

# Resection of gastric carcinoma with preservation of pancreas and clearance of lymph nodes along splenic artery: theory, technique and results

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**Subject headings** stomach neoplasms / surgery; lymph nodes; pancreas / blood supply; splenic artery

## INTRODUCTION

Cancers of whole gastric stomach, cardia, and gastric corpus often metastasize to splenic hylus and lymph nodes along the splenic artery<sup>[1]</sup>. There is ample statistical evidence to support the routine clearance of the lymph nodes along the splenic artery in cases of cancers in whole stomach, gastric corpus, cardia, and in certain invasive cancers in gastric antrum. Beginning from the mid 1940s, many surgeons adopted the procedure of resection of the spleen together with pancreatic body and tail in order to clear the lymph nodes of splenic hylus and along the splenic artery (pancreatic resection procedure). However, combined resection procedure carries the disadvantage of increased operative complication and mortality, and reduction of pancreatic function, especially in insulin output, hence increasing the incidence or aggravating diabetes mellitus. Based on the data and rationale of all those mentioned above, we began in 1968 our research on the operative procedure for gastric cancer, with preservation of pancreatic parenchyma with clearance of lymph nodes along the splenic artery (pancreatic preservation procedure)<sup>[2]</sup>.

## MATERIALS AND METHODS

### *Theoretical grounds of pancreatic preservation*

The lymph flow from the stomach does not enter into the pancreas. By injecting 2ml of methylene blue into the gastric cardia or corpus subserous space during operation, we observed the direction of gastric lymph flow in 54 cases. The direction of cardia lymph flow could be judged from the flow direction during operation and from anatomic examination of lymph nodes specimens. ① The direction of the lymph flow from the gastric cardia is ascending toward mediastinal lymph nodes along the esophageal

wall. ② Lymph from the lesser curvature flows toward the left gastric artery and then into lymph nodes along the celiac artery. ③ Lymph flowing along the short gastric arteries is running away from the greater curvature, and drains into lymph nodes of splenic hylus, then out along the splenic artery and finally to lymph nodes along the celiac artery. ④ Lymph from the posterior gastric wall along the post-gastric artery flows to retroperitoneal space and then into the lymph nodes along the splenic artery at the upper border of pancreas. ⑤ Lymph flowing along esophagocardiac branch of left subdiaphragmatic artery comes from the left side of gastric cardia, and drains to the para-aortic lymph nodes. The direction of lymph flow from the upper gastric corpus, besides being the same as that from cardia, may enter into lymph nodes of the splenic hylus and along the splenic artery via the left gastropiploic artery and its lymph nodes, and finally accumulate into lymph nodes along the celiac artery. Not a single case was found with lymphatic flow entering into pancreatic parenchyma.

It is infrequent for cancers from gastric cardia, gastric corpus, and whole stomach to invade pancreas itself. During the period from 1968 to 1986, in our hospital 439 cases of cancers in gastric cardia, gastric corpus, and whole stomach could be resected, of which 25 (5.7%) cases were found invading into the pancreas. From examination of the resected specimens of pancreatic body and tail in 22 cases, we found that direct invasion of gastric cancer to pancreatic parenchyma and capsule occurred in only 6 cases, with no metastasis to lymph nodes. This result is in agreement with the conclusion of the research on gastric lymphatic flow.

No necrosis of pancreatic body and tail occurred after resection of splenic artery and vein. The pancreatic body and tail is vascularized by pancreatic transverse artery, splenic artery, great pancreatic artery and pancreatic tail artery. The pancreatic transverse artery is the left branch of pancreatic dorsal artery. The splenic artery arises from the celiac artery and gives off 2-10 arterioles supplying the pancreas, one of which is called greater pancreatic artery, located between the middle and distal thirds of the pancreas. The right branch anastomoses with branches from pancreatic transverse artery and the splenic artery and a left branch anastomoses

