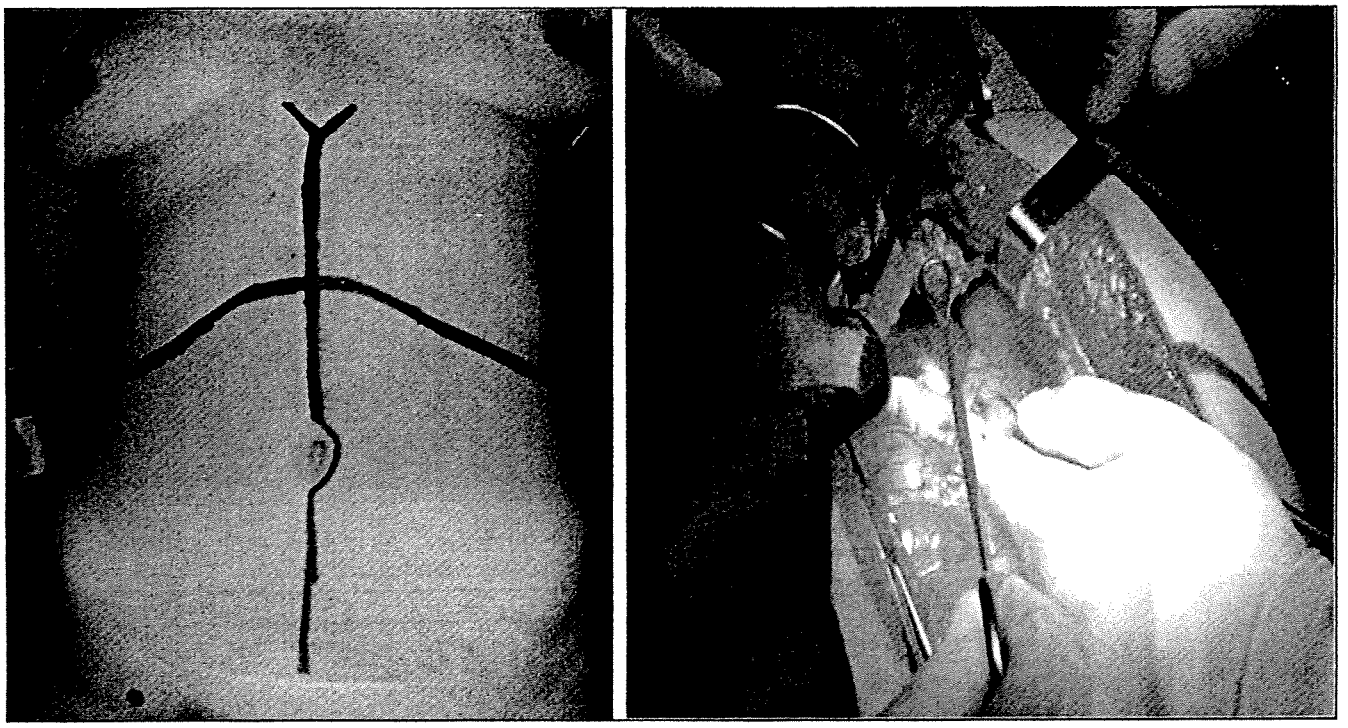

Fig. 16.2 – Abdominal incision and removal of xiphoid process.

intestinal- and diffuse-type cancers, some authors recommend to increase routinely the length of the proximal margin to at least 8 cm in case of diffuse cancer and to reduce it to 4 cm in case of intestinal type[7-9].

TOTAL D2 GASTRECTOMY

Incision and evaluation

In most IGCSG reference centres the upper midline incision from the xiphoid process till 2-3 cm above the umbilicus is the incision of choice performed by the majority of surgeons. The bilateral sub-costal incision and the so-called Mercedes incision (bilateral sub-costal incision associated to a high upper midline incision over the xiphoid process) are other incisions performed in western countries and in Japan[10].

In order to improve the access to the cardias and the subphrenic area, the xiphoid process should be removed at the xipho-sternal junction (Fig. 16.2).

Evaluation of the peritoneal cavity and peritoneal washing

A careful exploration of the peritoneal surface should be soon performed at the opening of the abdomen in order to exclude peritoneal spread of the cancer both on visceral and on parietal peritoneal leaves. At the same time the whole liver should be carefully examined at least also through intra operative ultrasonography in order to exclude unknown metastases. At the end of this intraoperative stage evaluation, the abdominal cavity is washed out with 100 mL of saline solution, while the stomach is carefully manipulated; the peritoneal lavage is then collected and immediately sent to the pathologist for intraoperative cytology (Fig. 16.3).

16B1 lymph node station sampling

The first surgical procedure entails a Kocher manoeuvre (Fig. 16.4), to access the para-aortic area

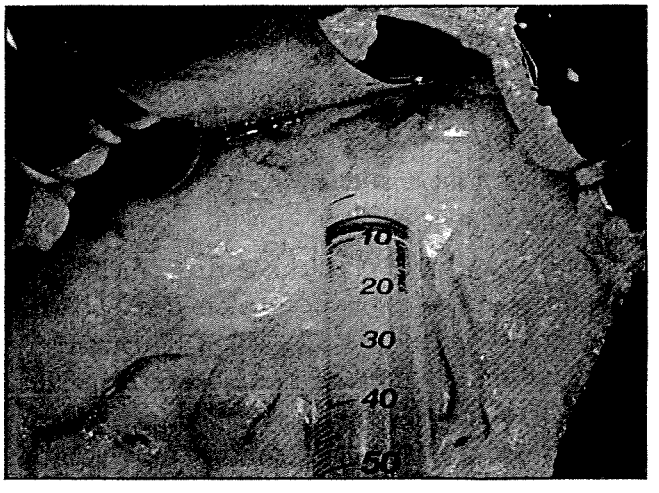

Fig. 16.3 – Peritoneal washing.

Fig. 16.4 – Kocker manouvre.

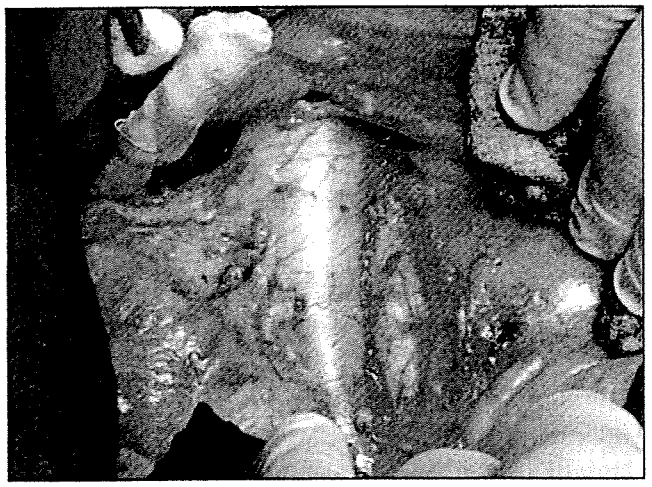

Fig. 16.5 – Interaorto-caval space: lymph node group 16B1.

(Fig. 16.5); this dissection allows a lymph node sampling of the group 16B1 (inferior para-aortic lymph nodes) for a frozen section analysis; the evidence of neoplastic cells at this level make the disease classified as M1 and any surgical treatment could not have a curative aim. On the other side, whenever a frozen section reveals no distant metastasis, a curative operation can be initiated.

☐ Dissection of the greater omentum from the transverse colon

Later (Figs. 16.6, 16.7), the greater omentum is dissected from the transverse colon together with the anterior sheet of the mesocolon (lesser sac). It is not sure that a complete removal of the greater omentum (omentectomy) and of the lesser sac (bursectomy) is necessary for T2 cancers; however it is absolutely necessary for T3 cancers which can involve the lesser sac. Many cancers that invade or are

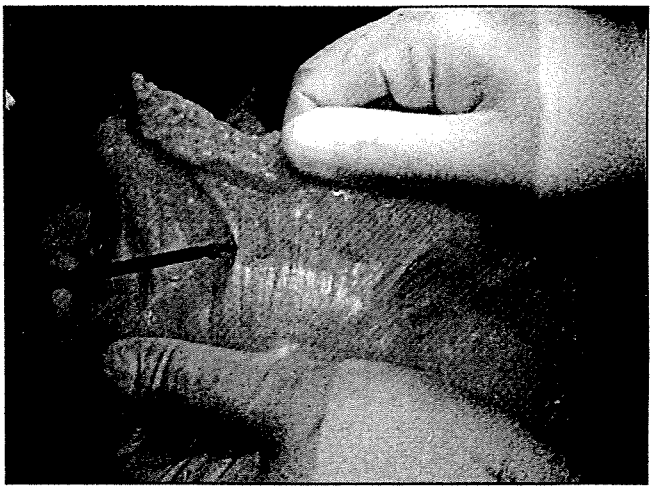

Fig. 16.6 – Dissection of the greater omentum and the anterior sheet of the transverse mesocolon.

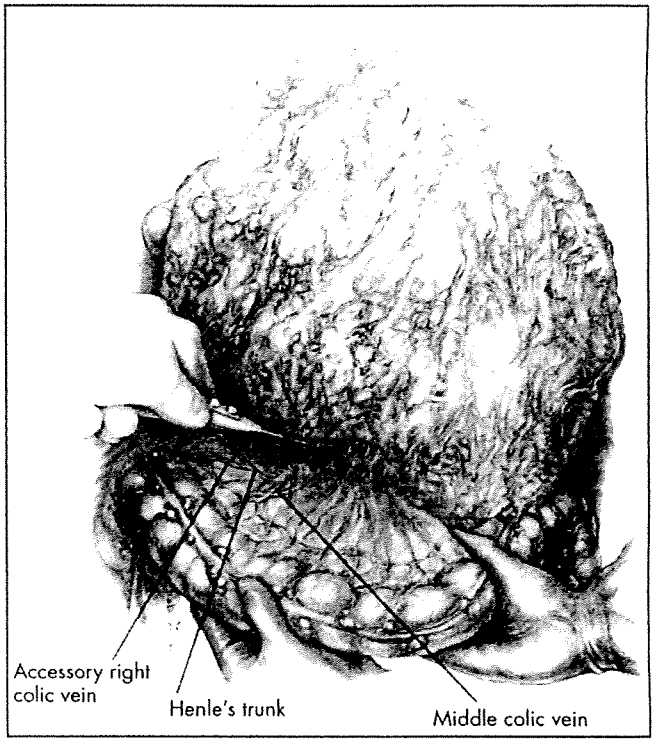

Fig. 16.7 – Dissection of the anterior leaf of mesocolon with omentum toward the pancreas. (Reproduced with permission of the author from Sasako[11]).

adherent to the anterior sheet of the mesocolon can be completely removed simply with the resection of the anterior sheet without resecting the transverse colon. The omentum is pulled up, while the first assistant spreads the transverse colon so that the operator can easily dissect the anterior sheet from the underlying tissue. This dissection is conducted from the hepatic flexure of the colon to the splenic one. The dissection is continued cranially from the colon toward the pancreatic body and tail and is

stopped close to the inferior border of the pancreas. On the right, the anterior sheet of the mesocolon continues on the duodenum and the head of the pancreas.

