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Michio Tanaka[*] Shuji Inatsuchi[†] Teiichi Terasaki[‡]

Jun Funaki[**] Tsuyosi Bandou[††] Kazuhiko Shimada[‡‡]

Hiroyuki Wakabayashi[§] Yoshiki Kubota[¶] Akiharu Watanabe[‖]

[*]Toyama Medical and Pharmaceutical University,
[†]Toyama Medical and Pharmaceutical University,
[‡]Toyama Medical and Pharmaceutical University,
[**]Toyama Medical and Pharmaceutical University,
[††]Toyama Medical and Pharmaceutical University,
[‡‡]Toyama Medical and Pharmaceutical University,
[§]Toyama Medical and Pharmaceutical University,
[¶]Toyama Medical and Pharmaceutical University,
[‖]Toyama Medical and Pharmaceutical University,

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Abstract

Clinical studies show that patients with liver cirrhosis associated with portal hypertension have a high incidence of duodenal ulcer and duodenitis. However, little information is available concerning pathophysiological process of such duodenal diseases in liver cirrhosis. Hemodynamics of the duodenal mucosa was studied in cirrhotics with esophageal varices (68 cases) and in noncirrhotics with non-ulcer dyspepsia (37 cases) as well. In each group, hemoglobin concentration in the peripheral venous blood was measured, and mucosal hemodynamics was examined in 4 regions of the duodenum by endoscopic reflectance spectrophotometer. No significant intergroup difference was noted in the mean age or sex ratio. Hemoglobin concentration in the peripheral venous blood was significantly lower (p less than 0.01) in the cirrhotics. There were no significant intergroup differences in duodenal mucosal blood volume. However, the cirrhotics showed significantly lower oxygen saturation of hemoglobin in all regions of the duodenum (p less than 0.01). These results show that the cirrhotics with esophageal varices had relative increase in blood volume and decrease in oxygen saturation of hemoglobin in the duodenal mucosa. Such microcirculatory disturbances seem to predispose liver cirrhosis patients to duodenal injury.

KEYWORDS: liver cirrhosis, portal hypertension, duodenal mucosa, reflectance spectrophotometry, duodenoscopy

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Duodenal Mucosal Hemodynamics in Patients with Liver Cirrhosis

Michio Tanaka*, Shuji Inatsuchi, Teiichi Terasaki, Jun Funaki, Tsuyosi Bandou, Kazuhiko Shimada, Hiroyuki Wakabayashi, Yoshiki Kubota and Akiharu Watanabe

Third Department of Internal Medicine, Faculty of Medicine, Toyama Medical and Pharmaceutical University, Toyama 930-01, Japan

Clinical studies show that patients with liver cirrhosis associated with portal hypertension have a high incidence of duodenal ulcer and duodenitis. However, little information is available concerning pathophysiological process of such duodenal diseases in liver cirrhosis. Hemodynamics of the duodenal mucosa was studied in cirrhotics with esophageal varices (68 cases) and in noncirrhotics with non-ulcer dyspepsia (37 cases) as well. In each group, hemoglobin concentration in the peripheral venous blood was measured, and mucosal hemodynamics was examined in 4 regions of the duodenum by endoscopic reflectance spectrophotometer. No significant intergroup difference was noted in the mean age or sex ratio. Hemoglobin concentration in the peripheral venous blood was significantly lower ($p < 0.01$) in the cirrhotics. There were no significant intergroup differences in duodenal mucosal blood volume. However, the cirrhotics showed significantly lower oxygen saturation of hemoglobin in all regions of the duodenum ($p < 0.01$). These results show that the cirrhotics with esophageal varices had relative increase in blood volume and decrease in oxygen saturation of hemoglobin in the duodenal mucosa. Such microcirculatory disturbances seem to predispose liver cirrhosis patients to duodenal injury.

Key words : **liver cirrhosis, portal hypertension, duodenal mucosa, reflectance spectrophotometry, duodenoscopy**

Liver cirrhosis associated with portal hypertension has been hypothesized to be involved in the pathogenesis of several alterations of either the stomach, such as congestive gastropathy (1) and ulcers (2), or the duodenum, such as duodenitis (3) and ulcers (4). The mechanisms underlying such gastric changes have been extensively studied over the past decade (5), and disturbance of mucosal blood flow and oxygen delivery in the gastric mucosa have been thought to play important roles in gastric mucosal injury in patients with liver cirrhosis. In contrast, little information is available concerning pathophysiological processes of duodenal alterations in liver cirrhosis associated with portal hypertension.

