average 56). Diagnosis of liver cirrhosis was confirmed whenever possible by biopsy, but when not possible, the diagnosis was confirmed by clinical, imaging, and hematobiological findings.

A 16-Fr polyethylene tube was inserted approximately 20 cm from the anal verge into the upper rectum to avoid physiological absorption toward the systemic circulation from the lower rectum. Then, using a disposable plastic syringe, 3 ml of $^{99m}TcO_4^-$ (specific activity: 370MBq) was rapidly injected intrarectally through the polyethylene tube. The data obtained were analyzed with a gamma-scintiscanner (GCA-401, Toshiba Co., Tokyo, Japan) and a nucleo-medical data processing device (Scintipak, Shimazu Co., Tokyo, Japan).

The region of interest (ROI) was set on the liver and heart, and the time activity curve was drawn at each ROI. The ratio of per-rectal portal shunt was then calculated by dividing the $^{99m}TcO_4^-$ count in the heart region (B) for ten seconds by the sum of B and the corresponding count in the liver region (A) as shown in Fig. 1.



Portosystemic shunt index (S.I.)

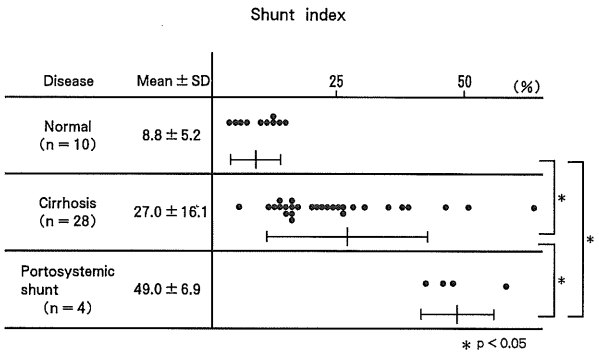
$$= \frac{B}{A+B} \times 100\ (\%)$$

$$A : \int_0^{10sec} \{ROI-L\}$$

$$B : \int_0^{10sec} \{ROI-H\}$$

Fig. 1. Technetium-99m pertechnetate activity over the liver and the heart using per-rectal portal scintigraphy

Table 1. Per-rectal portal shunt indices in liver cirrhosis and portosystemic shunt



RESULTS

Shunt index of per-rectal portal scintigraphy in hepatic disease (Table 1) The mean ± SD of shunt index was 8.8 ± 5.2% in the healthy controls. 27.0 ± 16.1% in the cases with liver cirrhosis and 49.0 ± 6.9% in the cases with portosystemic shunt.

Shunt index of per-rectal portal scintigraphy in liver cirrhosis cases with and without esophageal varices (Table 2) The mean ± SD of shunt index in the cirrhotic patients without esophageal varices was 21.2 ± 8.0%, which was significantly lower ($p<0.05$) than the value of 31.0 ± 18.5% in those with esophageal varices.

Form of esophageal varices and shunt index of per-rectal portal scintigraphy (Table 3) The mean ± SD of shunt index in F1 cases (linearly extended or tortuous varices) was 14.7 ± 6.4%, which was significantly lower ($p<0.05$) than the

Table 2. Shunt indices in cirrhotic patients with or without esophageal varices

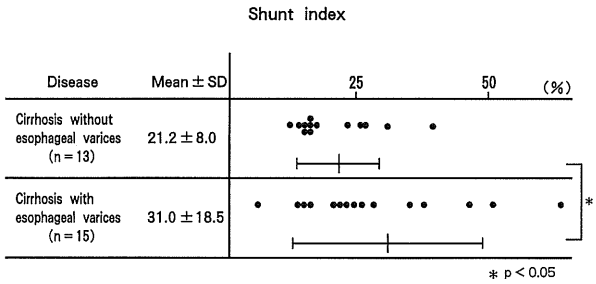
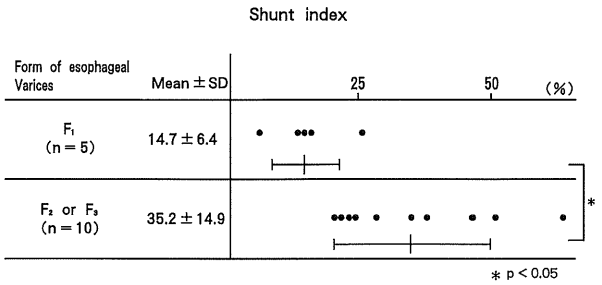