☐ Dissection of the right gastro-epiploic vein and pancreatic capsule

The dissection of the anterior sheet of the transverse mesocolon is continued towards right in order to find the right accessory colic vein which is followed cranially to the point where it joins Henle's trunk and the origin of the right gastro-epiploic vein (Fig. 16.8); this vein is ligated and divided at its origin. The middle colic vein, always outstanding on the mesocolon (Figs. 16.7-16.9), can lead this dissection towards Henle's trunk. A correct cranial traction of the omentum and the anterior leaf of the transverse mesocolon plays a fundamental role for this procedure (Fig. 16.10). As the mesocolon contains vessels emerging from behind the pancreas, the dissection of the anterior sheet of the mesocolon towards the pancreas leads to a plane behind it; therefore, at this point, the layer of dissection has to change from the posterior to the anterior surface of the pancreas. Several small vessels arising from behind the pancreas should be ligated and divided. The anterior leaf of the transverse mesocolon continues as "pancreatic capsule" which may contain lymphatic vessels and therefore should be dissected from the underlying pancreatic parenchyma and removed.

☐ Dissection of the right gastro-epiploic artery

The dissection of the pancreatic capsule is performed from the inferior to the superior border of the pancreas and from the middle of the pancreas body towards its head and the duodenum; the gastro-duodenal artery is found close to duodenum. This artery is followed caudally until the origin of the right gastro-epiploic artery, which is ligated and divided at its origin (Fig. 16.10). This dissection entails the removal of infrapyloric lymph nodes (group 6).

☐ Dissection of the left gastro-epiploic vessels

The dissection of the omentum and the anterior sheet of the transverse mesocolon continues to the left until the origin of the left gastroepiploic vessels is found, at the inferior border of the pancreas tail. The left gastroepiploic vessels will be accurately isolated, ligated and divided at their origin (Fig. 16.11); this dissection facilitates the complete removal of the left compartment of the lymph nodes of the greater curvature (group 4sb).

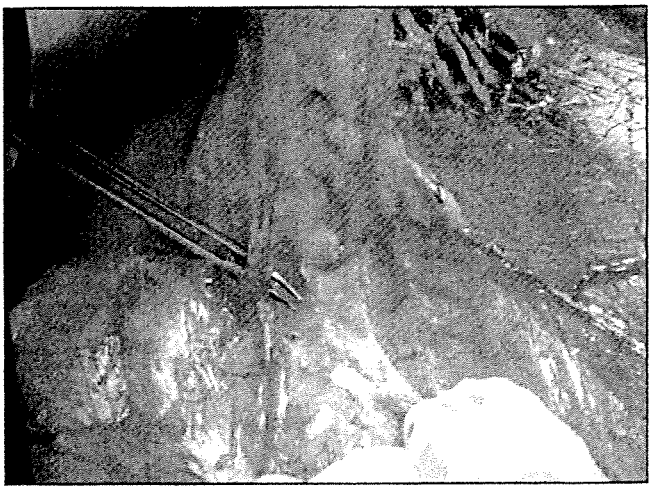

Fig. 16.8 – Right gastroepiploic vein.

Fig. 16.9 – Colic vessels and Henle's trunk.

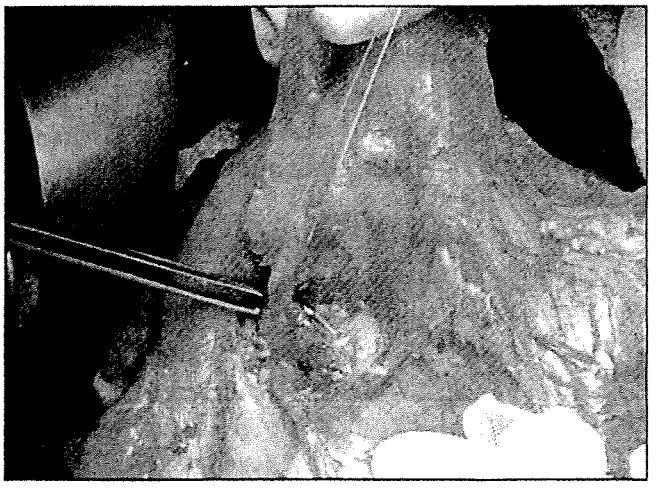

Fig. 16.10 – Right gastroepiploc artery.

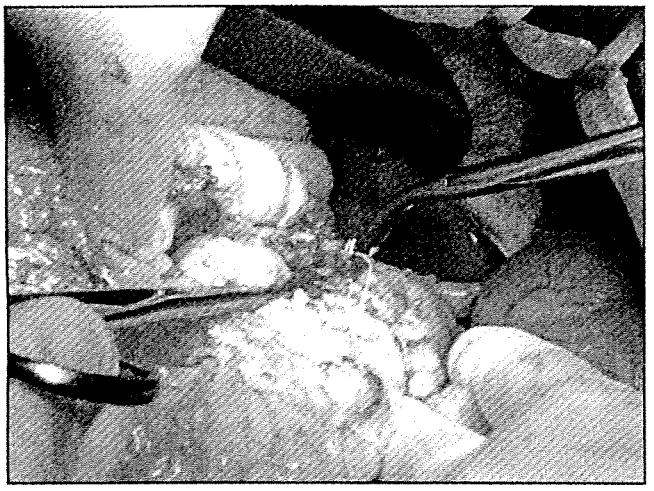

Fig. 16.11 – Left gastroepiploic vessels at their origin.

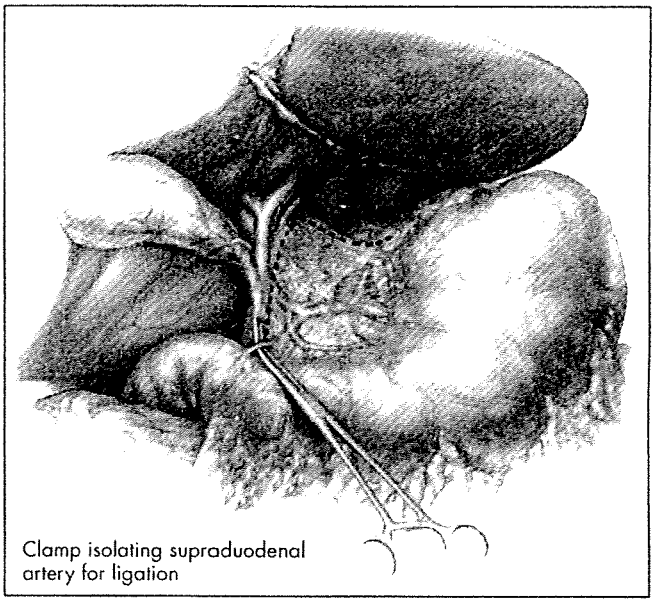

Fig. 16.12 – Incision line on lesser omentum. (Reproduced with permission of the author from Sasako[11]).

☐ Dissection of the lesser omentum

The dissection of the lesser omentum is a main step for a correct D2 lymphadenectomy. After the gastroepiploic artery is divided, the gastroduodenal artery is followed cranially until the common and proper hepatic arteries are recognised. There is usually a large lymph node lying in the space between the gastroduodenal and common hepatic artery and the superior border of the pancreas. Recent studies have documented that this node is often one of the sentinel node from tumors of the distal third of the stomach. The stomach is pulled down by the first assistant so that the lesser omentum and the serosa covering the esophageal hiatus are stretched. The lesser omentum is then divided 1 cm caudal to the attachment to the lateral sector of the liver (Figs. 16.12, 16.13), starting from the hiatus. In many cases an accessory left hepatic artery is found, arising from the left gastric artery (Fig. 16.14) and crossing the lesser omentum to the liver; in these cases it is necessary to preserve the accessory artery whenever it is possible, removing all the lymphatic tissue located around the origin of the left gastric vessel over the celiac trunk; in fact this tissue contains some of the lymph nodes of the station number 7.

The line of division of the peritoneal sheet of the lesser omentum just below the liver (Fig. 16.15) should be continued over the hepatoduodenal ligament, proceeding on the left side of the bile duct; the serosa of the ligament is then incised caudally toward the duodenum in order to discover the common hepatic artery at the level of its bifurcation in proper hepatic and gastro-duodenal arteries (Fig. 16.12).

Fig. 16.13 – Lesser sack, dissection from esophageal hiatus.

Fig. 16.14 – Left epatic artery branching off from left gastric artery.

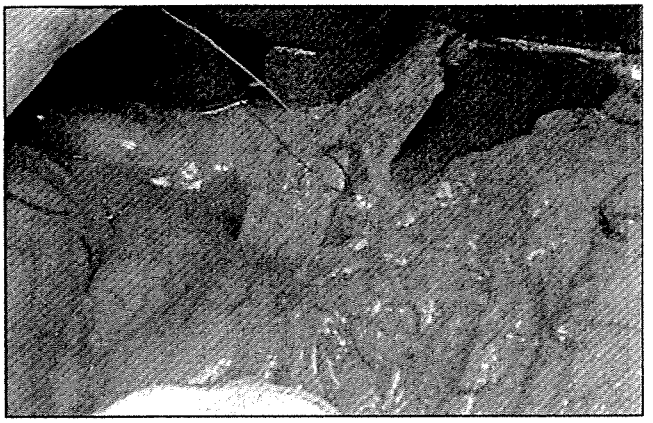

Fig. 16.15 – Lesser sack, dissection from the hiatus to the hepatoduodenal ligament.

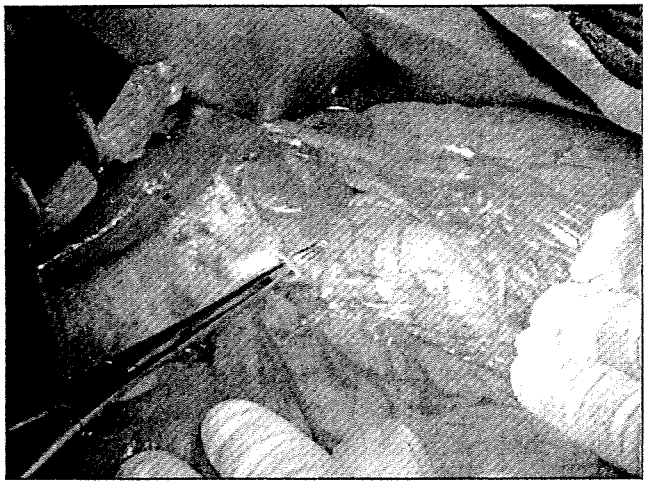

Fig. 16.16 – Dissection of the right gastric vessels.