The aim of our study is to clarify the hemodynamic changes of the duodenum occurring in patients with liver cirrhosis.

* To whom correspondence should be addressed.

Materials and Methods

Patients. One hundred and fifteen patients, divided into two groups, were investigated. Table 1 summarizes clinical features of two groups. The group of noncirrhotics consisted of 37 patients (26 men and 11 women, age: 50.8 ± 6.4 years, mean ± SD). In the all patients of noncirrhotics, clinical, biological, and ultrasonic examinations did not indicate liver disease or portal hypertension. Endoscopic examination was carried out because of various and mild upper abdominal symptoms. Ulcers, carcinomas and other neoplasms were not noted in the esophagus or the stomach of any of these subjects, and the endoscopic appearance of the duodenum was normal. Finally, we diagnosed their abdominal symptoms as depending on non-ulcer dyspepsia. The group of cirrhotics was comprised of 68 patients (48 men and 20 women, age: 56.5 ± 10.1 years, mean ± SD). All patients with liver cirrhosis had histologically verified liver cirrhosis and endoscopically confirmed esophageal varices. Liver cirrhosis patients without esophageal varices and those with esophageal varices complicated with gastric ulcers, duodenal ulcers, duodenitis or various neoplasms in the upper G-I tract were excluded.

Measurement of hemoglobin concentration in the peripheral venous blood. Hemoglobin concentration in the peripheral venous blood was measured in all patients of both two groups just before endoscopic reflectance spectrophotometry.

Endoscopic reflectance spectrophotometry. Each patient was forbidden to smoke or to take food and alcohol beverages for 12 h just before endoscopic examination. Premedication for the procedure with an intramuscular injection of butylscopolamine bromide (20 mg) was done 10 min before endoscopic examination. In all patients, fiberoptic endoscopy was undertaken with examination of the duodenum. A GIF-10 or JF-10 model of fiberscope (Olympus, Tokyo, Japan) and an endoscopic reflectance spectrophotometer (TS-200, Sumitomo Electric Industries, Ltd., Osaka, Japan) were used. The measuring probe of the endoscopic reflectance spectrophotometer consisted of two coaxial light guides. The incident light from the source was directed through the central guide to the spectrophotometer for analysis. The data were processed rapidly (40 msec) by a microcomputer data analysis unit. The spectral tracing and mucosal blood volume (△Er) and oxygen saturation (f) were printed. Details for the calculation of "△Er" and "f" have been reported previously (6). The measuring probe was gently touched to the 4 regions of the duodenum (the bulb, the proxymal and distal halves of the descending portion and the horizontal portion) through the body channel of the fiberscope. Mucosal blood volume and oxygen saturation of hemoglobin were measured in each of these regions.

Statistical analysis. All results were expressed as mean ± SD. Student's *t*-test was used to test the significance of intergroup differences. A p value of < 0.05 was considered to be significant.

Table 1 Clinical features of 68 patients with liver cirrhosis compared with 37 patients without liver cirrhosis.

Group	Age	Number of patients	
		Sex Male/Female	Esophageal varices
Cirrhotics (n = 68)	56.5 ± 10.1	48/20	68
Non-cirrhotics (n = 37)	50.8 ± 6.4	26/11	0
p value	NS	NS	

Age: the mean ± SD

Results

No significant intergroup difference was noted in the mean age or sex ratio.

Hemoglobin concentration in the peripheral venous blood was 11.9 ± 2.1 g/dl in the cirrhotics and 14.4 ± 1.5 g/dl in the noncirrhotics, as shown in Table 2. Hemoglobin concentration in the peripheral venous blood was significantly lower ($p < 0.01$) in the cirrhotics, as compared to the noncirrhotics.

Table 3 summarizes the regional mucosal blood volume, expressed as △Er, at 4 regions of

Table 2 Hb concentration in the peripheral venous blood

Group	Hb concentration (g/dl)
Cirrhotics (n = 68)	11.9 ± 2.1
Noncirrhotics (n = 37)	14.4 ± 1.5
p value	< 0.01

All values are the mean ± SD

Table 3 Regional mucosal blood volume expressed as △Er

Group	Duodenum			
	The first portion	The second portion		The third portion
		Proxymal half	Distal half	
Cirrhotics (n = 68)	0.51 ± 0.13	0.52 ± 0.13	0.48 ± 0.11	0.44 ± 0.12
Non-cirrhotics (n = 37)	0.49 ± 0.11	0.55 ± 0.14	0.49 ± 0.13	0.43 ± 0.14
p value	NS	NS	NS	NS

