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REVIEW

Extended lymphadenectomy in gastric cancer: when, for whom and why

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Although lymph node metastasis is a major prognostic factor in gastric cancer, the optimal extent of lymph node dissection still remains a subject of debate. The influence of extended D_2 lymphadenectomy on morbidity and long-term survival is controversial. Reports from many Japanese and some Western institutions show similar morbidity and mortality rates for both limited D_1 and extended D_2 resections. However, the four available randomised trials show a significant increase in operative morbidity and mortality after a D_2 resection. The authors of these trials believe that distal pancreaticosplenectomy is responsible for this increased morbidity and mortality and not the lymphadenectomy itself.

Retrospective and prospective non-randomised studies show superior stage (II/IIIA) specific survival rates after D_2 resections. However, these studies did not eliminate stage migration and randomised trials failed to show any survival advantage in favour of the D_2 resection.

Current data suggest that D_2 resection is beneficial to the subgroup of patients with N_1 or N_2 disease undergoing potentially curative resection. However, Western studies that support D_2 resection, fail to show any survival advantage for D_2 resection in N_2 patients, reporting a benefit only to N_0 or N_1 patients. In contrast, Japanese series report a large number of N_2 long-term survivors.

The question as to the possible beneficial effect of extended lymphadenectomy in gastric cancer is difficult and complex. D_2 resection increases the potentially curative resection rate, at least in N_2 patients, achieves a better locoregional tumour control and provides the only chance for cure among N_2 patients since adjuvant treatment in gastric carcinoma has not yet been proved effective. However, all randomised comparisons warn of an increased risk after D_2 resection. By avoiding pancreaticosplenectomy, however, the morbidity can be within acceptable limits. D_2 gastrectomy seems to be the most attractive procedure in the surgical management of gastric cancer.

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Carcinoma of the stomach remains the second most common lethal malignancy, despite the steady decline in its incidence worldwide *(1)*. In the United Kingdom and the USA, the disease affects 12 000 and 22 800 people a year, causing 11 000 and 14 700 deaths, respectively *(2,3)*. Surgical resection is the only hope for cure when the disease is localised but, in the West, the prognosis after resection for gastric cancer remains poor, with 5-year survival rates of approximately 20% *(4–6)*. The prognosis of gastric cancer in Japan is distinctly better. Since the early 1960s, great effort has been directed at combating this disease. This has led to a substantial increase in the overall 5-year survival rate of up to 50% *(7–9)*.

This discrepancy in survival between different countries has been the subject of discussion for many years. In Japan, the high incidence of gastric cancer and the advances in diagnostic techniques permitted development and application of cost-effective mass screening programmes. These led to the detection of a high percentage of patients with early (T_1) gastric cancer *(9)*. The prognosis for early gastric cancer patients is excellent, even in Western patients, and this could explain the superior overall survival rates in Japan.

However, a geographical difference in prognosis persists, even in cases with comparable pathological tumour stages. Japanese surgeons believe that their

superior stage-specific survival rates are the result of locoregional tumour control from the extended lymphadenectomy that has been performed as a standard procedure in the last three decades in Japan. However, many Western surgeons are sceptical *(10)*, or distinctly opposed, to the view that extended lymphadenectomy improves overall survival *(11)*. They regard the lymph nodes as indicators rather than governors of the disease *(12)*. According to their view, extensive resection merely improves the accuracy of tumour staging but not the long-term survival *(10–12)*.

Criticism of the explanation of superior Japanese results in each TNM stage of the disease is focused on the lack of a Japanese randomised trial and on the so-called 'stage migration' phenomenon *(13)*. This phenomenon increases the accuracy of staging as a result of the extensive lymphadenectomy, and improves the stage-specific survival without influencing overall survival. Other factors that might explain the geographical variations are the possibility that genetic differences predispose Japanese cancers to be less aggressive than Western cancers *(14–16)* and the uncertain role of adjuvant chemotherapy used as a standard treatment after resection in Japan. It is therefore questionable as to whether extensive lymph node resection is responsible for improved outcome.

The impressive Japanese survival figures have led some Western surgeons to employ extended lymphadenectomy but their results are inconclusive. Both the completed and the preliminary results of available randomised trials confound rather than solve the problem because of an inappropriate study design which includes distal pancreaticosplenectomy in the D_2 arms.

As a consequence, the optimal extent of lymph node resection in gastric cancer has not yet been determined.

The evaluation of the efficacy of the two surgical techniques, a conventional limited Western type D_1 resection and an extended Japanese style D_2 resection, requires an analysis of the literature regarding the risk (short-term mortality)/benefit (long-term survival) ratio of the two surgical procedures, as well as analysis of the different staging systems and the surgical/pathological stage migration.

Classification and prognostic significance of involved lymph nodes

Location of lymph node involvement

According to the rules of the Japanese Research Society for the Study of Gastric Cancer (JRSGC) *(17)*, the upper abdominal lymph node stations are numbered from 1 to 16 and subsequently grouped into four levels, designated N_1 to N_4 (Table I, Fig. 1). The grouping of stations into levels depends on the location of the primary tumour and to increasing anatomical distance from the stomach. Resection of the first level of lymph node stations, those directly attached to the stomach, is referred to as D_1 resection; in extended lymph node resection (D_2) the second-level stations, those surrounding the vessels of the coeliac axis and the splenic hilum, are removed. Even wider resections (D_3, or D_4) are practised in Japan, but only for patients with suspected invasion of these lymph node levels.