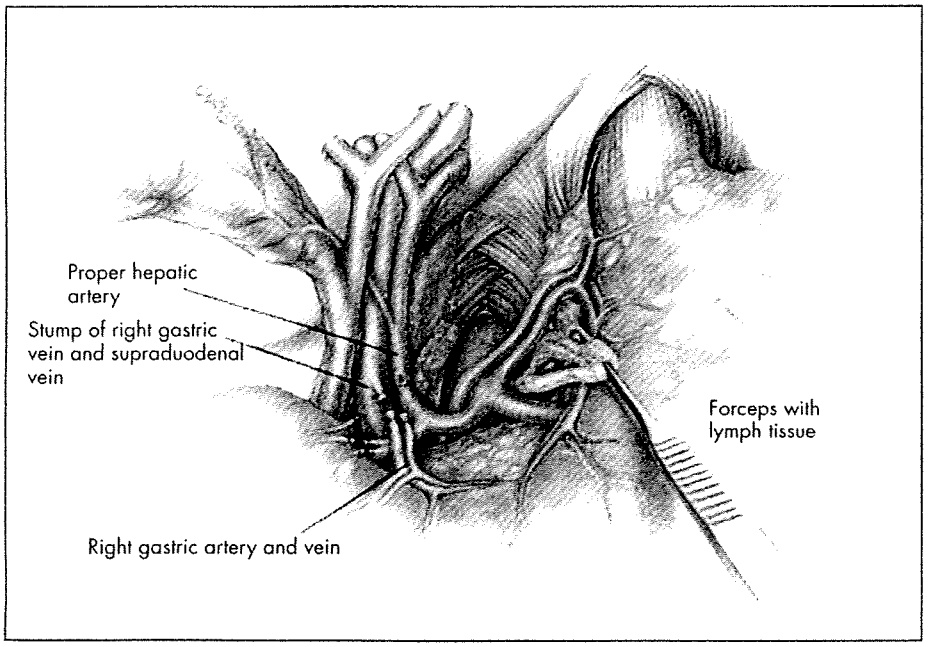

Fig. 16.17 – Division of the right gastric vessels. (Reproduced with permission of the author from Sasako[11]).

☐ Right gastric vessels isolation

The proximal ends of supraduodenal arteries are ligated at their origin from the gastroduodenal artery. Dissection of the hepato-duodenal ligament is continued to the bifurcation of the proper hepatic artery close to the hepatic hilum. The right and left hepatic arteries are recognised at this level and fatty connective tissue is dissected caudally and from the right to the left. The right gastric artery is found at this level, arising from either the gastroduodenal or proper hepatic artery in most cases. Sometimes the right gastric artery can arise from the left hepatic artery, expecially in case of low bifurcation of the proper hepatic artery (Figs. 16.12-16.17).

In this step of the procedure the first portion of the duodenum must be carefully dissected and divided in order to obtain the complete mobilisation of the stomach (Figs. 16.18, 16.19); this manouvre discovers the pancreatic surface and the loco-regional vascular structures originated from the celiac trunk. The pancreatic capsule must be completely removed together with the specimen (Figs. 16.20, 16.21), discovering the pancreatic parenchyma and the vascular and lymphatic tissue of its superior margin.

Before starting the dissection of the suprapancreatic nodes, lymph nodes along the left side and behind the portal vein are dissected, exposing the left and the posterior sides of the portal vein. Dissection of the suprapancreatic nodes, *i.e.*, common hepatic, coeliac, left gastric and splenic artery nodes, is now performed from right to left, from the portal vein to the middle of the splenic artery. The adipose tissue cranial to the pancreas contains many lymph nodes. This tissue is softly attached to the pancreatic parenchyma in most cases and therefore can be separated from the pancreas without difficulty. However in patients with a history of pancreatitis, dissection of suprapancreatic fatty tissue is difficult and the pancreas can be easily damaged, resulting in pancreatic leakages.

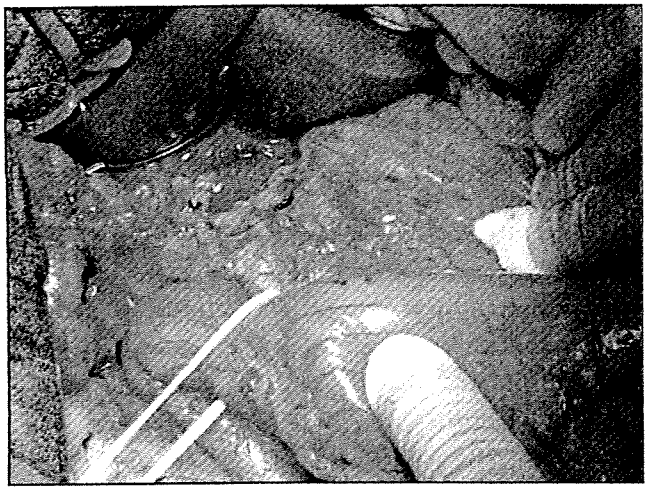

Fig. 16.18 – Duodenal dissection.

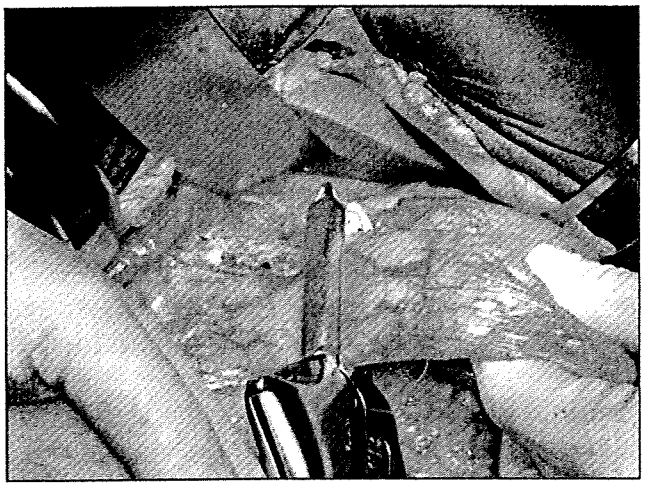

Fig. 16.19 – Duodenal division with a GIA device (Tyco srl).

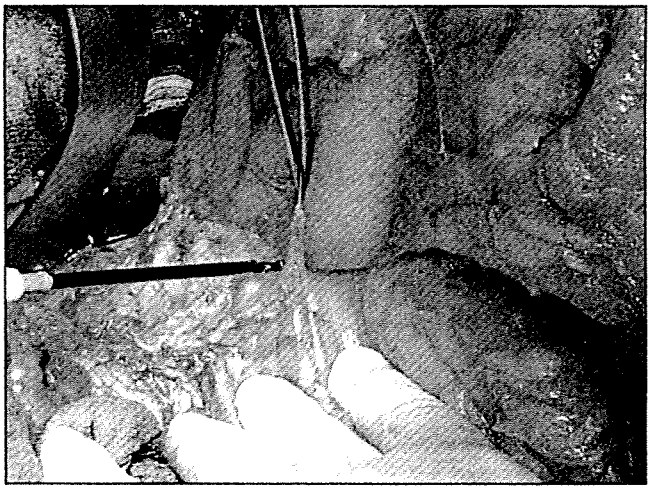

Fig. 16.20 – Removal of the pancreatic capsula.

glia should be preserved in case there are no obvious nodal metastases. The posterior border of this fatty tissue is the respective diaphragmatic crus on each side of the celiac artery. In about two thirds of the cases the left gastric vein is seen entering the portal vein close to the spleno-portal junction. The vein is then ligated and divided (Figs. 16.23, 16.24). After dissection of this tissue from the right crus, the right side of the celiac artery and the root of the left gastric artery can be recognized from its right side. The left gastric artery is sorrounded by thick nerve tissue, mainly celiac branches of the vagal nerves. Together with the nerve, the artery is ligated and divided near its origin (Figs. 16.23-16.25).

☐ Dissection of the left gastric vessels

Going towards left (Fig. 16.22), a left gastric vein crossing over the common hepatic artery or the splenic artery and entering the splenic vein is sometimes encountered during this stage of the procedure (about 30% of the cases). This vein should be ligated and divided near the superior border of the pancreas. The adipose tissue containing lymph nodes in this area is carefully dissected from the arteries and surrounding nerve tissue in a cranial direction. The nervous structures surrounding the arteries and including bilateral celiac gan-

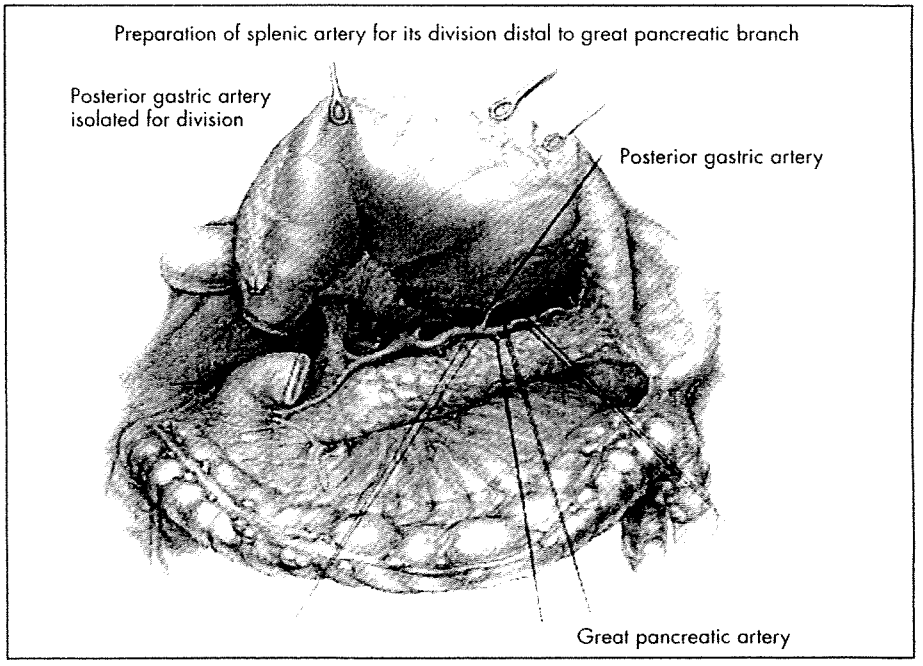

Fig. 16.21 – Removal of the pancreatic capsula (Reproduced with permission of the author from Sasako[11]).

☐ Spleen preserving D2 total gastrectomy (IGCSG technique)

Since the critical analysis of the two european randomised trials[1,2] documented that the increase of mortality and morbidity observed in the D2 arm was related to the pancreatectomy and splenectomy, usually performed as a routine step of the surgical standard treatment during total gastrectomy, several centres developed a different technique in order to preserve the pancreas and, in selected cases, also the spleen, during total gastrectomy.