All values are the mean ± SD

Table 4 Regional mucosal oxygen saturation of hemoglobin expressed as f

Group	Duodenum			
	The first portion	The second portion		The third portion
		Proxymal half	Distal half	
Cirrhotics (n = 68)	44 ± 7	44 ± 9	43 ± 9	43 ± 10
Non-cirrhotics (n = 37)	56 ± 13	52 ± 12	53 ± 14	52 ± 12
p value	< 0.01	< 0.01	< 0.01	< 0.01

All values are the mean ± SD

the duodenum in each group. Along the long axis of the duodenum, the mucosal blood volume in the cirrhotics was 0.51 ± 0.13 at the bulb, 0.52 ± 0.13 at the proxymal half of the second portion, 0.48 ± 0.1 at the distal half of the second portion, and 0.44 ± 0.12 at the horizontal portion. In the noncirrhotics, the regional mucosal blood volume was 0.49 ± 0.11, 0.55 ± 0.14, 0.49 ± 0.13, and 0.43 ± 0.14, respectively. There were no significant intergroup differences in mucosal blood volume in any of the 4 regions. Table 4 presents the regional oxygen saturation of hemoglobin (f), at the 4 regions of the duodenum in each group. Along the long axis of the duodenum, the oxygen saturation of hemoglobin in the cirrhotics was 44 ± 7 at the bulb, 44 ± 9 at the proxymal half of the second portion, 43 ± 9 at the distal half of the second portion, and 43 ± 10 at the horizontal portion. In the noncirrhotics, the regional oxygen saturation of hemoglobin was 56 ± 13, 52 ± 12, 53 ± 14, and 52 ± 12, respectively. The cirrhotics showed significantly lower oxygen saturation of hemoglobin in all 4 regions of the duodenum ($p < 0.01$).

Discussion

Clinical studies suggest that the gastric microcirculation is altered in portal hypertension by such factors as increased submucosal arteriovenous communications (7), and prominence and dilation of mucosal capillary and vascular ectasia in the submucosal layer (1, 8), thereby causing compromised blood flow and consequent oxygen (9) and nutrient deficiency. Impaired mucosal oxygenation supposedly increases the sensitivity of the portal hypertensive mucosa to gastric mucosal damage (10–12) resulting in a propensity for ulceration and bleeding (13, 14). Some clinical examinations showed that patients with liver cirrhosis associated with portal hypertension have

a high incidence of duodenal ulcer (15) and duodenitis (3). Vascular alteration of the duodenum, such as capillary dilatation (16) and varices (17) were also noted in patients with liver cirrhosis.

To our knowlege, the study presented in ths paper is the first clinical report about duodenal hemodynamics in liver cirrhosis with portal hypertension. Endoscopic reflectance spectrophotometry was used in our study. It has the advantage of rapid and repeated measurement of indices of mucosal blood volume (△Er) and oxygen saturation of hemoglobin (f). Although this technique does not measure blood flow in quantitative terms, △Er and f are sensitive and specific in measuring hyperemia and ischemia with or without congestion (6).

The experimental study showed that reduction in systemic blood volume after blood removal was linearly related to the decline in gastric mucosal blood volume measured by reflectance spectrophotometry (6). However, in this study, the cirrhotics did not show reduced duodenal mucosal blood volume in any of the 4 regions, which means no reduction of the hemoglobin concentration in the duodenal mucosa (18), despite of significantly low Hb concentration in the peripheral venous blood. These results suggest the existence of an intergroup difference in distribution of blood volume between the periphery and duodenal mucosa: the cirrhotics had relatively higher blood volume in the duodenum. Studies in animals with portal hypertension demonstrated increased mucosal blood flow in the duodenum (19, 20). It is difficult to determine the significance of comparative analysis of differences in duodenal hemodynamics between such animal studies and our clinical study because the etiology and the duration of the portal hypertension are quite different between the animals and the patients in these studies.

The cirrhotics showed significantly lower mucosal oxygen saturation of hemoglobin in every region of the duodenum. Characteristic patterns of the duodenal hemodynamics in cirrhotics such as relative increase in blood volume and decrease in oxygen saturation of hemoglobin suggest congestion and ischemia of the duodenal mucosa. A similar hemodynamic pattern was reported in the gastric mucosa of patients with liver cirrhosis (21). The results of our study indicate that the microcirculatory disturbances in the duodenum, predisposing liver cirrhosis patients to duodenal injury, are similar to those in the gastric mucosa of cirrhotics.