Survival rates are strongly related to the existence of lymphatic metastases. Significant differences between N_0 and N_1 and N_1 and N_2 groups have been demonstrated in univariate and multivariate analyses *(18–22)*, so that there is no doubt that nodal status is an important tumour-related prognostic factor. However, the JRSGC rules are believed by many to be too complicated to be used routinely, and a more simple staging of lymph node involvement has been recommended.

Table I. Grouping of regional lymph nodes in stations and levels according to their location and location of primary tumour according to JRSGC *(5)*

	N-level			
Lymph node station	*Entire stomach*	*Proximal third of the stomach*	*Middle third of the stomach*	*Distal third of the stomach*
1				N2
2			N2	N3
3		N1		
4				
5				
6				
7				
8		N2		
9				
10				
11				
12				
13		N3		
14				
15				
16		N4		

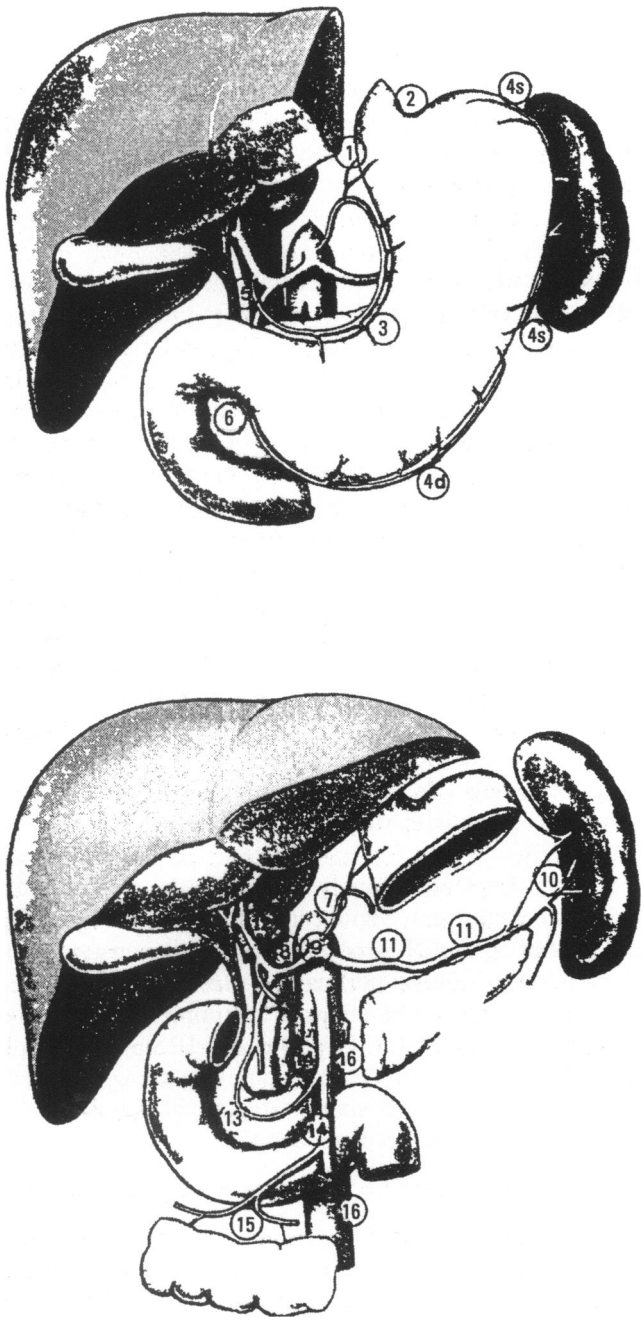

Figure 1. Lymph node locations according to the JRSGC. 1, right cardial; 2, left cardial; 3, along the lesser curvature; 4, along the greater curvature, (s) left gastroepiploic artery, (d) right gastroepiploic artery; 5, suprapyloric; 6, infrapyloric; 7, along the left gastric artery; 8, along the common hepatic artery; 9, around the coeliac axis; 10, at the hilus of the spleen; 11, along the splenic artery; 12, in the hepatoduodenal ligament; 13, retropancreatic; 14, at the root of the mesentery; 15, in the transverse mesocolon; 16, para-aortic.

Classification of lymph nodes according to the TNM system (UICC)

The UICC in its 4th edition in 1987 *(23)* and with the agreement of the American Joint Committee on Cancer (AJCC) TNM committee *(24)* has defined the nodal status (N) based on the distance of the lymph nodes from the margins of the primary gastric tumour. Pathologically assessed (pTNM) involved lymph nodes are classified in pN-categories; pN_0: nodes without metastases; pN_1: metastases in nodes within 3 cm from the primary tumour; and pN_2: metastases in nodes at a distance more than 3 cm or in those at the coeliac axis, splenic artery, and/or splenic hilum. Metastases in more distant lymph nodes (N_3, N_4) are defined as pM_1 (nodes) *(23,24)*.

pN_1 and pN_2 categories of the TNM system correspond approximately to involved N_1 and N_2 lymph node levels of JRSGC. However, pN_2 status includes lymph nodes at a distance of more than 3 cm from the tumour but does not define the exact location. This confounds D_1 and D_2 resections comparisons because some of pN_2 nodes can be removed with a D_1 resection (JRSGC, stations 1–6). In contrast, N_2 level nodes of JRSGC are exactly defined at the coeliac axis (stations 7–11) or in correlation with location of the primary tumour at defined sites (stations 1–6).