Today there is not evidence of a survival benefit of splenectomy during total gastrectomy for cancer and data from JGCA randomised trial are not yet available. However, Japanese authors consider pancreas preserving D2 total gastrectomy with splenectomy as described by Maruyama (see below) the standard procedure for gastric cancer requiring total removal of the stomach; recently, following the worldwide discussion based on the several critical analysis of the recent European randomised trials, the Italian Gastric Cancer Study Group has developed a technique of total D2 gastrectomy that entails the preservation of the spleen in all cTNM T1 tumours, and in T2 and T3 cancers of the right part of the stomach, while requiring

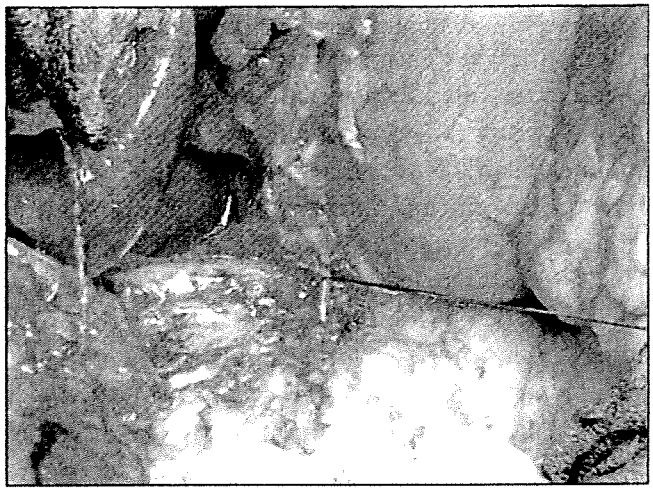

Fig. 16.24 – Left gastric vein.

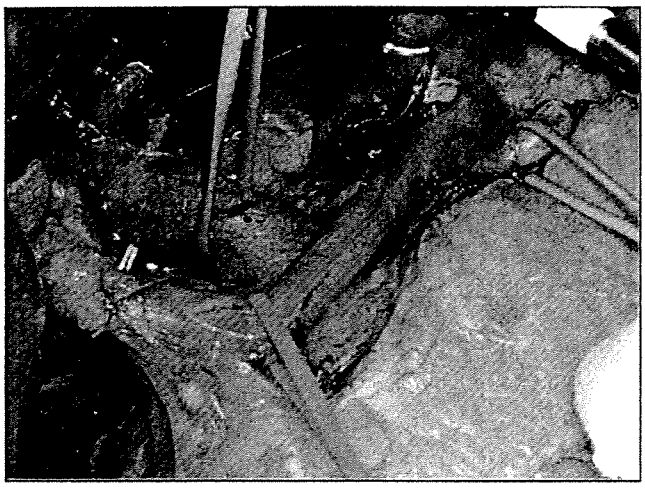

Fig. 16.22 – Final result of lymphatic dissection.

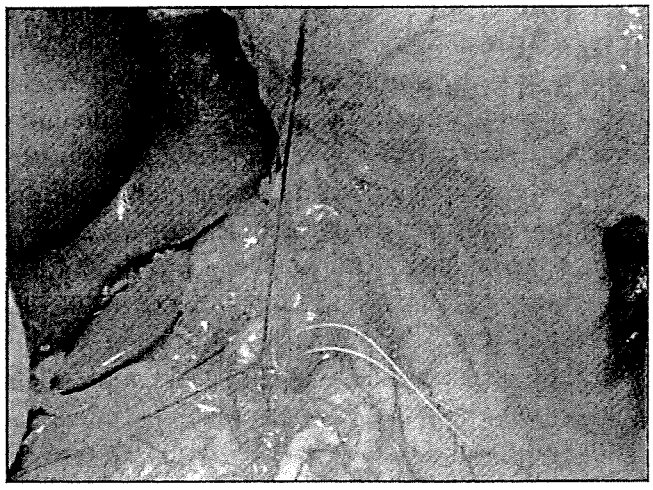

Fig. 16.25 – Left gastric artery.

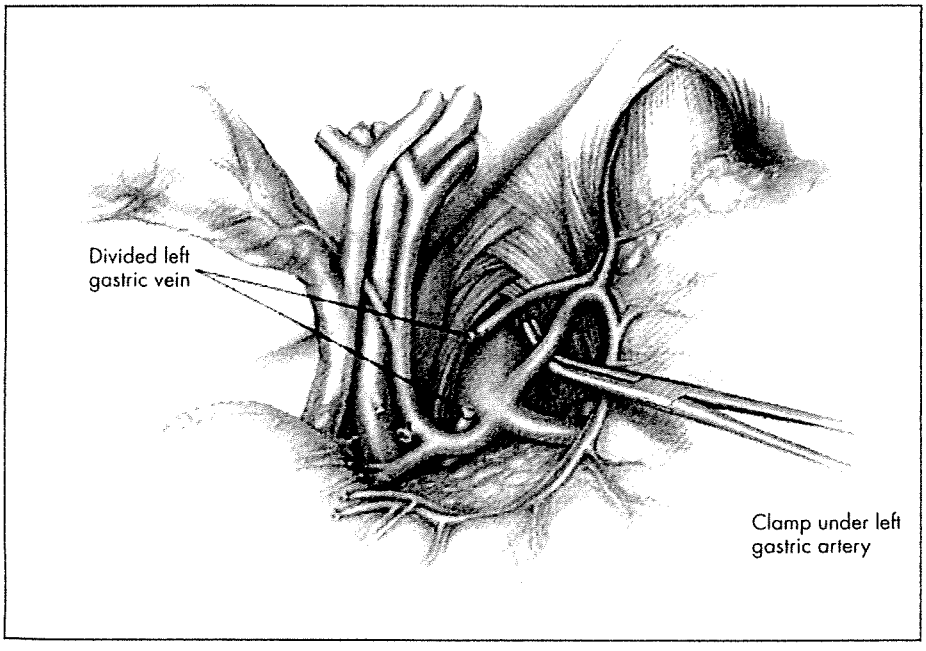

Fig. 16.23 – Dissection of left gastric vessels. (Reproduced with permission of the author from Sasako[11]).

splenectomy in all T4 cancers and in T2 and T3 tumors of the left part of the stomach. This technique will be described hereafter.

Following the lymphadenectomy on the left side of the celiac tripod, the dissection along the anterior surface of the splenic artery is continued until the posterior gastric vessels are encountered (Fig. 16.21); during total gastrectomy this artery should be dissected, ligated and divided at the origin of the splenic artery. All the lymph nodes along the splenic artery must be removed, starting from the proximal lymph nodes (group 11p). The dissection along the splenic artery continues until the pancreas tail, allowing the removal of all the lymph nodes of the distal group (group 11d).

Therefore, at the splenic *hilum*, we continue the dissection that was previously performed with the ligation and division of the left gastro-epiploic vessels, exposing the gastro-splenic ligament containing the short gastric vessels. During the surgical procedure with spleen preservation, the operation continues with the dissection of the short gastric vessels in order to completely remove all the lymph nodes of the group 4sa. This dissection is stopped on the left pericardial area. The stomach now can be further pulled up, exposing the left pericardial lymph nodes that should be complete removed dissecting the cardio-esophageal branch of the inferior left phrenic artery (Fig. 16.26), branching off to the left side of the cardia. The vagal trunks are divided at a suitable level based on the proximal extension of the tumor.

The continuous cranial pulling of the stomach by the first assistant (Fig. 16.21) facilitates to correctly expose the different structures to be dissected.

The abdominal esophagus is then divided with a safe surgical margin (Fig. 16.27) and the stomach is removed together with the loco-regional lymph node stations.

On the opposite, if splenectomy is performed (Fig. 16.28), the splenic artery should be divided distal to the origin of the great pancreatic artery (arteria pancreatica magna), which branches off at the same point of the posterior gastric artery, in order to improve blood supply to the tail of the pancreas as suggested by Sasako's modification of the original Maruyama's pancreas preserving D2 total gastrectomy. The splenic vein is preserved all along the surface of the pancreas and is ligated at pancreas tip of the tail, being necessary for the venous blood supply of the gland (see *pancreas preserving D2 total gastrectomy technique*).

Fig. 16.26 – Cardio-esophageal branch of the inferior left phrenic artery.

Fig. 16.27 – Esophageal section.

This kind of surgical treatment entails the removal of the following lymph nodes stations (according to the Japanese Gastric Cancer Association):

- group 1: right paracardial lymph nodes;
- group 2: left paracardial lymph nodes;
- group 3: lymph nodes along the lesser curvature;
- group 4 d, sb, sa: lymph nodes of the greater curvature (along the right and left gastro-epiploic vessels and the short gastric vessels);
- group 5: suprapyloric lymph nodes;
- group 6: infrapyloric lymph nodes;
- group 7: lymph nodes along the left gastric artery;
- group 8a: lymph nodes along the common hepatic artery (anterosuperior group);
- group 9: lymph nodes around the celiac artery;

- group 10: lymph nodes of the splenic hilum (only in case of splenectomy);
- group 11p and d: lymph nodes along the proximal and distal splenic artery;
- group 12 a + b: lymph nodes in the hepato-duodenal ligament, along the proper hepatic artery and the common bile duct.

☐ Reconstruction of the alimentary tract

The alimentary tract is reconstructed preferably through a stapled Roux-en-Y oesophago-jejunal anastomosis (Figs. 16.29-16.31). Usually the Roux limb (jejunum) should be placed through a slit of mesocolon just to the right of the middle colic vessels. The length of jejunum above the mesocolon should be not too long (as short as 10 cm) and streight, in order to avoid kinking and adhesion to the dissected surface. Usually we prefer and end-to-side esophago-jejunal anastomosis for safety, being careful to leave a very short jejunal stump to avoid a blind loop and stasis of food. The Roux limb is fixed to the transverse mesocolon with closure of the slit.

☐ Pancreas preserving D2 total gastrectomy (Maruyama technique)

Maruyama's technique represents the standard D2 gastrectomy with splenectomy and preservation of the pancreas for proximal cancer of the stomach.

Since the '60s Japanese reference centres for gastric surgery had been performing D2 total gastrectomy with splenectomy and distal pancreatectomy for proximal and middle third gastric cancer; this procedure entailed the complete removal of loco-regional lymph node stations, including peri-pancreatic (lymph nodes along the upper border of the pancreas) and splenic hilum lymph

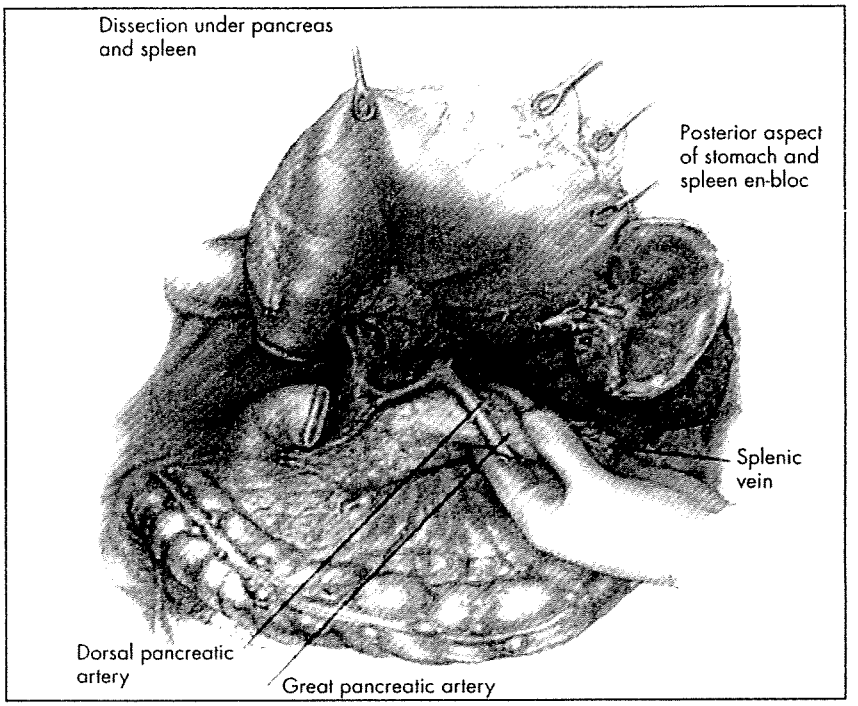

Fig. 16.28 – Vascular dissection at the body of the pancreas. (Reproduced with permission of the author from Sasako[11]).