References

1. McCormack TT, Sims J, Eyre-Brook I, Kennedy H, Gopel J and Johnson AG: Gastric lesions in portal hypertension: Inflammatory gastritis or congestive gastropathy? Gut (1985) **26**, 1226-1232.
2. Fanco D, Durandy Y, Deporte A and Bismuth H: Upper gastrointestinal haemorrhage in hepatic cirrhosis: Causes and relation to hepatic failure and stress. Lancet (1977) **29**, 218-220.
3. Inatsuchi S and Inoue K: Study of the characteristic endoscopic pictures of duodenitis in hepatocirrhosis. Gastroenterol Endosc (1986) **28**, 1146-1149 (in Japanese).
4. Lipp WF and Lipsitz MH: The clinical significance of the coexistence of peptic ulcer and portal cirrhosis, with special reference to the problem of massive hemorrhage. Gastroenterology (1952) **22**, 181-189.
5. Baxter JN and Dobbs BR: Special article, Portal hypertensive gastropathy. J Gastroenterol Hepatol (1988) **3**, 635-644.
6. Leung FW, Morishita T, Livingston EH, Reedy T and Guth PH: Reflectance spectrophotometry for the assessment of gastroduodenal mucosal perfusion. Am J Physiol (1987) **252**, G797-G804.
7. Hashizume M, Tanaka K and Inokuchi K: Morphology of gastric microcirculation in cirrhosis. Hepatology (1983) **3**, 1008-1012.
8. Foster PN, Wyatt JI, Bullimore DW and Losowsky MS: Gastric mucosa in patients with portal hypertension: Prevalence of capillary dilatation and Campylobacter pylori. J Clin Pathol (1989) **42**, 919-921.
9. Adachi H, Mitsunaga A, Yokoyama S, Hashimoto H, Hirose H, Kurokawa H and Obata H: The study of gastric mucosal changes and their mechanism in patients with liver cirrhosis. J Gastroenterol Hepatol (1989) **4** (Suppl 1) 96-98.
10. Sarfeh IJ, Soliman H, Waxman K, Coccia M and Rypins EB: Impaired oxygenation of gastric mucosa in portal hypertension. Dig Dis Sci (1989) **34**, 225-228.
11. Sarfeh IJ, Malki A, Tarnawski A, Ivery KJ and Mason GR: Portal hypertension and gastric mucosal injury in rat: Effects of alcohol. Gastroenterology (1983) **84**, 987-993.

12. Sarfen IJ, Tarnawski A, Maeda R, Raymont K, Mason GR and Ivey KJ: The gastric mucosa in portal hypertension: Effects of topical bile acid. Scand J Gastroenterol (1984) **19** (suppl 92), 189–194.
13. Maeda R, Guilmette E and Tarnawski A: Bile acid-induced gastric mucosal injury: Significance of portal hyopertension and mucosal capillary permeability. J Surg Res (1984) **36**, 312–314.
14. Khodadoost J and Glass GBJ: Erosive gastritis and acute gastroduodenal ulcerations as source of upper gastrointestinal bleeding in liver cirrhosis. Digestion (1972) **7**, 129–138.
15. Fukumoto Y and Matsuda K: Studies of gastric mucosal lesions in the patients with chronic liver diseases. Gastroenterol Endosc (1986) **28**, 1131–1133 (in Japanese).
16. Gallagher C, Bonar F, Dempsey J and Crowe J: Small bowel capillary dilatation in portal hypertension. Postgrad Med J (1985) **61**, 541–543.
17. Amin R, Alexis R and Korzis J: Fatal ruptured duodenal varix: A case report and review of literature. Am J Gastroenterol (1985) **80**, 13–18.
18. Sato N, Kawada T, Shichiri M, Kawano S, Abe H and Hagihara B: Measurement of hemoperfusion and oxygen sufficiency in gastric mucosa *in vivo*. Gastroenterology (1979) **76**, 814–819.
19. Vorobioff J, Bredfeldt JE and Groszmann RJ: Hyperdynamic circulation in portal-hypertensive rat model: A primary factor for maintenance of chronic portal hypertension. Am J Physiol (1983) **244**, G52–G57.
20. Benoit JN, Womack WA, Korthuis RJ, Wilborn WH and Granger DN: Chronic portal hypertension: Effects on gastrointestinal blood flow distribution. Am J Physiol (1986) **250**, G535–G539.
21. Fukuda M, Kawano S, Sato N, Shimizu R, Nagano K, Tsuji S, Fusamoto H and Kamada T: Mucosal hemodynamics and oxygen sufficiency in patients with liver cirrhosis assessed by reflectance spectrophotometry. Jpn J Gastroenterol (1986) **83**, 26–32 (in Japanese).

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