Number of lymph nodes involved

Survival is strongly correlated to the total number of involved lymph nodes. The greater the total number of positive nodes, the less the survival rates *(21,25,26)*.

Opinions differ on whether the anatomical level *(26)* or the total number *(25,27,28)* of metastatic nodes is the more important in assessing the prognosis.

The UICC now recognises the prognostic significance of both anatomical location and number of metastatic nodes and recommends that the numbers of involved/examined nodes should be recorded in the pathology report in parentheses, eg pN_0 (0/11) or pN_1 (2/12) or pN_2 (5/16) *(24)*.

Prognostic significance of the extent of lymph node resection

The rationale for extended lymphadenectomy is that it achieves a more radical nodal clearance than does a limited lymph node dissection and could therefore improve both locoregional tumour control and patient outcome. However, a proof of the beneficial effect of extended lymphadenectomy on long-term survival has not yet been achieved. Many factors, with stage migration the most important, confound the survival comparisons between D_1 and D_2 resections.

Surgical/pathological stage migration

Variability in the extent of lymphadenectomy and in the number of lymph nodes examined significantly affects nodal staging *(29–31)*. This stage migration is known as the Will Rogers phenomenon, ie the migration of disease into a more advanced stage by demonstrating lymph node metastases that would remain unidentified if conventional surgical treatment and pathological staging techniques were applied *(13)*.

Bunt *et al. (32)* demonstrated, in a randomised trial, that the application of a D_2 resection induced stage migration to a more advanced N-status in 34% of patients; 32% migrated from N_1 to N_2 status and 2% from N_0 to N_2 status, skipping the first level lymph nodes (N_1). In a previous report *(33)*, we underlined the possibility of metastases skipping the N_1 level, the incidence of migration of our D_2 patients from N_0 to N_2 status being 5.4% *(33)*. According to Bunt *et al. (32)* not only did extended lymphadenectomy influence TNM staging and stage-specific survival but also other factors such as detection of lymph nodes outside the area of nodal clearance, incomplete lymph node dissection and the diligence of the pathologist. It is well known that the method of retrieving lymph nodes and the method of examining each node contributes to stage migration *(31,34,35)*. UICC recommend *(24)* that the number of lymph nodes that are microscopically evaluated must be noted as well as the number of tumour-containing nodes per N level and the presence of micrometastases (metastases not larger than 0.2 cm) in order that the pathological report establishes the TNM stage.

Effect of limited (D_1) and extensive (D_2) lymph node resection on long-term survival

In the early 1960s, Jinnai and Tanaka *(36)* recommended extended radical surgery to reduce local and regional tumour recurrence and to improve the outcome in gastric cancer. Subsequently, the concept of radical resection of the lymph nodes has become an integral part of the surgical treatment of patients in Japan. Impressively high survival rates have been reported in several retrospective analyses and some recent Western studies also report higher survival rates after D_2 resection than after D_1 resection. However, none of these studies had eliminated the stage migration effect. In the Dutch randomised trial *(32)*, the upstaging after D_2 resection was 34% and the calculated effect of this stage migration on known 5-year survival rates was an increase of 1% in TNM stage IA, 2% in stage IB, 7% in stage II and 15% in stage III. The authors conclude that the superior stage-specific survival rates after D_2 compared with D_1 resections are explained, at least partially, by the stage migration and maybe D_2 resection does not increase overall survival *(32)*.

Long-term survival—methods for the evaluation of efficacy of extended lymphadenectomy

There are three different methods suggested for the assessment of therapeutic values of lymph node dissection. The data attributable to each method will be discussed.

I. Anatomical location of lymph nodes

Several Japanese series based on retrospective historical comparisons found significantly higher 5-year survival rates in patients with involved regional lymph nodes undergoing D_2 resection *(37–39)*. In contrast, in the 1960s Lawrence *et al. (40)* and Gilbertsen *(41)* in the United States found that the operative mortality was lower and the overall survival slightly higher after a D_1 resection than when a more extensive D_2 lymphadenectomy was performed.

In the West, the beneficial effect of extended lymph node resection still remains the subject of debate. Retrospective series *(33)* and two completed, small randomised trials *(42,43)* failed to show any significant survival advantage in favour of D_2 resection. The trial from Cape Town *(42)* randomised 22 patients with a D_1 resection and 21 with a D_2 resection. There was no significant difference in 3-year survival rates between the two groups. In the trial from Hong Kong *(43)*, 55 patients with antral carcinoma were randomised to undergo either a limited D_1 subtotal gastrectomy or an extensive D_3 total gastrectomy with distal pancreaticosplenectomy. D_1 patients in a univariate analysis had longer survival than D_3 patients. However, multivariate analysis showed that after correction for blood transfusion there was no survival difference between D_1 and D_3 patients.

Two large European randomised trials, one in Holland *(44)* and the other by the Medical Research Council (MRC) in the UK *(45)*, are ongoing. The long-term results of these trials are awaited with interest. The preliminary results of the MRC trial, however, are disappointing. Survival beyond 3 years was 30% in the D_2 arm compared with 50% in the D_1 arm. However, several Western series *(46–50)* and the large, prospective but non-randomised multicentre German trial of 1654 gastric resections *(51)*, report a stage-specific survival advantage of 20–30% in D_2 patients with tumour stages II and III.