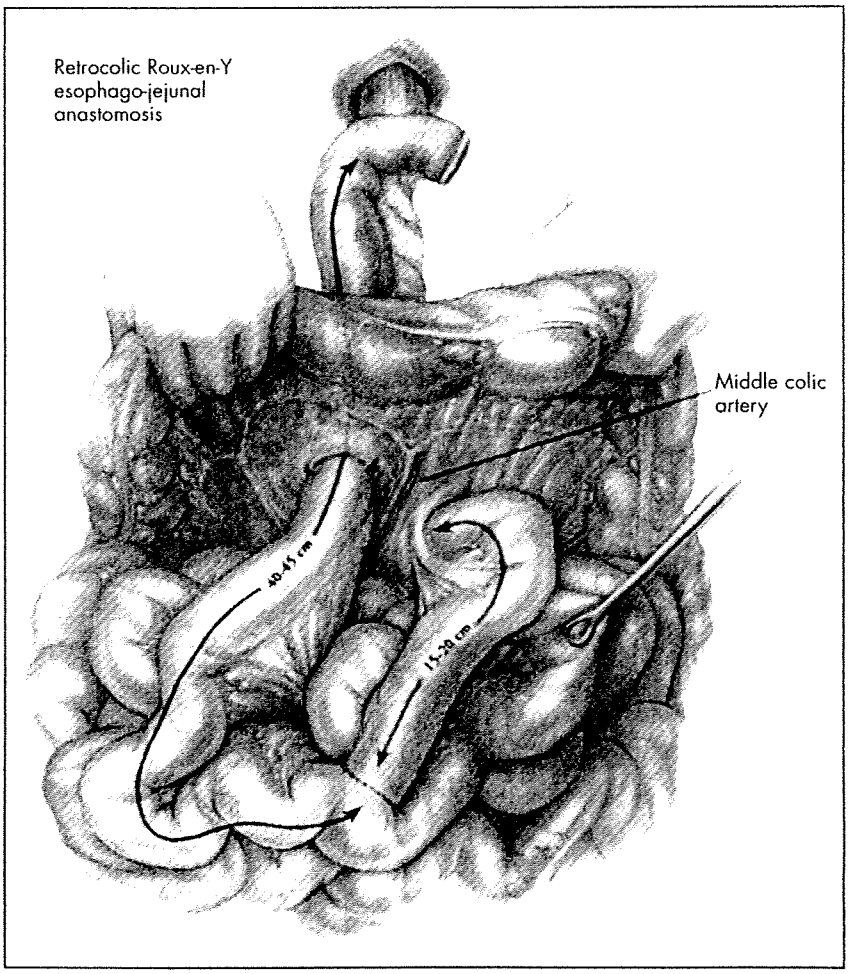

Fig. 16.29 – Reconstruction of the alimentary tract. (Reproduced with permission of the author from Sasako[11]).

Fig. 16.30 – Cardio-esophageal branch of the inferior left phrenic artery.

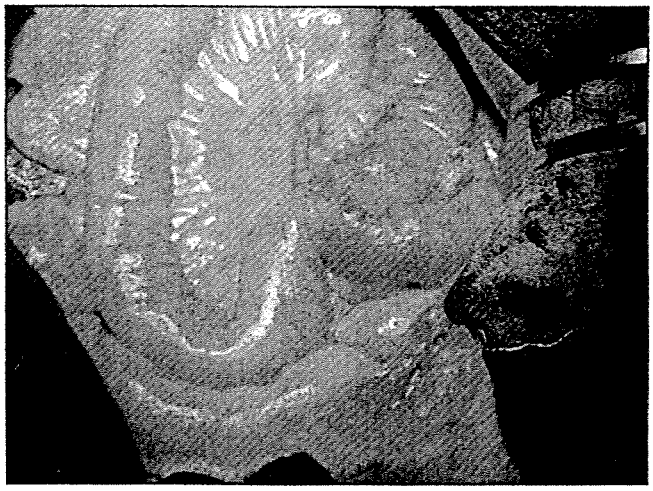

Fig. 16.31 – Jejuno-jejunal end to side anastomosis (trans-mesocolic Roux-en-y).

nodes. This operation was followed by a high rate of complications such as pancreatic fistulas, left sub-phrenic abscesses, serious pancreatitis and postoperative diabetes[11]. Even in recent studies, the mortality rate after splenectomy and distal pancreatectomy during total gastrectomy for proximal cancer was very high[12].

To avoid the increase of mortality and morbidity related to this procedure, Japanese Authors studied how to preserve the pancreas in proximal and middle third cancers; lymphatic channels from the stomach, lymph node metastasis around the pancreas, blood supply of the pancreas and technique of mobilization of the spleen and distal pancreas were studied. Endoscopic and intraoperative lymphography documented that lymphatic channels were located only in the subserosal space of the pancreas but never inside the parenchyma; this demonstration could theoretically support D2 total gastrectomy with pancreas preservation as a curative procedure for cancer[13,14].

In addition, histopathological studies[12] using resected and autopsy materials from gastric cancer patients revealed that lymph nodes are observed only in subserosal fatty connective tissue of the pancreas, particularly along the splenic artery and at the splenic hilum. This result supported data from lymphography, confirming that lymph node metastasis does not occur in pancreas parenchyma and that survival results should not be negatively affect by preservation of the pancreas (Fig. 16.32).

As lymph node metastasis are located along the splenic artery and this artery should be removed during D2 pancreas preserving total gastrectomy with splenectomy, the blood supply of the preserved pancreas has been indagated. Anatomical studies

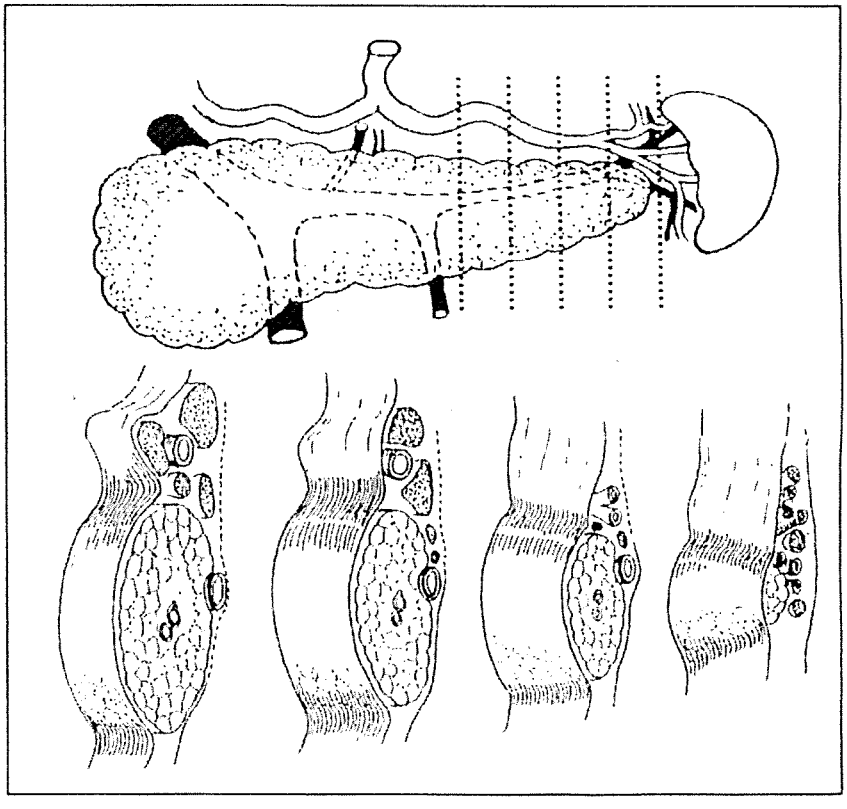

Fig. 16.32 – Lymphatic nodes and pancreas parenchyma (reproduced with permission from Maruyama[12]).

Fig. 16.33 – Periponcreatic dissection and removal of lymph nodes along the origin of the superior mesenteric vessels.

and celiac angiographies have clearly demonstrated that the distal pancreas receives blood supply through the transverse pancreatic artery (along the pancreatic duct) branching off from the dorsal pancreatic artery and that the dorsal pancreatic artery branches off 2 cm from the origin of the splenic artery from the celiac trunk. Therefore the division of the splenic artery distal to the origin of the dorsal pancreatic artery can preserve blood supply to the body and tail of the pancreas, as documented by celiac angiographies[12] of patients submitted to D2 pancreas preserving total gastrectomy with splenectomy. The splenic vein is adherent to the pancreas and is not surrounded by any lymphatic tissue. It can be preserved all along the pancreas parenchyma and divided at the tip of the tail of the pancreas, without negatively affect the curativity of the operation and the venous blood drainage of the pancreas.

Surgical technique

The aim of pancreas preservation technique is to completely remove the serosal membrane and all the fatty connective tissue containig lymphatic channels and lymph nodes from pancreatic parenchyma (Fig. 16.33).

After the completion of all the standard surgical procedure such as removal of the serosa from the pancreas head surface and lymph node dissection along the common hepatic artery, left gastric artery and celiac artery, the pancreas preserving procedure is started. The serosal membrane is carefully pealed off from the distal pancreas and all the fatty connective tissue including splenic artery lymph node is also completely removed from the slenic artery. Then the splenic artery is ligated and divided at about 2 cm from its origin from the celiac trunk paying attention to preserve the dorsal pancreatic artery whenever it branches off from the splenic artery and not from the celiac or the superior mesenteric vein as usual (Fig. 16.34).