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Received 1998-09-23

with artery of the pancreatic tail. The artery of the pancreatic tail arises from the distant 1/3 of splenic artery or from the left gastroepiploic artery. The pancreas has an abundant venous anastomosis, with the veins mainly accompanying synonymous arteries. There are 3-13 veins from the pancreatic body and tails (average 7). They drain into the splenic vein, more often into the upper mesenteric vein and upper part of the inferior mesenteric vein or left gastroepiploic vein. There is usually a vein which accompanies the inferior pancreatic artery and drains into the upper mesenteric vein, sometimes into the inferior mesenteric vein or the splenic vein<sup>[3]</sup>. Since about 40% of the pancreatic dorsal artery arises from the first part of the splenic artery, it is enough to resect the splenic artery at the distal end of the pancreatic dorsal artery. The pancreatic body and tail may be supplied by the left branch of the dorsal pancreatic artery, i.e., the transverse pancreatic artery. After resection of splenic vein, the pancreatic body and tail can be drained by transverse pancreatic vein and collateral vein with surrounding tissues several days after operation, therefore necrosis of pancreatic body and tail will not occur.

***Procedure for preservation of pancreatic parenchyma with resection of the splenic artery and vein and pancreatic capsule with surrounding lymphatic and neural connective tissues***

We first resected the omentum with concomitant freeing of the transverse mesocolon to the lower border of pancreas. After clearance of the capsule in front of the pancreas from the lower pancreatic border, the spleno-renal ligament was then resected up to gastric fundus and the left side of the cardia. After lifting up the spleen, we freed the pancreatic body and tail along the retroperitoneal space, and cleared the lymph nodes along the common hepatic artery, celiac artery and the root of left gastric artery together with the attached fatty and connective tissues. After the roots of the left gastric artery and the splenic artery were exposed, these arteries were separated and ligated. If the pancreatic dorsal artery arised from the first part of the splenic artery, one should ligate the splenic artery to the left of the dorsal artery, or when it arised from other arteries at the root of the splenic artery. After the operator changed his position to the left side of the patient, the assistant lifted the spleen and pancreatic body and tail out of the incision and turned them to the right side. After incising the splenic vein sheath, the splenic vein was exposed and resected at the left of the entrance of the inferior mesenteric vein. With slight traction of the severed ends of the splenic artery and vein, the vascular

branches which arose from the splenic artery and entered into the pancreatic parenchyma, the most important of which were the great pancreatic artery and artery of the pancreatic tail, should be freed and ligated. Concomitantly, we resected several venous tributaries arising from the pancreatic parenchyma and draining into the splenic vein. In the end, we freed completely the pancreatic body and tail, the splenic artery and vein, the pancreatic capsule and surrounding lymphatic, fatty, nerve and connective tissues.

By adopting the procedure described above, we found the operation expedient and with less possibility of injuring the pancreatic dorsal artery and inferior mesenteric vein. The lymph nodes and connective tissue were cleared in front of distal splenic vessels and at the periphery from the branch of the distal splenic artery and vein to the root of splenic vessels and finally the pancreatic capsule and splenic artery and vein surrounding lymphatic, fatty, neural and connective tissues were freed from the pancreatic body and tail. The other operative procedure was the same as the radical operation for gastric cancer.

## RESULTS

***Comparison of lymph node metastasis between two different operation groups***

From 1968 to 1992, we performed radical resection of gastric carcinoma by two different techniques, on 216 cases with preservation of pancreas and clearance of lymph nodes along the trunk of splenic artery and 30 cases with resection of pancreas. The metastasis rates of lymph nodes in splenic hylus and those along the trunk of splenic artery were 20.8% (45/216) and 25% (54/216) in the first group, and 20% (6/30) and 23.3% (7/30) in the second group. There was no significant difference statistically ( $P>0.05$ ).

***Comparison of postoperative complication, mortality and survival rates***

In the first operation group (preservation of pancreas), the postoperative complications occurred in 9 (4.2%), diabetes mellitus in 2 (0.9%) and death in 2 (0.9%); and in the second operation group in 12 (40%) diabetes mellitus in 3 (10%) and death in 1 (3.3%). The 5-year survival rates were 57% and 36% and 10-year survival rates were 47% and 30%, respectively. There was significant statistical difference ( $P<0.05$ ) between the two in the incidence of complication, but no marked difference in the mortality rate.