II. Number of resected lymph nodes or lymph node ratio

The number of resected nodes and the lymph node ratio, ie the ratio between the number of tumour-containing nodes and microscopically evaluated nodes have both been identified as independent prognostic factors *(18,22,52,53)*. Thus, the extent of the lymph node dissection may improve survival by increasing the number of removed nodes and thereby reducing the lymph node ratio *(18,51)*.

III. Calculation of the incidence of metastasis and 5-year survival rate in each lymph node station

To eliminate the stage migration phenomenon, the group of the National Cancer Center (NCC) in Tokyo proposed a new method for the evaluation of the value of lymph node resection *(54)*. They selected 1281 patients from a large series who underwent a complete resection of the primary tumour and its lymphatic drainage between 1972 and 1986 after excluding 1118 patients with early (T_1) gastric cancer and 511 patients with a non-curative resection. They estimated the beneficial effect by multi-

plying the incidence of metastases and the percentage 5-year survival rate of patients with metastases in each lymph node station. For example, the incidence of metastases at the coeliac nodal station (no. 9) was 11%, the 5-year survival rate 47.5% with the benefit calculated to be 5.2% by multiplication of these percentages (11×47.5=5.2%). This number demonstrates the benefit to be expected from the use of prophylactic extended node resection. The survival benefit of D_2/D_3 resection was calculated at approximately 4% (range 0% to 10.5%) depending on tumour location and the incidence of metastases in each lymph node station. Among patients with N_2 disease there were approximately 20% long-term survivors who would not have survived if the involved N_2 nodes had been left *in situ* as in a D_1 resection. This assumption is supported by the dismal survival of those patients in whom unresected involved nodes are seen and recorded at operation *(55,56)*. The large number of eligible patients and the detailed documentation of lymph node status and of survival data in the NCC study *(54)* permit optimism for the therapeutic value of extended lymphadenectomy, although it needs to be confirmed in a randomised controlled trial.

Using the type of analysis based on the incidence of metastases and the expected long-term survival, a preoperative plan of the extent of prophylactic lymphadenectomy is possible *(54)*. The performance of node clearance in an area with expected low incidence of node metastasis can be avoided. For example, for antral carcinomas, a review of the Japanese experience *(57)* and our recent report *(58)* show that the incidence of node metastases at the splenic hilum or along the splenic artery (stations nos 10 and 11) is extremely low. Therefore resection of the spleen and the distal pancreas does not improve survival *(43,57–59)* and, furthermore, is associated with increased postoperative morbidity and mortality *(43–45,59)*.

The long-term survival results are shown in Table II.

Effect of the extent of lymphadenectomy on short-term postoperative morbidity and mortality

D_2 resection has a much lower morbidity and mortality in Japan than in the West, the mortality rate being less than 3% *(8,59)*. Some institutions in Western countries report similar morbidity and mortality figures for D_1 and D_2 procedures *(33,46,50,52)*. The lowest combined morbidity and mortality rates after D_2 resections in the West have been reported from the Sloan Kettering Institute in the USA *(60)*, and from Leeds in the UK *(61)*, but these are both retrospective selective single-centre series. The multicentre German study *(51)* also demonstrated a low mortality for D_2 resections (5%) but, although prospective, it was not a randomised trial.

However, the results of the four available randomised trials show a significant increase in morbidity and mortality after D_2 compared with D_1 gastectomy *(42–45)*. In the trials from Holland *(44)* and the UK *(45)*, with 711 and 400 patients respectively, D_2 patients had a higher operative mortality rate than D_1 patients (10% *vs* 4% and 13% *vs* 6.5% respectively; $P=0.04$). They also experienced more complications ($P<0.001$).

The mortality rate was particularly high in D_2 subgroups with distal pancreaticosplenectomy or splenectomy alone ranging between 15% and 17% *(44,45)*. Pancreatic duct leakage, direct pancreatic injury, or ischaemia are all possible factors that may lead to intra-abdominal fluid accumulation, subphrenic abscess, generalised sepsis and the development of fistula *(43,45)*. The adverse effect of splenectomy on morbidity and mortality could not be explained in the MRC trial by a higher incidence of serious infections *(45)*. Left-sided pancreatectomy is not performed as a standard procedure in Japan or in the West because the assessed increased morbidity is well known. Furthermore, Marujama *et al. (59)* have shown that pancreatectomy does not increase the radicality of the operation because lymph nodes are not located within the pancreatic parenchyma but at its surface. These authors propose a new surgical procedure for proximal gastric cancer, the pancreas-preserving splenectomy.

Comments

There are two main arguments against extended lymphadenectomy.

