

A STATISTICAL ANALYSIS OF THE RESULTS OF GASTRIC CANCER SURGERY DURING THE PAST TWENTY-FIVE YEARS AT NIIGATA UNIVERSITY

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(Received December 7, 1987)

INTRODUCTION

While amazing progress has been made in the field of gastric cancer treatment during the past quarter century, it seems to be worthwhile at this moment to investigate certain factors contributing to the progress and improvement of surgical results in gastric cancer patients in the same period. This study aims to evaluate such factors on the basis of statistical analysis of resection cases with gastric cancer during the past 25-year period from 1961 to 1985.

MATERIALS AND METHODS

A total of 1,786 patients with gastric cancer underwent gastrectomy at the Niigata University Hospital in the past 25-year period between 1961 and 1985 (Table 1). Of these, 1,724 patients with an average age of 56.5 years, 1,098 males with age averaging 57.5 years and 626 females with age averaging 54.6 years, excluding 28 accompanied synchronously by malignancy in another organ or other organs, and 34 with cancer occurring in the gastric remnant (Table 1), were submitted for routine investigation. The total series was divided into 5 groups, each on a 5-year basis: Group A from 1961 to 1965, Group B

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from 1966 to 1970, Group C from 1971 to 1975, Group D from 1976 to 1980, and Group E from 1981 to 1985. Most factors employed for the analysis were on the guidelines described in "The General Rules for Gastric Cancer Study in Surgery and Pathology."¹⁾ The curability of gastric cancer was also dependent principally on the definition in the guidelines¹⁾ with the acceptable concept described in our report.²⁾ The decision of "in-situ carcinoma" was also made likewise on the basis of the criteria previously defined.²⁾ The groups as mentioned above were further subdivided, when indicated, into a curative resection group and a non-curative resection group.

Statistical analysis was performed on the basis of the chi-square test.

OBSERVATION

1. Chronological analysis of curability (Table 1):

Table 1 shows chronological analysis of curative and non-curative gastric resections registered at Niigata University in the past 25 years. The ratio of curative resection cases to non-curative cases was 3.0 (1,291/430), and the rate of curative resection to all resections excluding cases with remnant stomach cancer or synchronous dual malignancies, was 74.9% (1,291/1,724). The incidence of early carcinoma of curative resection to overall curative resections was 28.4% for the entire series and 47.6% for the series of the last 5-year period E.

2. Age and sex distribution:

Table 2 indicates age and sex distribution. No significant difference of the average age was found among each 5-year period. The male/female ratio ranged between 1.6 and 2.3.

3. Depth of invasion and lymph node metastases:

Table 3 shows the relationship between the depth of invasion of gastric cancer and the incidence of lymph node metastases. The incidence of lymph node metastases increased as the involvement of the lesions became deeper. No significant difference in incidence of lymph node metastases was, however, noted between cases with subserosal invasion $\alpha \cdot \beta$ (ss $\alpha \cdot \beta$) and γ (ss γ) and between cases with invasion to the serosa (se) and to the neighboring organs (sei, si). There was no significant statistical significance among the incidences of lymph node metastases in each period. A significantly high incidence, 24.3%, of lymph node metastases was found in cases with submucosal invasion (sm), but the overall incidence of lymph node metastases in the early-stage carcinoma group (m, sm) was 14.6%.

The incidence of cases with lesions in relation to depth of invasion was found, as shown in Table 4, to have chronological changes. A significant increase was noted in the number of cases in early-stage carcinoma groups with both intramucosal and submucosal lesions, 3.0% in Period A up to 18.8% in Period E in the former and 4.1% in Period A up

Table 1. Chronological Analysis of Curability in Gastric Cancer Surgery at Niigata University

