ON THE DUODENAL SPREAD OF GASTRIC CANCER  
(Plates XXIX—XXXII)  
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INTRODUCTION  

The adequate removal of the cancer of the stomach is difficult because of deficient knowledge as to the nature of its spread. Studies on metastasis of gastric cancer have been reported by various authors (1-4). Jinnai has indicated that the cancer consisting of smaller cancer cells is metastasized more frequently and reaches more distant lymph nodes than in the case of the metastasis of the cancer consisting of larger cancer cells (5). On the histological observations of cancer tissues, Imai has established the CPL classification on the mode of cancer growth (6-8), and the classification is said to be available in the determination of the prognosis of a cancer patient (9).  

In 1861 Rokitansky laid down the law that the pyloric cancer was exactly bound by the pyloric ring, and never reached beyond that to the duodenum (10). It is described in some text-books of surgery and pathology that the growth of stomach cancer has no tendency to invade the duodenum (11). However, after performing gastrectomy for stomach cancer, various authors have indicated the recurrence at duodenal stump (12-15). It is noticed that the duodenal extensions of gastric cancer occurred in various degrees and the extension reached several centimeters according to the observations from either surgical or autopsy materials (16-18). Reviews of the literatures including the study on the duodenal spread of gastric cancer were given by Castleman, Fodden and Zinninger (16-18).  

In the present paper, the duodenal spread of gastric cancer is discussed on the observations from autopsy materials and on the experiments on rabbits.  

I. Observations on autopsy materials  

The materials in this study included 27 cases of gastric cancer autopsied at the Department of Pathology, Nara Medical College, of which 22 were of gastric cancer without gastrectomy and 5 with gastrectomy.  

A) Observations on the cases of gastric cancer without gastrectomy  
Materials and Methods: Twenty two cases of gastric cancer were studied, of which 12 were of the cancer of the pylorus, 5 were that of the body, 3 that of the cardia and 2 that of the diffuse type. In these cases, the site, form, metastasis and the extension
of the cancer were examined macroscopically. The duodenal spread of gastric cancer were studied on the specimens which were taken crosswise to the long axis of the duodenum from 1 cm to 3 cm distal from the pyloric ring.

Results:

1) On the pyloric cancer. The cancerous invasion into the duodenum were found in 5 cases out of 12 pyloric cancers. In 4 cases of them the invasion was macroscopically visible and 1 case showed only microscopic invasion. Macroscopically, the involved duodenal mucosa showed plaque-like thickening or ulceration, and no sharp margin could be seen between the mucous membrane of the stomach and of the duodenum. Microscopically, the invasions of cancer were found within all layers of the duodenum, especially remarkable within the submucosa and subserosa. The cancer cells were chiefly noticed in the lymphatics (Fig. 1, 3) and occasionally the extension was revealed by continuous infiltration (Fig. 2). Case No. 138 showed the clumps of cancer cells in the lymph vessels of the mucosal villi. The invaded cancer tissues showed solid or adenocarcinomatous or scirrhous pattern.

The gastric cancers with duodenal spread were macroscopically ulcerative or diffuse infiltrative and not polypoid in type. In these cases, the metastatic involvement of perigastric lymph nodes was remarkable, and the extensions of cancer along the both curvatures were prominent. Microscopically, these cancers showed the P or L Form by Imai's Classification.

2) On the cancer of the body of the stomach. Two cases out of 5 cancers of the body showed microscopic invasion into the duodenum. In case No. 180, the invasion was found within all layers of the duodenal wall, especially in submucosal (Fig. 4) and subserosal lymphatics. In case No. 253, the invasion revealed continuous growth of cancer in subserosal layer (Fig. 5). These gastric cancers which had the duodenal spread, macroscopically showed large ulcerative or diffuse pattern, however, mucosa of the antrum of the stomach was not involved. The metastasis of cancer in the perigastric and hepatic lymph glands was significant, and large conglomerated lymph nodes were obtained. In case No. 180, the gastric cancer showed remarkable extension along the lesser curvature, and in case No. 253, the extension along the greater curvature was prominent.

3) On the cancer of the cardia of the stomach. Microscopic invasion into the duodenum was noticed in 2 cases out of 3 of the cancer of the cardia. These invasions were revealed by the presence of cancer cells in the lymphatics within the duodenal subserosa (Fig. 6).

Macroscopically, these gastric cancers which had duodenal spread, showed a large ulcerative pattern, and the cancerous involvements along the lesser or greater curvature were manifest. In the antrum of the stomach, the mucosa was not involved macroscopically, but the extensive lymphatic spread of cancer cells was microscopi-
cally noticed within the suberosal and the submucosal network of the lymphatics. The peripyloric glands were involved with cancer and showed large conglomerates.

4) On the diffuse cancer of the stomach. In 1 case out of 2 of diffuse cancer, the duodenal spread was microscopically found in the muscle and suberosal layer, although macroscopically the duodenal wall was not involved. The extension was revealed by direct continuous growth of cancer cells in the tissue cleavage (Fig. 7). This stomach cancer was grossly scirrhous, and showed extension along the lesser curvature and metastasized in the peripyloric glands. Microscopically, the cancer tissue showed adenocarcinomatous pattern.