First, it is associated with increased postoperative morbidity and mortality which is, however, a result of distal pancreaticosplenectomy rather than of the lymph-

Table II. Comparison of 5-year survival rates (5-YSR) between limited D_1 resection and extended D_2 lymphadenectomy in gastric cancer patients

	Studies without differences of 5-YSR	Studies with significant increase of stage-specific 5-YSR (TNM-stages II, III) in favour of D_2 dissection
	Reference numbers	*Reference numbers*
Retrospective analyses	33, 40, 41	6, 8, 16, 37–39, 47–50, 54
Prospective non-randomised studies		46, 51
Randomised trials	42, 43, 45*	

45*: Preliminary results of the MRC trial (3-year survival rates)

adenectomy itself. There is also no doubt that there is a learning curve associated with a D_2 resection. Current data *(33,46,50–54,60,61)* suggest that with experience the morbidity associated with D_2 resection can be within acceptable limits, provided that resection of the spleen and pancreas is avoided.

The second argument against D_2 resection, is that the many divided lymphatic vessels allow local tumour spillage which increases the recurrence rate and reduces survival. This potential adverse effect of D_2 resection should not affect patients with N_0 or N_1 disease, but patients with N_2 disease, particularly those where the tumour has involved the whole node and the perinodal fatty tissue, may be at risk for implantation and proliferation of tumour cells in the upper retroperitoneal area. There is not yet conclusive data regarding this possibility.

Until recently, the view that a D_2 resection does not improve survival in patients with N_0 disease, was accepted by most surgeons *(8,29,37–39,62)*. However, a survival advantage in pN_0 patients was shown in the German study *(51)* and in several retrospective series *(50,63)*. The authors of the German study attempted to explain this finding by performing a retrospective immunohistological analysis *(64)*. They found microinvolvement in 90% (56/62) of pN_0 patients and they demonstrated that microinvolvement was of no prognostic significance once metastasis had been identified (pN_1) and in pN_0 patients was of importance only above a certain threshold (three or more tumour cells per lymph node in more than 10% of the sampled lymph node per case). Based on these data they expressed the view that microinvolvement is a 'premetastatic phase' of tumour cell dissemination in which cancer cells have arrived in the lymph nodes via the circulation. However, their view that D_2 resection improves survival in pN_0 cases requires further investigation because of the very small number of pN_0 patients ($n = 10$) who benefited from a D_2 resection. Furthermore, the exact location of the lymph nodes with microinvolvement was not reported.

The most convincing argument in favour of the efficacy of extended lymphadenectomy is provided by some Japanese series which demonstrate 5-year survival rates after D_2/D_3 resections for N_2 patients of approximately 25% *(8,21,25,26,54)*. These results have not yet been achieved in the West *(51)*. Why does this discrepancy between Japanese and Western studies exist? One possible explanation is the shallow abdominal cavity in Japanese patients with relative absence of intra-abdominal fatty tissue, allowing the more experienced Japanese surgeons to perform a more extensive (D_2/D_3), standardised and systematic lymph node resection. The suggestion that gastric cancer in Japan may be biologically less aggressive than that found in the West is opposed by a recent study *(65)*.

The prognosis of patients with N_3, N_4 disease is poor even in Japan, despite the wider D_3/D_4 resection. However, results from the NCC have shown a high 5-year survival rate of 35% for a subgroup with involved lymph nodes at the ligamentum hepatoduodenal (station 12, N_3 level) and the tumour location on the distal third of the stomach *(54)*. Recently, the dissection of hepatoduodenal lymph nodes has been adopted as a routine procedure by some specialised Western institutions *(51,52)*.

Although the long-term survival results in the two ongoing large trials are awaited *(44,45)*, the higher mortality in both trials, probably owing to inappropriate study design, the disappointing preliminary results of the MRC trial and the low expected survival benefit of the D_2 resection, do not permit optimism that a survival advantage will be shown for the D_2 resection.

Critical analysis of current data suggests that D_2 resection should be beneficial to that group of patients with N_1 or N_2 disease and a potentially curative resection. In patients with N_0 disease, further investigations are required whereas patients with non-curative resection or distant metastasis do not benefit from a D_2 resection.

Identification and selection of patients for extended lymph node dissection

The optimal surgical management of resectable, potentially curative, gastric cancer should be an extended D_2 resection for patients with involved nodes. The staging of patients with distant metastases is possible preoperatively by TNM staging which uses endoscopy, conventional ultrasonography, endoluminal ultrasonography (EUS), biopsy and computed tomography of the abdomen. If the presence of distant metastases can be confirmed intraoperatively and histologically a D_2 resection should be avoided. However, the determination of nodal status in those patients without apparent distant metastasis is not reliable. The diagnostic accuracy of nodal status even by the more sophisticated EUS is not high *(66)* and even intraoperatively the surgeon cannot reliably determine the nodal status *(67)*. Nodes that are invaded but not enlarged cannot be differentiated. The preoperative diagnosis of the nodal status with relatively high accuracy is possible indirectly, as there is a correlation between the T stage and the N status and the overall sensitivity of T staging using EUS is high, about 85% *(66)*. The incidence of node-positive in T_1 disease is less than 10% and much lower at N_2-level (less than 3%) while the respective rates for T_3 disease are 75% and 41% *(54)*. The need for D_2 resection is therefore reasonable for T_3 disease while for T_1 disease only a very small subgroup could benefit from the D_2 resection.

Important for the plan of the extent of lymphadenectomy is also information regarding tumour location. For antral tumours, lymph node metastases at the splenic hilum or the left cardial nodes mean little or no chance of cure. This explains the poor results of studies comparing D_2 total gastrectomy plus splenectomy with D_1 subtotal gastrectomy *(43,58)*.