Period	A	B	C	D	E	Total
Resection, overall	370	377	314	359	366	1,786
Other malignancies*	1	2	5	6	14	28
Remnant stomach	4	4	10	9	7	34
Resection	365	371	299	344	345	1,724
ca	174	179	140	202	234	929
cb	95	87	79	62	39	362
Curative Total	269	266	219	264	273	1,291
Curative/all resection	73.7	71.7	73.2	76.7	79.1	74.9
na	25	28	21	28	44	146
nb	71	74	59	52	28	284
NR	0	3	0	0	0	3
Early carcinoma	26	58	60	96	133	373
ca	19	52	52	89	130	342
cb	7	5	7	6	0	25
Curative Total	26	57	59	95	130	367
Curative:early/resection	9.7	21.4	26.9	36.0	47.6	28.4
na	0	0	1	1	3	5
nb	0	1	0	0	0	1
Surgical techniques						
TSP	56	61	63	96	103	379
ca	11	17	20	43	47	138
cb	23	21	23	29	25	121
na	5	8	11	13	28	65
nb	17	15	9	11	3	55
S	238	244	188	199	193	1062
ca	132	141	110	144	161	688
cb	57	53	47	34	13	195
na	17	14	10	14	14	69
nb	32	33	21	16	5	107
NR	0	3	0	0	0	3
T + TS	30	22	15	22	31	120
ca + cb	17	13	12	13	25	80
na + nb	13	9	3	9	6	40
Misc	41	44	33	27	18	163
ca + cb	29	21	7	10	2	69
na + nb	12	23	26	17	16	94

ca: absolute curative resection. cb: relative curative resection. na: relative non-curative resection. nb: absolute non-curative resection. NR: not recorded. TSP: total gastrectomy with splenectomy and caudal hemipancreatectomy. S: subtotal gastrectomy. TS: total gastrectomy with splenectomy. T: simple gastrectomy. Misc: consists of proximal gastrectomy and conventional gastrectomy. A: 1961-1965. B: 1966-1970. C: 1971-1975. D: 1976-1980. E: 1981-1985.

*Synchronous dual malignancies.

to 19.7% in Period E in the latter. Cases with lesions involving the serosa showed a considerable decrease in incidence from 62.5% in Period A down to 39.4% in Period E.

4. Depth of invasion and 5-year survival rates (Table 5):

The overall 5-year survival rate in a series of cases in the period of 20 years from 1961 to 1980 was 47.1% with a statistically significant difference ($p < 0.01$) between the negative node group (79.2%) and the positive node group (29.9%). The overall 5-year-

Table 2. Age and Sex Distribution

Periods	A	B	C	D	E	Total
Male	222	258	191	213	214	1,098
Age, average	55.6	57.3	57.9	57.1	60.0	57.5
Female	143	113	108	131	131	626
Age, average	52.9	52.5	52.4	57.3	57.4	54.6
M/F	1.6	2.3	1.8	1.6	1.6	1.8
Total	365	371	299	344	345	1,724
Age, average	54.5	55.8	56.0	57.2	59.0	56.5

A: 1961-1965. B: 1966-1970. C: 1971-1975. D: 1976-1980. E: 1981-1985.

Table 3. Depth of Invasion and Lymph Node Metastases

Level of invasion	Overall		Periods; Metastases-%				
	No. of cases	Metastases-%	A [365]	B [366]	C [291]	D [343]	E [345]
Intramucosal	181	4.4	18.2	8.3	3.4	1.9	3.1
		>14.6					
Submucosal	189	24.3	33.3	15.6	33.3	29.5	19.1
Muscular	210	48.6	61.0	38.1	45.2	40.0	54.5
Subserosal $\alpha \cdot \beta$	122	59.8	58.1	73.5	36.4	72.7	41.7
γ	34	55.9	60.0	41.7	100.0	75.0	44.4
On to the serosa	895	82.7	78.1	83.3	87.2	83.4	83.1
To the neighboring organs	79	81.0	81.3	72.2	81.8	84.6	90.0
Total	1,710	61.5	69.9	64.5	66.7	57.7	49.0

Excluding 14 cases with unfavorable histology for lymph nodes.

[] : effective number of cases.

Table 4. Depth of Invasion: Chronological Changes

Depth of invasion	Overall		Periods; Incidence-%				
	No. of cases	Incidence-%	A [365]	B [366]	C [291]	D [343]	E [345]
Intramucosal	181	10.6	3.0	6.6	10.0	15.2	18.8
Submucosal	189	11.1	4.1	8.7	10.3	12.8	19.7
Muscular	210	12.3	16.2	11.5	10.7	13.1	9.6
Subserosal $\alpha \cdot \beta$	122	7.1	8.5	9.3	3.8	6.4	7.0
γ	34	2.0	1.4	3.3	1.4	1.2	2.6
On to the serosa	895	52.3	62.5	55.7	56.4	47.5	39.4
To the neighboring organs	79	4.6	4.4	4.9	7.6	3.8	2.9
Total	1,710	100.0	100.0	100.0	100.0	100.0	100.0

[] : effective number of cases.