B) Observations on gastric cancer with gastrectomy

Materials and Methods: Five cases of gastric cancer with gastrectomy were examined macroscopically, and the tissues were taken from the remaining stomach, oral stump of the duodenum, and the jejunum near the operative junction of the stomach and the jejunum, and these tissues were microscopically studied by hematoxylin and eosin staining.

Results: Cancerous involvements in remaining stomach wall were noticed in 3 cases out of 5 of this series. In these 3 cases, the cancer cells invaded the wall of the jejunum for several centimeters beyond the junction of the stomach and jejunum (Fig. 8). In 2 cases out of the above 3, the microscopic invasions of cancer cells were noticed in muscular and suberosal layer of the duodenal stump (Fig. 9), although no cancerous masses were noticed macroscopically in the stump.

II. Experiments concerning the lymph flow in the pyloric region of the rabbits

Materials and Methods: Male and female rabbits, weighing about 1 kg, were used. Case No. 1 had 0.1 cc of 3 per cent of Indian Ink injection into the gastric submucosa, about 1 cm proximal from the pyloric ring along its lesser curvature. Case No. 2 had a similar dose of Indian ink injection into the subserosa of the stomach wall at the same portion as the above. In case No. 3, 0.3 cc of the ink was injected in all layers of the stomach at the same portion as the above. In case No. 4, the same dose of the Ink was injected in all layers of corpus of the stomach.

These rabbits were sacrificed 5 days after injection. The stomach and the duodenum were examined were macroscopically, and were fixed in formalin. After fixation, the tissues were taken longitudinally from the portion, including the injected gastric wall with duodenal wall 3 cm distal from pyloric ring. These tissues were embedded in paraffin and stained with hematoxylin and eosin for microscopic examination.

Results: In these experiments, it is noticed that the Indian Ink injected into the gastric wall was discharged through the lymph channels in the subserosa toward the regional lymph nodes. But the flows of the Ink through the lymph channels never
reached the duodenal subserosa.

Within 5 days after injection, Indian Ink were recognized at the injected portion in gastric wall, and in enlarged lymph nodes in all cases. In case No. 1 and 2 in which small amount of Indian Ink had been injected into the gastric wall near the pyloric ring, it was observed that the injected Indian Ink had reached the pyloric ring, but not extended into the duodenal wall beyond the pyloric ring. In case No. 3 which had been injected large amount of Indian Ink in the gastric wall near the pyloric ring, the injected Ink extended grossly into the subserosa and submucosa of the duodenum about 1cm distal beyond the pyloric ring (Fig. 10, 11). Microscopically, many macrophages with carbon particles were noticed in subserosa and in submucosa of the duodenum, occasionally in the lymphatics within such layers (Fig. 12). In case No. 4 which had Indian Ink injection in the corpus of the stomach, Ink was not extended into the duodenum.

**DISCUSSION**

From the observations on autopsy materials, it was demonstrated that about one-half of the cases of gastric cancer showed the duodenal invasion microscopically, and main lesion of those cancers existed in nearly every part of the stomach. Macroscopically those gastric cancers showed ulcerative or diffuse infiltrative form. Histological types of the gastric cancer had no relation to the frequency of the duodenal spread.

The involved cancer cells were chiefly found in the lymphatic plexuses or spaces within the subserosa or submucosa of the duodenum. These findings revealed that the duodenal spread of gastric cancer has not been caused by dissemination of cancer cells on serosa of the duodenum, but may have been caused by lymphatic permeation through the lymphatic plexuses or continuous extension through the lymphatic spaces. The mode of duodenal invasion of pyloric cancer has been well described by Fodden (17). However, it is not established whether there may exist free communication between the lymphatic plexuses of gastric wall and that of the duodenal wall. Fodden had indicated that anatomical pathways existed in plenty between the two viscera, proved by his experiment and the natural migration of cancer cells. Kihara had point out the presence of “Extravasculaires Saftbahnsystem (Kihara)” within the loose connective tissue everywhere (19). From these opinions, it is supposed that there may exist lymphatic communication between the two viscera, as reported by some authors (20). Our supplementary experiments revealed that when small amount of Indian ink was injected into the gastric wall near the pyloric ring, the ink was not extended into the duodenal wall beyond the pyloric ring. However, when fairly large amount of Indian ink was injected at the same portion as the above, it was noticed the ink extended into both submucosa and subserosa of the
duodenal wall. These results may suggest that there may be no presence of free communication between the lymph plexuses of gastric wall and that of the duodenal wall, but they may indicate that when certain disturbances in lymph flow in the wall of pyloric antrum occurred, some amounts of lymph in the pyloric region will be discharged through the lymphatic plexuses or spaces to the duodenal wall. Zhdanov has described that the lymph plexuses of gastric wall may freely communicate with that of duodenal wall anatomically, and that the lymph in the pyloric region physiologically discharged through the lymph plexuses within the gastric wall, but not through that within the duodenal wall, to the peripyloric lymph glands, and the lymph in the starting portion of the duodenum was never discharged through the pyloric wall. However, such lymph flow was easily disturbed on some occasions, for example, in the case of pyloric cancer or of a high pressure caused by the injection of the pigment (21). Therefore, if the cancerous growth exists to some extent in pyloric antrum, it may be possible that cancer cells invade into the duodenal submucosa or subserosa by the lymphatic permeation or by the continuous extension through the lymphatic spaces.