To plan the extent of prophylactic lymphadenectomy, the sophisticated Marujama computer programme based on the incidence of node metastases and the expected long-term survival using information such as tumour type, location, depth of invasion, size of tumour and

histological type to predict nodal involvement has been proposed *(68)*. It is useful for surgeons planning to perform lymph node resection for gastric cancer to know the expected benefit of resection in each nodal station according to the location of the tumours, so as to prevent unnecessary resection of lymph nodes, the spleen and the pancreas.

In general, D_2 resection may be beneficial mainly to $T_{2-3}N_{1-2}M_0$ patients, while in those with T_1 or T_4 disease or N_3 or N_4 disease the possibility for therapeutic benefit is small. T_1 tumours metastasise to the N_2 nodes very rarely; in most patients with T_4 disease a curative resection is not possible.

Addressing the problem

There is often an initial enthusiasm for a new treatment, based on non-randomised comparisons with later disappointment when subsequent randomised trials fails to support the initial findings based on historical controls. In this regard, the available data from randomised trials of D_2 resection are not encouraging.

However, there is no doubt that D_2 resection achieves a better and a more radical node clearance than D_1 resection. There is also no doubt that the complete resection of the primary tumour and its lymphatic drainage determines the prognosis of gastric cancer. Cure is not possible if there is residual tumour after resection. Thus, a D_2 resection provides the only chance of cure for N_2 patients.

In view of these considerations, the optimal surgical management of curable gastric cancer is a balance between maximum locoregional tumour control and acceptable morbidity and mortality. Selection of the extent of lymphadenectomy based on preoperative information regarding tumour location and depth of invasion, as well as on intraoperative findings, is of paramount importance. For example, patients with a distal advanced carcinoma will benefit more from a dissection at the ligament hepatoduodenal than from a splenectomy.

The resection of node tissue at the coeliac axis and ligament hepatoduodenal avoiding a left-sided pancreatectomy with splenectomy in selected cases only seems to be an attractive surgical procedure in the treatment of gastric cancer.

However, extended lymphadenectomy alone does not prevent cancer cell dissemination to the liver and peritoneum. Ongoing phase III randomised trials will show if patients at high risk for recurrence of the disease (T_3/T_4, N_1/N_2) will benefit from a multimodality treatment consisting of neo-adjuvant treatment and a D_2 resection.

References

1 Whelan SL, Parkin DM, Masuyer E, eds. *Trends in Cancer Incidence and Mortality*. Lyon, France: IARC Scientific Publications, 1993 (IARC Scientific Publications no. 102.)

2 *Cancer Statistics: Registrations. England and Wales*. London: HM Stationery Office, 1989.

3 American Cancer Society. *Cancer Facts and Figures 1995*. American Cancer Society, 1995.

4 Allum WH, Powell DJ, McConkey CC, Fielding JWL. Gastric cancer: a 25-year review. *Br J Surg* 1989; **76**: 535–40.

5 Wanebo HJ, Kennedy BJ, Chmiel J, Steele G, Winchester D, Osteen R. Cancer of the stomach: a patient care study by the American College of Surgeons. *Ann Surg* 1993; **218**: 583–7.

6 Akoh JA, MacIntyre IMC. Improving survival in gastric cancer: review of 5-year survival rates in English language publications from 1970. *Br J Surg* 1992; **79**: 293–9.

7 Miwa K. Cancer of the stomach in Japan. *Gann Monogr Cancer Res* 1979; **22**: 61–75.

8 Marujama K, Okabayashi K, Kinoshita T. Progress in gastric cancer surgery in Japan and its limits of radicality. *World J Surg* 1987; **11**: 418–25.

9 Nakajima T, Nishi M. Surgery and adjuvant chemotherapy for gastric cancer. *Hepatogastroenterology* 1989; **36**: 79–85.

10 Jessup JM. Is bigger better? *J Clin Oncol* 1995; **13**: 5–7.

11 Lawrence W, Horsley JS. Extended lymph node dissections for gastric cancer—is more better? *J Surg Oncol* 1996; **61**: 85–9.

12 Cady B. Lymph node metastases—indicators, but not governors of survival. *Arch Surg* 1984; **119**: 1067–70.

13 Feinstein AR, Sosin DM, Wells CK. The Will Rogers phenomenon. Stage migration and new diagnostic techniques as a source of misleading statistics for survival in cancer. *N Engl J Med* 1985; **312**: 1604–8.

14 Cady B, Rossi RL, Silverman ML, Piccione W, Heck TA. Gastric adenocarcinoma. A disease in transition. *Arch Surg* 1989; **124**: 303–8.

15 Fielding JWL. Gastric cancer: different diseases. *Br J Surg* 1989; **76**: 1227.

16 Milewski PJ, Bancewicz J. Improving the results of treating gastric cancer. *BMJ* 1989; **299**: 278–9.

17 Japanese Research Society for Gastric Cancer. The general rules for the gastric cancer study in surgery and pathology. *Jpn J Surg* 1981; **11**: 127–39.

18 Roder JD, Boettcher K, Siewert JR, Busch R, Hermanek P, Meyer HJ and the German Gastric Carcinoma Study Group. Prognostic factors in gastric carcinoma. Results of the German Gastric Carcinoma Study 1992. *Cancer* 1993; **72**: 2089–97.