## DISCUSSION

The severe organic deficiency caused by expanded resection of gastric cancer has been of great concern

in recent years. It is a subject of dispute among surgeons that after clearance of lymph nodes along the splenic artery, whether one should adopt the procedure of pancreatic body and tail preservation or resection. After 20 years' research on this subject, we think that pancreatic preservation conforms better to the rationale of radical gastric cancer resection. The reasons are: ① The results of our research on lymphatic flow of gastric cardia and corpus indicated that the direction of the lymphatic flow from those area is along the upper border of the pancreas and the splenic artery, draining to relevant lymph nodes, but not into pancreatic parenchyma. Maruyama<sup>[4]</sup> found no case with gastric lymphatic flow entering into pancreatic parenchyma with preoperative gastroscopic photography after injection of opaque medium into inferior posterior wall of gastric cardia and upper part of gastric corpus and photography of specimens 1 to 5 days later and by injecting dye into gastric subserous space during operation. ② By serial sections of autopsy material of gastric cancer and pancreatic body and tail resected together with gastric cancer, Maruyama<sup>[5]</sup> found that only a small part of gastric cancer lesion invaded pancreas directly from the serous surface without any intrapancreatic lymphatic metastasis. We got the same conclusion from pathologic examination of resected pancreatic body and tail. ③ Maruyama<sup>[5]</sup> adopted the procedure of pancreatic preservation with clearance of lymph nodes along the splenic artery in 76 cases after 1976, with an operative mortality of 1.1%. Various common complications occurred in 25% cases, and pancreatic complication in 6.5%, but not a single case of diabetes mellitus occurred postoperatively. During the same period, Maruyama adopted pancreatic resection procedure in 58 cases and common complications occurred in 59.2% and pancreatic complications in 25%, and postoperative diabetes mellitus in 9.2%, and the operative mortality was 2.6%. In our group of 216 cases, postoperative complication occurred in 4.2%, the mortality rate being 0.9%, and the postoperative diabetes mellitus was found in 0.9%. In 30 cases with resection of pancreas, the postoperative complication occurred in 40%, and the postoperative mortality being 3.3%, postoperative diabetes mellitus in 10%. The incidence of postopera-

tive complications and diabetes mellitus of pancreatic preservation adopted by our group and Maruyama were lower than those applying procedures with pancreatic resection ( $P < 0.05-0.001$ ). The postoperative survival rates after pancreatic preservation operation by our group and Kinoshita, Maruyama<sup>[6]</sup> were higher than those applying pancreatic resection procedure ④. The lymph nodes of splenic hilus and along the splenic artery can be completely removed by pancreatic preservation procedure with resection of spleen, splenic artery and vein, pancreatic capsule, and surrounding lymphatic tissues together with the fatty, nerve and connective tissues. Maruyama<sup>[5]</sup> first cleared the lymph nodes along the splenic artery with preservation of pancreatic parenchyma, then resected the pancreas and the specimens were examined histologically. The result showed that on lymph nodes were left. In summary, the procedure with pancreatic preservation has advantages of easy performance, complete clearance of lymph nodes along the splenic artery, and low incidence of common postoperative complications and diabetes mellitus, and the 5-year survival rates being higher than that with pancreatic resection.

The indications for pancreatic preservation procedure are cancers from gastric cardia, corpus, whole stomach and certain cases with cancer from gastric antrum requiring clearance of lymph nodes along the splenic artery. Patients with preoperative diabetes mellitus or diabetic tendency are indicated absolutely for this procedure. If, however, the cancerous lesion or metastatic lymph nodes have invaded the pancreas parenchyma and Borrmann 4 type carcinoma, the combined resection procedure should be adopted.

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Edited by MA Jing-Yun