Table 3. Shunt indices in the various types of esophageal varices



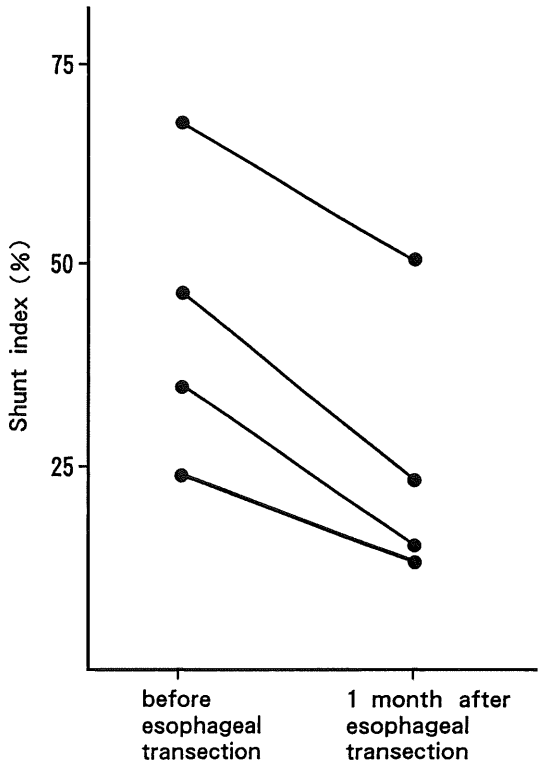


Fig. 2. Change of shunt index before and after transabdominal esophageal transection.
The decrease of shunt index was observed after transabdominal esophageal transection.

value of 35.2 ± 14.9% in F2 cases (varicocele) or F3 cases (varicose vein).

Changes of shunt index of per-rectal portal scintigraphy before and after the transabdominal esophageal transection (Fig. 2) After transabdominal esophageal transection, the shunt indices were lowered in all cases. Morphological improvement, F2 to F1 in three cases and F3 to F1 in one case, was also observed.

DISCUSSION

Non-invasive per-rectal scintigraphy using radioisotope (RI) for imaging allows diagnosis of the portal collaterals and measurement of the portal shunt index. Per-rectal portal scintigraphy was performed with ^{133}Xe solution by Castel et al[3], and with ^{131}I-Na by Steinberg et al[7]. Such procedures were, however, not suitable for the detailed analysis of portal circulation because they provided unclear imaging. Newly developed methods, using $^{201}TICI$ by Tonami et al[9], ^{123}I-IMP by Yen et al[10] or using $^{99m}TcO_4^-$ by Kuroki et al[5] have improved the conventional approaches enabling portal circulation to be recorded and registered appropriately. These methods have also made possible the quantitative measurement of abnormal portal circulation, which can be expressed as per-rectal portal shunt index.

Ikeoka et al[4] reported the mean value of per-rectal portal shunt index as 4.8% in healthy controls, 6.6% in chronic nonactive hepatitis, 9.8% in chronic active hepatitis, and 48.5% in cirrhosis. D'Arienzo et al[2] also reported the shunt index as 5.66 ± 1.66% in healthy controls, 15.27 ± 2.83% in chronic active hepatitis and 24.88 ± 3.95% in cirrhosis. In our study, the shunt index was 8.8 ± 5.2% for controls and 27.0 ± 16.1% in cirrhotic patients. In any report, increase in the shunt index was observed with progression of the hepatic disease. Differences in the shunt index among these three reported values may be ascribed to the different group of patients studied.

The patients with portosystemic shunt had a relatively higher shunt index of 37.4 ± 14.4%, but showed only a slight degree of esophageal varices. Three out of these 4 have showed also hepatic encephalopathy as in the report of Ikeoka et al[4] which showed a mean shunt index as high as 78.1% in cases with hepatic encephalopathy. Presence of the portosystemic shunt should be considered in cases with a low degree of esophageal varices and recurrent hepatic encephalopathy.

Concerning the relationship between esophageal varices and the shunt index, the shunt index in the cirrhotic patients with esophageal varices was significantly higher than that in patients without esophageal varices. Ikeoka et al[4] also reported that the mean shunt index was 63.8% in patients with esophageal varices, which was significantly higher than the mean value 21.0% in patients without esophageal varices. In our study, a statistically significant difference in the shunt index was observed among the forms of esophageal varices, that is, F1, F3 groups. A close relationship was shown between exacerbation of esopageal varices and the shunt index.

According to the results of Ikeoka et al[4], among patients with cirrhosis, the developmental rate in esophageal varices within the first three years was higher in patients with a shunt index over 20% than in patients with a shunt index below 20%. They concluded, therefore, that determination of the shunt index was useful for prediction of onset of esophageal varices. Currently, rupture of esophageal varices has being generally predicted from endoscopic findings, but this prediction is not always reliable. Shirasaki et al[6] have stated that rupture of esophageal varices was unmistakably predictable from analysis of the condition of the collaterals and form the appearance time of hepatic images in addition to the endoscopic findings. They also emphasized the usefulness of per-rectal portal scintigraphy.

Changes of portal circulation after treatment for esophageal varices have been variously reported. Azuma et al[1] studied these changes after endoscopic esophageal sclerotherapy in seven patients by per-rectal scintigraphy. The shunt index was decreased in three cases, increased in two, and unchanged in the remaining two. No consistent trend was observed. Tonami et al[8] also reported similar results, showing that the reduced shunt index could be attributed to a decrease in the shunt flow via esophageal varices and an increase of the blood flow to the liver. In contrast, an increased shunt index was related to an increase of blood flow to the extrahepatic shunt other than esophageal varices after endoscopic injection sclerotherapy[8].

To date, there have been no reports dealing with changes of shunt index after transabdominal esophageal transection. In all the four cases in our study, a decrease in shunt index and an improvement in the morphology of the esophageal varices were observed after operation. These findings indicate that the transabdominal esophageal transection may be an effective procedure for reduction of the shunt index.

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