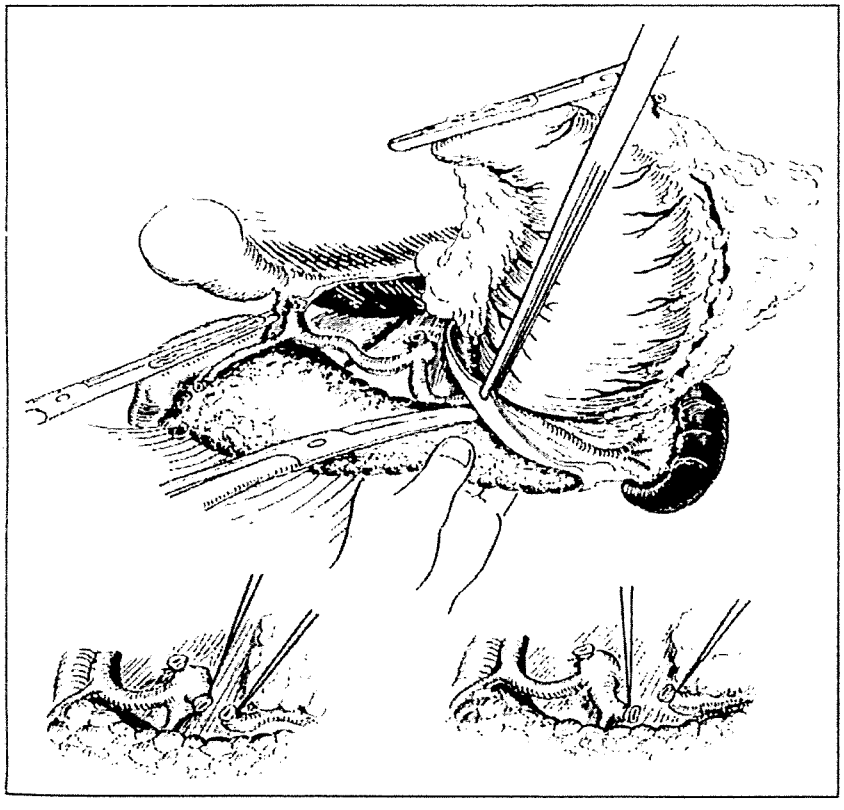

Fig. 16.34 – Preservation of dorsal pancreatic artery (reproduced with permission from Maruyama[12]).

Afterwards, it is necessary to completely mobilize the spleen and the distal pancreas (Fig. 16.35); in fact, embryologically, the spleen and the pancreas are located in the dorsal mesogastrium which has no vascular connection with the retro-peritoneum. The spleen and the pancreas can therefore be easily mobilised with safety and without bleeding following the ideal layer between the posterior surface of the pancreas and the anterior surface of the retro peritoneum, ligating and dividing only a couple of small vessels at the surface of left adrenal gland.

The mobilization goes on following the posterior surface of the splenic vein. The spleen is pulled up,

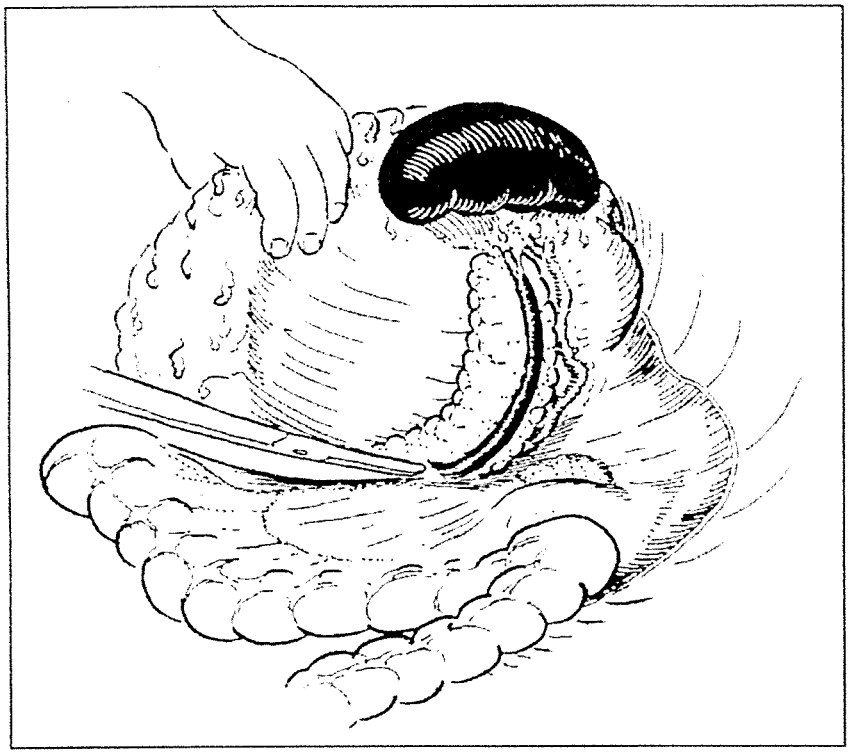

Fig. 16.35 – Mobilization of spleen and pancreas (reproduced with permission from Maruyama[12]).

the serosal membrane is removed from the posterior surface of distal pancreas and the tail of the pancreas is carefully exposed by removing the connective tissue from the gland. A couple of small pancreatic caudal arteries can be divided; the splenic vein is double ligated and divided at the tip of the tail of the pancreas (Figs. 16.36, 16.37). Fatty connective tissue is carefully removed from the pancreas upper border, together with the distal part of the splenic artery, by ligating and dividing a couple of small branches to the parenchyma.

The spleen, the splenic artery and all the fatty connective tissue containing lymph nodes around the pancreas are removed, while the pancreatic parenchyma and splenic vein are preserved.

COMMENTS

Maruyama *et al.* demonstrated that pancreas preserving D2 total gastrectomy with splenectomy reduces complications related to pancreas resection such as pancreatic juice leakage, left subphrenic abscesses, severe pancreatitis and postoperative diabetes, without negatively affect the curativity of the procedure[12].

The procedure is indicated for patients with cancer of the proximal and middle third of the somach without direct involvement of the pancreas and/or large macroscopic metastasis along the upper border of the pancreas.

Fig. 16.36 – Splenectomy with splenic vein preservation (reproduced with permission from Maruyama[12]).

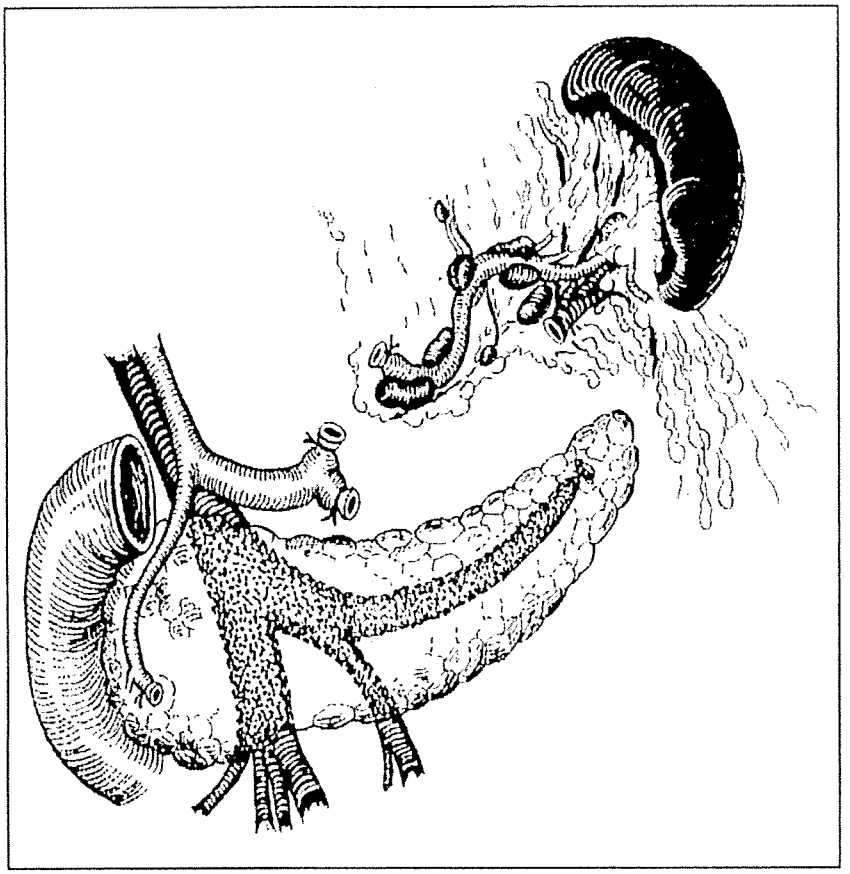

Fig. 16.37 – Splenectomy with removal of splenic artery (reproduced with permission from Maruyama[12]).

D2 DISTAL GASTRECTOMY

The surgical steps of total gastrectomy are reproduced for a partial gastrectomy: careful exploration of the abdominal cavity, peritoneal washing for intraoperative cytology, removal of the lymph nodes of the group 16B1 for intraoperative frozen section.

Lymph node dissection is continued until the removal of lymph node stations of the proximal part of the splenic artery (group 11p). A particular attention must be paid in order not to damage the splenic artery during this dissection in order to absolutely preserve the spleen and the pancreas. The posterior gastric artery must be preserved as well in order to guarantee a good blood supply of the gastric remnant together with the short gastric vessels.

The right paracardial lymph nodes (group 1) should be removed (Fig. 16.38) even if the proximal third of the stomach will be preserved; on the opposite, left paracardial nodes (group 2) should not be resected.

In order to remove the right paracardial lymph nodes all the branches towards the gastric wall departing from the superior gastro-oesophageal branch of the left gastric artery should be ligated and divided (Fig. 16.38); this will entail the removal of the fatty tissue of the lesser curvature containing lymph nodes group 1, from the origin of the superior gastro-oesophageal artery to the cardia. Lymph node stations No 3 (lesser curvature) and No 5 (right gastric artery) will be removed together with the specimen.

On the greater curvature the lymph node dissection should preserve the short gastric vessels, in order to guarantee a good blood supply of the gastric proximal third together with the posterior gastric artery.

As for total gastrectomy, lymphadenectomy will entail also lymph nodes of the hepatoduodenal ligament, common hepatic artery, coeliac trunk, left gastric artery, as well as the splenic artery until the origin of the posterior gastric artery.

For a complete D2 distal gastrectomy the removal of the lymph nodes of the superior mesenteric vein at the inferior pancreatic border (Fig. 16.33, LN group 14v) is required as well. For this procedure all the fatty tissue above the anterior face of the superior mesenteric vein, from the inferior

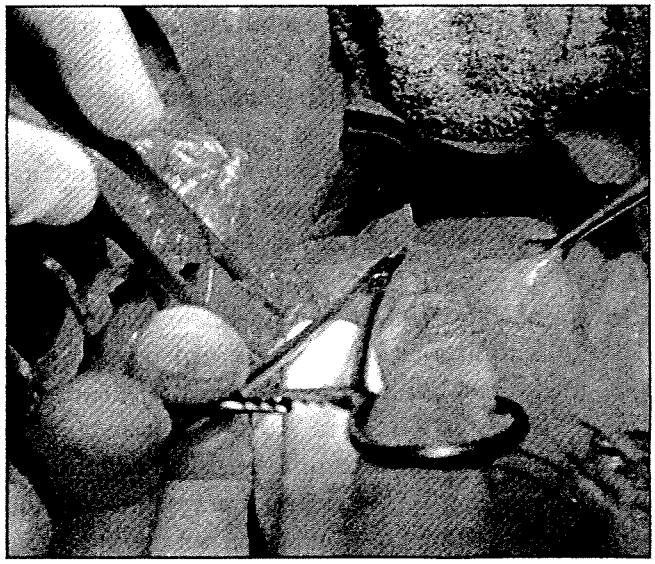

Fig. 16.38 – Dissection of right paracardial lymph nodes.