19 Bozzeti F, Bonfanti G, Morabito A, Bufalino R, Menotti V, Andreola S. A multifactorial approach for the prognosis of patients with carcinoma of the stomach after curative resection. *Surg Gynecol Obstet* 1986; **162**: 229–34.

20 Marujama K. The most important prognostic factors for gastric cancer patients: a study using univariate and multivariate analyses. *Scand J Gastroenterol* 1987; **22**: 63–7.

21 Okusa T, Nakane Y, Boku T *et al.* Quantitative analysis of nodal involvement with respect to survival rate after curative gastrectomy for carcinoma. *Surg Gynecol Obstet* 1990; **170**: 488–94.

22 Boettcher K, Becker K, Busch R, Roder JD, Siewert JR. Prognosefaktoren beim Magenkarzinom: Ergenbnisse einer uni- und multivariaten Analyse. *Chirurg* 1992; **63**: 656–61.

23 UICC: *TNM Classification of Malignant Tumours*, 4th Edition. P. Hermanek, LH Sobin, eds. Berlin: Springer-Verlag, 1987.

24 Hermanek P, Wittekind C. News of TNM and its use for classification of gastric cancer. *World J Surg* 1995; **19**: 491–5.

25 Harujama K. Quantitative statistical studies on lymph node

metastasis of gastric carcinoma, with reference to its relationship with primary lesion and prognosis. *Nippon Geka Gakkai Zasshi* 1981; **82**: 612–21 (in Japanese).

26 Isozaki H, Okajima K, Kawashima Y *et al.* Prognostic value of the number of metastatic lymph nodes in gastric cancer with radical surgery. *J Surg Oncol* 1993; **53**: 247–51.

27 Makino M, Moriwaki S, Yonekawa M, Oota M, Kaibara N. Prognostic significance of the number of metastatic lymph nodes in patients with gastric cancer. *J Surg Oncol* 1991; **47**: 12–16.

28 Ichikura T, Tomimatsu S, Uefuji K *et al.* Composition of the prognostic significance between nodal stage according to general rules for the gastric cancer. *Japanese Journal of Gastroenterological Surgery* 1993; **26**: 1963–8 (in Japanese).

29 Noguchi Y, Imada T, Matsumoto A *et al.* Radical surgery for gastric cancer. A review of the Japanese experiences. *Cancer* 1989; **64**: 2053–62.

30 Brennan MF. Radical surgery for gastric cancer. A review of the Japanese experiences. *Cancer* 1989; **64**: 2063–6.

31 Candela FC, Urmacher C, Brennan MF. Comparison of the conventional method of lymph node staging with a comprehensive fat-clearing method for gastric adenocarcinoma. *Cancer* 1990; **66**: 1828–32.

32 Bunt AMG, Hermans J, Smit VTHBM, van de Velde CJH, Fleuren GJ, Bruijn JA. Surgical/pathologic-stage migration confounds comparison of gastric cancer survival rates between Japan and Western countries. *J Clin Oncol* 1995; **13**: 19–25.

33 Roukos D, Hottenrott C, Lorenz M, Koutsogiorgas-Couchell S. A critical evaluation of effectivity of extended lymphadenectomy in patients with carcinoma of the stomach. *J Cancer Res Clin Oncol* 1990; **116**: 307–13.

34 Wilkinson EJ, Hause L. Probability in lymph node sectioning. *Cancer* 1974; **33**: 1269–74.

35 Natsugoe S, Aiko T, Shimazu H. A detailed histological study on occult matastasis of the lymph nodes. *Jpn J Surg* 1991; **21**: 528–32.

36 Jinnai D, Tanaka S. Technique of extended radical operation for gastric cancer. *Geka Ghiyo* 1962; **7**: 316–24 (in Japanese).

37 Mine M, Majiama JS, Harada M, Etani SI. End results of gastrectomy for gastric cancer: effects of extensive lymph node dissection. *Surgery* 1970; **68**: 753–8.

38 Inokuchi K. Prolonged survival of gastric cancer on a specific adjuvant chemotherapy. *Jpn J Surg* 1984; **14**: 351–9.

39 Kodama Y, Sugimachi K, Soejima K, Matusaka T, Inokuchi K. Evaluation of extensive lymph node dissection for carcinoma of the stomach. *World J Surg* 1981; **5**: 241–8.

40 Lawrence W Jr, McNeer G. An analysis of the role of radical surgery for gastric cancer. *Surg Gynecol Obstet* 1960; **111**: 691–6.

41 Gilbertsen VA. Results of treatment of stomach cancer. An appraisal of efforts for more extensive surgery and a report of 1983 cases. *Cancer* 1969; **23**; 1305–8.

42 Dent DM, Madden MV, Price SK. Randomised comparison of R_1 and R_2 gastrectomy for gastic carcinoma. *Br J Surg* 1988; **75**: 110–12.

43 Robertson CS, Chung SCS, Woods SDS *et al.* A prospective randomised trial comparing R_1 subtotal gastrectomy with R_3 total gastrectomy for antral cancer. *Ann Surg* 1994; **220**: 176–82.

44 Bonenkamp JJ, Songun I, Hermans J, Sasako M *et al.* Randomised comparison of morbidity after D_1 and D_2 dissection for gastric cancer in 996 Dutch patients. *Lancet* 1995; **345**: 745–8.