The duodenal spread of the cancer of the cardia and of the body of the stomach was revealed by the presence of cancer cells in the lymphatics within the duodenal subserosa. In these cases, the subpyloric and retropyloric groups of lymph glands were involved by cancerous metastasis and large conglomerate of lymph glands was noticed. Anatomically, it is obvious that these lymph nodes receive the lymph flow from the duodenal and pyloric subserosa (17, 20). Therefore, if these glands were involved by cancer cells in the cancer cases of the cardia and of the body, the duodenal invasions may happen owing to the lymphatic permeation of cancer cells. Thus certain disturbances in lymph flow in the gastric wall may play an important role in the duodenal spread of gastric cancer.

Zinninger et al. have described that about 30 per cent of the cases of pyloric cancer, which were removed surgically, showed cancerous invasion into the duodenum. Fodden has noticed that the duodenal spread of pyloric cancer was more widespread and destructive in autopsy cases than in surgical cases. The present studies indicated that the duodenal spread of cancer cells occurred not only in cases of pyloric cancer but also in cases of the cancer of the cardia of the stomach. Even though cancerous involvements of the duodenum were not recognized grossly, the extent of such invasions varied from a few millimeters to several centimeters. More attention should be paid to the duodenal spread of gastric cancer which will influence the prognosis of cancer patient.

**SUMMARY**

Twenty-seven cases of gastric cancer were studied with respect to frequency of
spread into the duodenum and mode of invasion. In supplementary experiments through rabbits, the extension of Indian ink injected into the gastric wall to the duodenum was presented.

1) The duodenal spread of cancer cells was noticed in 5 out of 12 cases of pyloric cancer, and in 4 of the 5 the spread was recognized grossly. In 2 out of 5 cases of cancer of the body, in 2 out of 3 cases of the cancer of the cardia, and in 1 out of 2 cases of the diffuse cancer, microscopic invasions of cancer cells into the duodenum were noticed. In those cases peripyloric lymph glands were enlarged and conglomerated by the metastatic involvements of cancer. In 3 out of 5 cases of gastric cancer with gastrectomy, the oral stump of the duodenum was microscopically invaded with cancerous lesions. Macroscopic types of those gastric cancers were ulcerative or diffusely infiltrative. Histological types of the gastric cancers had little relation to the frequency of the duodenal spread of the cancer. Those invasions of cancer cells were chiefly noticed in the lymphatics within the duodenal wall, particularly within the subserosa or submucosa.

2) On the experiments on rabbits, in which fairly large amount of Indian ink was injected into the gastric wall near the pyloric ring it reached the subserosa or submucosa of the duodenum for about 1 cm distal from the pyloric ring, but when small amount of Indian ink was injected in the similar portion its extension into the duodenal wall was not recognized. Therefore it is of interest that the physiological lymph flow in the pyloric region may be easily disturbed by a trifling factor.

The above results may suggest that certain disturbances in lymph flows in gastric wall play an important role in the duodenal spread of gastric cancer, and that these spread are chiefly caused by lymphatic permeation of cancer cells or continuous extension of cancer cells through the lymphatic spaces.

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References

10) C. Rokitansky. Quoted by Fooden (1891).
Explanation of Plates XXIX—XXXII

Fig. 1 (Case 228) Section of duodenum, showing carcinoma in lymphatic vessels among Brunner's glands. The carcinoma showed the adenocarcinomatous pattern.

Fig. 2 (Case 45) Section of duodenum, showing diffusely infiltrated cancer cells in subserosa and muscularis.

Fig. 3 (Case 148) Section of duodenum, showing carcinoma within the lymphatics in muscle layer.

Fig. 4 (Case 180) Section of duodenum, showing extensive permeation of carcinoma within the periglandular and subglandular lymph plexus.

Fig. 5 (Case 253) Section of duodenum, showing cancerous invasion into subserosa.

Fig. 6 (Case 133) Section of duodenum, showing the mass of cancer within the lymphatics in subserosa.

Fig. 7 (Case 154) Section of duodenum, showing the continuous growth of cancer in subserosa and in muscularis.

Fig. 8 (Case 250) Section of duodenum, showing masses of cancer within the lymphatics in submucosal layer.

Fig. 9 (Case 265) Section of duodenal stump, showing collections of cancer cells in muscle layer.

Fig. 10 Transection including stomach of rabbit (Case 3), showing extension of injected Indian Ink into duodenal submucosa from stomach wall.

Allow: (1) Approximate position of pyloric ring. (2) Limit of extension of Indian Ink into duodenum.

Fig. 11 Transection of the same portion as the above, showing extension of Indian Ink into subserosa of duodenum.

(1), (2) same portion as above.

Fig. 12 Photomicrograph of area 2 in Fig. 10, showing macrophages storing carbon particles between Brunner's glands and muscularis.