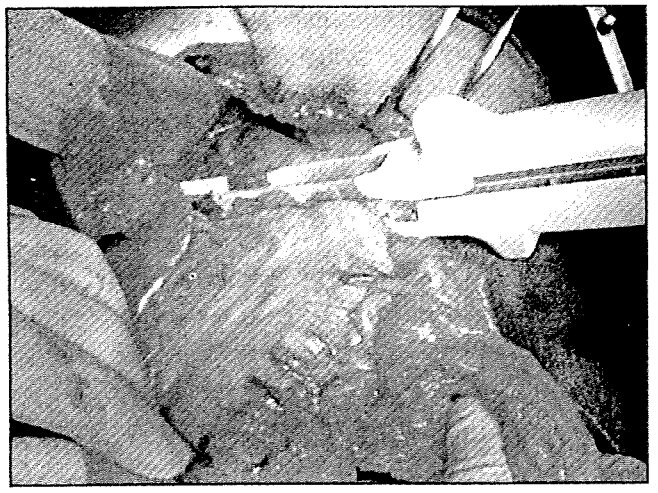

Fig. 16.39 – Division of the stomach between its proximal and middle third.

Fig. 16.40 – Manual seromuscolar reinforcement of stapled suture of gastric stump.

margin of the pancreas until its first branch of division should be dissected and removed.

The following lymph node stations (according to the Japanese Gastric Cancer Association) should be removed:

- group 1: right paracardial lymph nodes;
- group 3: lymph nodes along the lesser curvature;
- group 4sb, d: lymph nodes along the greater curvature (along the left gastro-epiploic vessels, along the right gastro-epiploic vessels);
- group 5: suprapyloric lymph nodes;
- group 6: infrapyloric lymph nodes;
- group 7: lymph nodes along the left gastric artery;
- group 8a: lymph nodes along the common hepatic artery, anterosuperior group;
- group 9: lymph nodes around the celiac artery;
- group 11p: lymph node along the proximal splenic artery, until the branching off of the posterior gastric artery;
- group 12a: lymph nodes in the hepatoduodenal ligament (along the proper hepatic artery);
- group 14v: lymph nodes along the superior mesenteric vein.

The stomach is resected with a linear stapler (Fig. 16.39). A continous suture is performed in order to guarantee the complete blood control of the suture line.

The reconstruction technique usually perfomed by the IGCSG surgical team is a trans-mesocolic end-to-side Roux-en-Y gastro-jejunostomy, performed with a mechanical stapler (Figs. 16.40-16.42).

Fig. 16.41 – Introduction of the envil into gastric stump.

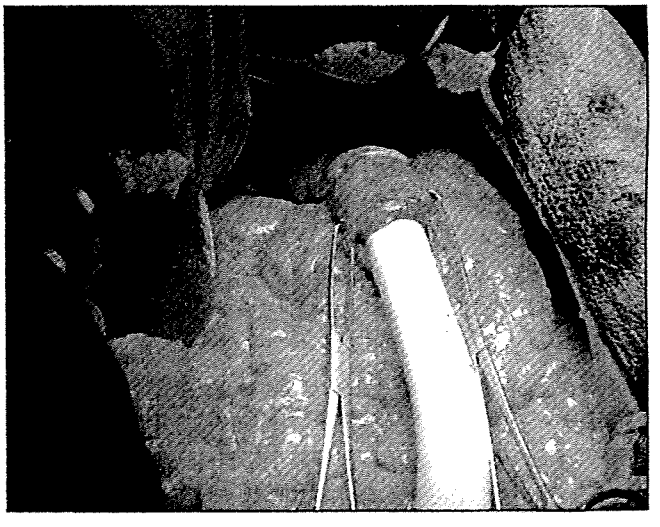

Fig. 16.42 – End-to-side stapled gastro-jejunal anastomosis with CEEA.

Diffuse cancers

Total D2 gastrectomy is the treatment of choice for diffuse tumours. In these cases, lymphadenectomy entails the removal of the following stations:
- group 1: right paracardial lymph nodes;
- group 2: left paracardial lymph nodes;
- group 3: lymph nodes along the lesser curvature;
- group 4 sa, sb, d: lymph nodes along the greater curvature (along the short gastric vessels, along the left gastro-epiploic vessels, along the right gastro-epiploic vessels);
- group 5: suprapyloric lymph nodes;
- group 6: infrapyloric lymph nodes;
- group 7: lymph nodes along the left gastric artery;
- group 8a: lymph nodes along the common hepatic artery, anterosuperior group;
- group 9: lymph nodes around the celiac artery;
- group 10: lymph nodes at the splenic hilum;
- group 11p: lymph node along the proximal splenic artery, until the branching off of the posterior gastric artery;
- group 12a: lymph nodes in the hepatoduodenal ligament (along the proper hepatic artery);
- group 14v: lymph nodes along the superior mesenteric vein.

Postoperative care

A good postoperative care enables an early recovery of patient's functions and a rapid mobilization, in order to prevent complications linked to hospitalization.

Nutrition

Patients submitted to total or distal gastrectomy receive artificial nutrition (parenteral or enteral nutrition) in order to enable a rapid consolidation of the surgical sutures and prevent the peritoneal spreading in case of anastomotic leakage.

Seven days after surgery, an upper GI series with a water-soluble contrast medium is requested to verify the healing of the anastomosis; only after the regularity of the suture has been documented patients can restart oral intake.

Hence, artificial nutrition plays a main role in these patients. At this purpose, as it is demonstrated that the enteral feeding can reproduce the physiological oral intake also in the early postoperative period, after total gastrectomy patients receive total parenteral nutrition together with enteral nutrition, which is administered through a catheter jejunostomy performed during the main procedure, following the technique described by Delaney[15,16] (Fig. 16.43).

The TPN is calibrated according to patient's demands. Total parenteral and enteral nutrition are managed by a multidisciplinary board of surgeons, nutritionists and dieticians; patient's nutritional schedule is revalued every single day from medical board and eventually modified depending on patient's specific demands during his postoperative course.

Enteral nutrition can be started on the first postoperative day; during the first 24-48 hours 5% glucose solutions, than nutritional solutions with high osmolarity are used.

Sometimes enteral nutrition through catheter jejunostomy can cause significant diarrhoea syndromes; in these cases enteral nutrition is stopped and TPN will be the sole artificial nutrition administered.

Analgesia

The opioids have a significant role in postoperative analgesia; during the first stage of postoperative course, opioids are given by intravenous administration often through elastomeric pumps. After few days of treatment the opioids are usually replaced by other kinds of drugs (*i.e.* paracetamol, NSAID), with a good control of postoperative surgical pain and less negative effect on bowel voiding.

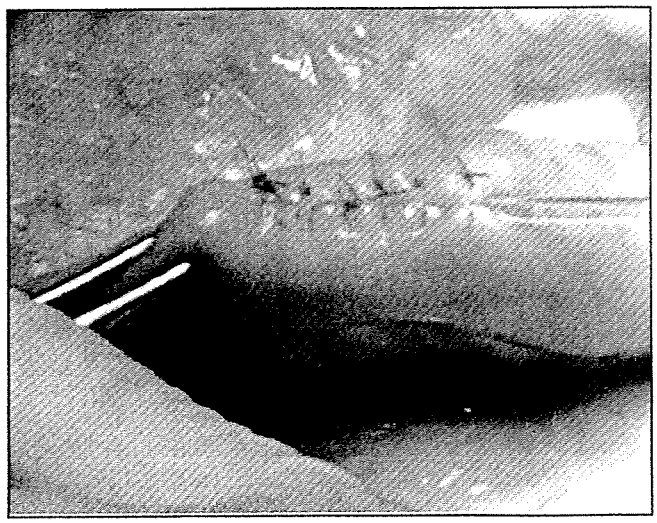

Fig. 16.43 – Nutritional catheter jejunostomy: Witzel's suture.

Recently, postoperative analgesia is obtained also through epidural infusion of analgesic and anaesthestic drugs administered through a catheter placed intraoperatively. The synergy between intravenous and spinal analgesia allows a complete control of surgical postoperative pain and a prompt recovery of patient's mobilization.

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Surgical Treatment of Advanced Gastric Cancer: Japanese Perspective

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Key Words
Esophagogastric junction · Gastric cancer, advanced · Surgical treatment

Abstract
The results of clinical trials regarding surgery of curable advanced gastric cancer and esophagogastric junction (EGJ) tumors are reviewed and summarized. Four clinical trials have evaluated D2 dissection for curable gastric cancer in the West. Two large trials in the UK and the Netherlands failed to prove the efficacy of D2 dissection. However, these trials had critical weak points. As they were carried out in a number of hospitals where there was no experience with this surgery, the quality of surgery and postoperative care were very poor making the hospital mortality unacceptably high. After these trials, an Italian group started a phase II study in 8 hospitals with a relatively high volume to confirm the safety of this procedure for Caucasians. They achieved 3% mortality, which was much smaller than that of even D1 in the former trials. These results first highlighted the importance of learning and hospital volume in D2 dissection. Survival results of the Dutch trial showed some difference between D1 and D2, but the difference was not statistically significant. This was attributed to the high hospital mortality and poor quality of surgery, especially low compliance of D2 and the high rate of extension of D1, making this comparison similar to that between D1.3 and D1.7. The results of the phase III study by the Italian group are awaited. Recently a Taiwanese trial proved the benefit of D2 dissection over D1 in a phase III trial. This was a single institutional trial with a sample size of 221 patients. The 5-year survival rate of D2 and D1 was 59.5 and 53.6%, respectively ($p = 0.04$). The Dutch trials for EGJ tumors showed a large difference in overall survival between the transthoracic and transhiatal approach for Siewert type 1 and 2 tumors, but this was not statistically significant, most likely due to the small sample size. In the subgroup analysis, they demonstrated that there was no survival difference in Siewert type 2 but a large difference in Siewert type 1. A Japanese study showed that there is no benefit to the thoraco-abdominal approach over the transhiatal approach for EGJ tumors whose invasion in the esophagus is 3 cm or less. These two trials clearly demonstrated that mediastinal dissection through a right thoracotomy is recommendable for Siewert type 1, while the transhiatal approach should be considered as standard for Siewert type 2.

Background

In the guidelines of the Japan Gastric Cancer Association, standard surgery for curable advanced gastric cancer is defined as a more than 2/3 gastrectomy with D2 dissection [1]. With the results of several important

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Table 1. Morbidity and mortality after D2 dissection and hospital volume

Trial	Type	n	Number of patients per hospital per year	Mortality %	Morbidity %	Reference
Hong Kong	RCT	30	7.5	3	57	Robertson et al. [7]
MRC	RCT	200	1.5	13	46	Cuschieri et al. [8]
Dutch	RCT	331	1.0	10	43	Bonenkamp et al. [2]
Taiwanese	RCT	211	18.5	0	17	Wu et al. [16]
IGCSG	Phase II	191	8.0	3	21	Degiuli et al. [4]
IGCSG	RCT	82	4.3	0	16	Degiuli et al. [6]
Italian study	Retro	451	21.5	2	17	Roviello et al. [9]

RCT = Randomized controlled trial; MRC = Medical Research Council; IGCSG = Italian Gastric Cancer Study Group.

clinical trials, not only in surgery but also multidisciplinary treatment, this policy of the Japanese guidelines might be challenged. In this article, the Japanese perspective of curative surgery for advanced gastric cancer is explained.