45 Cuschieri A, Fayers P, Fielding J *et al.* Postoperative morbidity and mortality after D_1 and D_2 resections for gastric cancer: preliminary results of the MRC randomised controlled surgical trial. *Lancet* 1996; **347**: 995–9.

46 Pacelli F, Doglieto GB, Bellantone R, Alfieri S, Sgadari A, Crucitti F. Extensive versus limited lymph node dissection for gastric cancer: a comparative study of 320 patients. *Br J Surg* 1993; **80**: 1153–6.

47 Gall FP, Hermanek P. New aspects in the surgical treatment of gastric carcinoma—a comparative study of 1636 patients operated on between 1969 and 1982. *Eur J Surg Oncol* 1985; **11**: 219–25.

48 Meyers WC, Damiano RJ Jr, Rotolo FS, Postlethwait RW. Adenocarcinoma of the stomach. Changing patterns over the last 4 decades. *Ann Surg* 1987; **205**: 1–8.

49 Breaux JR, Bringaze W, Chappuis C, Cohn I Jr. Adenocarcinoma of the stomach: a review of 35 years and 1710 cases. *World J Surg* 1990; **14**: 580–86.

50 Fass J, Hungs M, Reineke TH, Nachtkamp J, Schumpelic V. Zur Frage der Prognoseverbesserung durch R_1- und R_2-Lymphadenektomie beim Magencarcinom. *Chirurg* 1994; **65**: 867–72.

51 Siewert JR, Boettcher K, Roder JD, Busch R, Hermanek P, Meyer HJ and the German Gastric Carcinoma Study Group. Prognostic relevance of systematic lymph node dissection in gastric carcinoma. *Br J Surg* 1993; **80**: 1015–18.

52 Jaehne J, Meyer HJ, Maschek H, Geerlings H, Bruns E, Pichlmayr R. Lymphadenectomy in gastric carcinoma. *Arch Surg* 1992; **127**: 290–94.

53 Shiu MH, Moore E, Sanders M, Huvos A, Freedman B, Goodbold J. Influence of the extent of resection on survival after curative treatment of gastric carcinoma. *Arch Surg* 1987; **122**: 1347–51.

54 Sasako M, McCulloch P, Kinoshita T, Marujama K. New method to evaluate the therapeutic value of lymph node dissection for gastric cancer. *Br J Surg* 1995; **82**: 346–51.

55 Irvin TT, Bridger JE. Gastric cancer: an audit of 122 consecutive cases and the results of R_1 gastrectomy. *Br J Surg* 1988; **75**: 106–9.

56 Rohde H, Gebbensleben B, Bauer P, Stuetzer H, Zieschang J. Has there been any improvement in the staging of gastric cancer? Findings from the German Gastric Cancer TNM Study Group. *Cancer* 1989; **64**: 2465–81.

57 Okajima K, Isozaki H. Splenectomy for treatment of gastric cancer: Japanese experience. *World J Surg* 1995; **19**: 537–40.

58 Roukos D, Schmidt-Mathieson A, Encke A. Adenocarcinoma of the gastric antrum: does D_1 total gastrectomy with splenectomy improve prognosis compared to D_1 subtotal gastrectomy? A long-term survival analysis with emphasis on Lauren classification. *Surg Oncol* 1995; **4**: 323–32.

59 Marujama K, Sasako M, Kinoshita T, Sano T, Katai H, Okajima K. Pancreas-preserving total gastrectomy for proximal gastric cancer. *World J Surg* 1995; **19**: 532–6.

60 Smith JW, Shiou MH, Kelsey L, Brennan MF. Morbidity of radical lymphadenectomy in the curative resection of gastric carcinoma. *Arch Surg* 1991; **126**: 1469–73.

61 Sue-Ling HM, Johnston D, Martin IG, Dison MF *et al.* Gastric cancer: a curable disease in Britain. *BMJ* 1993; **307**: 591–6.

62 Bonenkamp JJ, van de Velde CJH. Lymph node dissection in gastric cancer. *Br J Surg* 1995; **82**: 867–9.

63 Babba H, Maehara Y, Takeuchi H *et al.* Effect of lymph node dissection on the prognosis in patients with node-negative early gastric cancer. *Surgery* 1995; **117**: 165–9.

64 Siewert JR, Kestlmeier R, Busch R, Boettcher K, Roder JD, Mueller J *et al.* Benfits of D_2 lymph node dissection for

patients with gastric cancer and pN_0 and pN_1 lymph node metastases. *Br J Surg* 1996; **83**: 1144–7.

65 McCulloch PG, Ochiai A, O'Dowd GM, Nashi JRG, Sasako M, Hirohashi S. Comparison of the molecular genetics of c-*erb*-B_2 and p53 expression in stomach cancer in Britain and Japan. *Cancer* 1995; **75**: 920–25.

66 Sendler A, Dittler HJ, Feussner H *et al.* Preoperative staging of gastric cancer as precondition for multimodal treatment. *World J Surg* 1995; **19**: 501–8.

67 Douglas HO Jr. R-2 dissection in the treatment of gastric malignancy. *Surg Oncol Clin North Am* 1993; **2**: 413–31.

68 Kampschoer GHM, Marujama K, van de Velde CJH, Sasako M, Kinoshita T, Okabayashi K. Computer analysis in making preoperative decisions: a rational approach to lymph node dissection in gastric cancer patients. *Br J Surg* 1989; **76**: 905–8.

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