Results of European Trials

There have been four European clinical trials on D2 dissection for curable gastric cancer [2–5]. Three of them were phase III trials and the remainder was the only phase II trial in the world. The phase III trials were carried out by the Medical Research Council (MRC) [3], the Dutch Gastric Cancer Group (DGCG) [2] and the Italian Gastric Cancer Study Group (IGCSG) [5]. The first two trials have already shown negative results, while the long-term results of the last one are awaited. After the first two large phase III trials showed quite high hospital mortality after D2 dissection on Caucasians, the IGCSG started with a phase II study to confirm the safety of the D2 dissection in their population [4].

Morbidity and Mortality of D2 Dissection in These Trials

The Dutch and the MRC studies showed extremely high hospital mortality after D2 dissection, 10 and 13%, respectively. Such a high mortality is no longer accepted for any cancer surgery today. These results were heavily criticized and attributed to a very low hospital volume [6]. Table 1 shows the clear negative correlation between hospital volume and hospital mortality after D2 dissection in the literature. This high mortality was also attributed to splenectomy and pancreatectomy. Especially in the MRC trial, many surgeons thought that D2 distal gastrectomy included splenectomy, and splenectomy was carried out in many distal gastrectomy cases [10]. This was based on the misunderstanding of the definition of D2 gastrectomy by the Japanese Research Society for Gastric Cancer [11]. In Japan, splenectomy was included in D2 dissection only when a total gastrectomy was carried out. Together with thorough lymph node dissection of the lesser curvature, splenectomy causes serious ischemia of the remnant stomach, necrosis of the remnant stomach or anastomotic leakage. This was also the case in the DGCG trial [12]. In the multivariate analysis of hospital mortality, splenectomy was one of the factors most responsible for mortality. The lack of experience in treating major surgical complications after D2 dissection, namely, anastomotic leakage, pancreatic fistula (juice leak) or intra-abdominal abscess, led to a much higher mortality than a Japanese specialist center where a few hundred patients were treated yearly (table 2) [6]. With less than a few cases yearly, surgeons can never learn how to treat these major complications to avoid treatment-related death. This high mortality after D2 dissection in the Dutch trial might also be attributed to the greater fragility of the Dutch compared with the Japanese. However, the results of another Dutch trial comparing a transthoracic esophagogastrectomy via right thoracotomy with a transhiatal approach for esophagogastric junction (EGJ) tumors showed a much lower mortality in the both treatment arms, 4% for the former and 2% for the latter [13]. This trial was carried out exclusively in two major cancer hospitals which have a reasonably high hospital volume. This suggests that high mortality in the D1/D2 trial was not attributed to the fragility of the Dutch patients but to the very low hospital volume.

Table 2. Mortality after postoperative major surgical complications

Complication	Dutch trial (n = 711)			NCCH trial (1982–1987; n = 1,197)			p
	deceased patients	affected patients	%	deceased patients	affected patients	%	
Leakage	19	46	41.3	12	84	14.3	0.0005
Distal	9	22	40.1	2	23	8.7	0.012
Total	10	24	41.7	10	60	16.7	0.0047
Abscess or pancreatic fistula	19	91	20.9	2	75	2.7	0.0004

NCCH = National Cancer Center Hospital.

After these two trials with dismal short-term results, the IGCSG started a phase II trial to confirm the safety. Actually a 3% mortality was found in 8 hospitals with a total of 191 patients [4]. They avoided the routine use of distal pancreatectomy in cases of total gastrectomy; instead they adopted pancreas-preserving total gastrectomy, the so-called Maruyama technique [5]. Thus they avoided splenectomy in distal gastrectomy and distal pancreatectomy in total gastrectomy. The morbidity and mortality shown by the phase II study was confirmed by the results of the interim analysis of the IGCSG phase III trial. Hospital mortality was 1.3% after D1 but 0% after D2 gastrectomy in this study [6].

Survival Results after D2 Dissection

In the MRC trial, the survival curve of D2 was never better than that of D1 until the end of the trial. In the Dutch trial, the survival curve of D2 caught up with that of D1 after 4 years and remained superior, but the difference between D1 and D2 survival never reached statistical significance. Practically, in the MRC trial, there was no quality control of surgery and the quality seemed poor due to the mortality. In the Dutch trial, there were several efforts to control the quality of performance including direct tuition of the D2 dissection in the operation theater and quality evaluation by the number of dissected nodes. According to their results, there were many cases in the D1 group where more extended dissection than D1 was actually carried out and many patients in the D2 group underwent less than D2 dissection [14]. Eventually they compared D1.3 versus D1.7, for example, minimizing the difference between the arms. Low-quality surgery together with a much higher mortality immediately after surgery could explain why D2 dissection was not found to be beneficial. In fact, the Italian group showed much better survival results in their phase II trial than those of the Dutch trial [15]. The 5-year survival rates for stages IA, IB, II, IIIA and IIIB were 93, 88, 60, 40 and 20%, respectively, while those in the Dutch trial were 81, 61, 42, 28 and 13%, respectively. Survival results of the phase III study by the IGCSG are awaited.

Results of Taiwanese Trial

Recently a Taiwanese hospital published the results of a phase III study comparing D1 versus D2/3 surgery for curable gastric cancer in a single institution [16]. Their D3 includes lymph node stations in the hepatoduodenal ligament, on the superior mesenteric vein, behind the common hepatic artery and on the posterior pancreatic surface in addition to D2 dissection, according to the 1st English Edition of the Japanese Classification of Gastric Carcinoma [17]. They showed statistically significant improvement in survival by D2/3 surgery over D1. The 5-year overall survival of D2/3 and D1 was 59.5 and 53.6%, respectively ($p = 0.04$; fig. 1). This study included only three surgeons at a single institution, therefore the quality of surgery in this study seemed to be more identical than in multicenter trials. This is the first randomized controlled study which showed significantly better overall survival of D2/3 surgery than D1 in the world. There are several remarkable differences between this study and the Dutch study. Due to the much higher hospital volume and good quality control at a single institution, the hospital mortality after D2/3 was 0% in this study, while it was as high as 10% in the Dutch trial. More patients in the Taiwanese study had antral tumors and underwent distal subtotal gastrectomy than the Dutch trial. The proportion of those who underwent distal subtotal gastrectomy in this study and the Dutch study was 76 and 66%, respectively. Due to the rather small sample size and

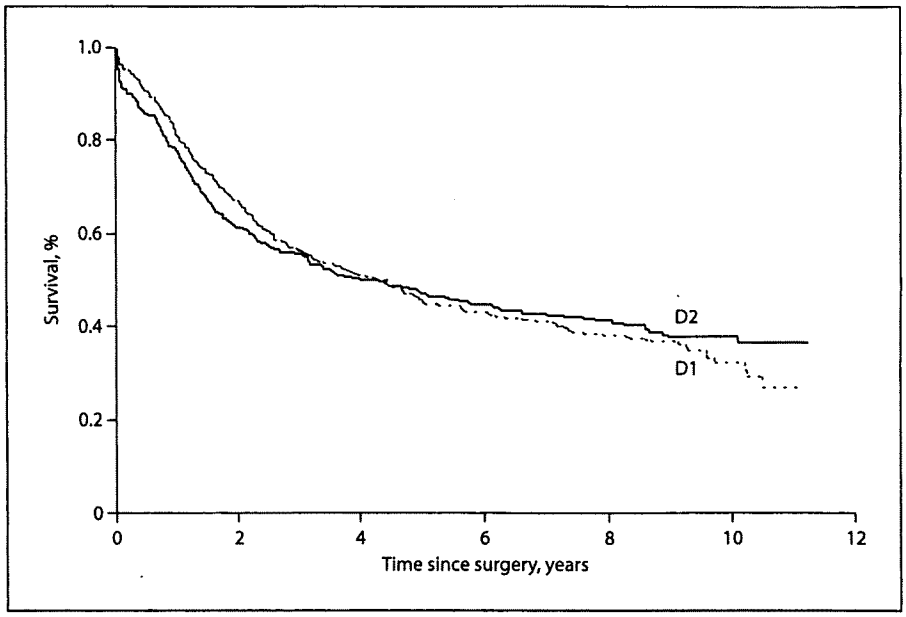

Fig. 1. Overall survival curves of the entire patient population by treatment groups in the Dutch trial.

modest survival benefit, this study cannot be considered as solid evidence for the superiority of D2 over D1 dissection.

Results of Adjuvant Chemoradiotherapy

A phase III study comparing surgery alone with postoperative adjuvant chemoradiotherapy (CRT), the INT0116/SWOG9008, showed a large survival benefit of CRT for curable gastric cancer; the median survival time of surgery alone was 27 months, compared with 36 months for CRT [18]. The hazard ratio for death was 1.35 (95% CI 1.09–1.66; $p = 0.005$). In this trial, the tested arm included curative surgery and radiation therapy of 45 Gy with combination chemotherapy using fluorouracil and leucovorin (5 courses of 5-day continuous infusion, including 2 courses of concomitant administration). However, detailed analysis of the type of surgery revealed that 54 and 36% of the patients underwent D0 and D1 surgery, respectively, while only 10% underwent D2 dissection. Although there was no statistically significant interaction between the subgroups divided by the degree of lymph node dissection and the effect of treatment, a benefit from treatment was observed only in the D0 or D1 group in the subset analysis [19]. In the retrospective detailed analysis, the researchers of this study found that surgical undertreatment clearly undermined the survival of patients [20]. Thus this study for the first time proved the efficacy of local control by radiation for gastric cancer and proved that limited surgery alone cannot be sufficient treatment for this cancer.

The patient population enrolled in the test arm of this study was by chance quite similar to the population enrolled in a Japanese clinical trial comparing surgery alone with surgery followed by adjuvant CTX (JCOG9206-2) [21]. Table 3 shows the tumor and patient characteristics of the 2 groups. Most of the prognostic factors, i.e., histological type, tumor location, age, tumor size, and, most important, tumor depth, were reasonably comparable between the groups. Although these 2 groups were the patients of two different trials with two different treatment methods, they are identical and therefore the treatment results are more or less comparable. The 5-year overall survival was 42 and 61% in the INT0116 and JCOG9206-2, respectively. This suggests strongly that D2 surgery alone might produce better survival than limited surgery followed by CRT and that the effect of adjuvant CTX might not be expected after D2 as suggested by the subgroup analysis.

Surgical Treatment for Esophagogastric Junction Tumors

Hulscher et al. [13] reported the results of a phase III trial for Siewert type 1 and 2 tumors, comparing two surgical approaches, a transthoracic esophagogastrectomy