Table 5. Depth of Invasion & Five-Year Survival Rates (1961-1980)

Level of invasion	Nodal involve- ment	Overall				Periods				
		Overall [1267]		Curative cases [941]		A [338]	B [346]	C [271]	D [312]	D : C u r a - t i v e [243]
Mucosal	Average	97.2	104/107	97.2	104/107	90.9	95.5	100.0	97.9	97.9
	(-)	98.0	99/101	98.0	99/101	100.0	95.0	100.0	97.8	97.8
	(+)	(83.3)	5/6	(83.3)	(5/6)	(50.0)	(100.0)	(100.0)	(100.0)	(100.0)
Submucosal	Average	92.2	107/116	83.3	105/113	86.7	96.8	85.7	95.2	95.1
	(-)	95.2	79/83	95.2	79/83	80.0	100.0	88.9	96.6	96.6
	(+)	82.8	28/33	86.7	26/30	90.0	80.0	80.0	92.3	91.7
Muscular	Average	70.1	115/164	75.5	111/147	54.7	82.5	66.7	80.5	86.1
	(-)	87.1	74/85	87.1	74/85	78.9	88.0	87.5	92.0	92.0
	(+)	51.9	41/79	59.7	37/62	41.2	73.3	42.9	62.5	72.7
Subserosal	Average	53.6	60/112	58.5	55/94	53.1	69.2	71.4	40.9	56.3
	(-)	62.5	25/40	63.2	24/38	69.2	53.3	71.4	(60.0)	(60.0)
	(+)	48.6	35/72	55.4	31/56	42.1	55.2	71.4	35.3	54.5
On to the serosa	Average	28.2	200/708	40.7	184/452	25.4	25.0	28.9	35.8	49.5
	(-)	55.7	68/122	63.8	67/105	54.3	55.9	52.6	60.9	76.5
	(+)	22.5	132/586	32.7	117/347	17.4	18.4	25.6	31.3	43.9
To the neighbor- ing organs	Average	18.3	11/60	35.7	10/28	(14.3)	17.6	25.0	11.1	25.0
	(-)	46.2	6/13	60.0	6/10	(66.7)	20.0)	(50.0)	(100.0)	(100.0)
	(+)	10.6	5/47	22.2	4/18	0.0	16.7	18.8	0.0	0.0
Total	Average	47.1	597/1267	60.5	569/941	37.0	46.0	48.0	58.7	72.0
	(-)	79.1	351/444	82.7	349/422	69.0	76.0	81.1	88.4	91.9
	(+)	29.9	246/823	42.4	220/519	23.5	29.0	31.5	37.7	51.7

Figures in parentheses are calculated from the negligible number of cases.

[] : effective number of cases.

survival rate of the same series, when limited exclusively to curative resection cases, showed a significantly higher figure of 60.5% and, when further limited to the cases in Period D, the last five years from 1976 to 1980, showed a still higher figure of 72.0% (175/243) with the highest rate of 91.9% (113/123) for the node negative groups. A steady improvement of the 5-year survival rate was found in the positive node groups, 23.5% in Period A and 37.7% in Period D. As expected the 5-year survival rates regularly decreased as the depth of invasion became deeper on the average, and likewise in each group of negative nodes and positive nodes.

5. Gross classification of lesions and 5-year survival rates:

Gross configurations of lesions classified on the basis of gross classification of gastric cancer¹⁾ and their distribution are shown in Table 6. Types II and III comprised approximately 60% of the series. Polypoid lesions belonging to Type I showed a significantly low incidence. The highest incidence of lymph node metastases was found in the gross type IV group.

The 5-year survival rates in relation to gross configurations of lesions are shown in Table 7. Of 1,236 patients in this series, Type 0 cases which consisted mostly of early-stage lesions showed a high 5-year survival rate of 94.5%, and Type IV cases with diffuse infiltration of cancer cells demonstrated the lowest 5-year survival rate of 15.9%. Type V cases, unclassified or miscellaneous lesions, which were composed mostly of lesions simulating early-stage carcinoma, were found to have a relatively favorable prognosis.

6. Histologic types of lesions, lymph node metastases and 5-year survival rates:

The incidence of histologic types of gastric cancer is shown in Table 8. Two groups of moderately to well-differentiated carcinomas and signet-ring cell and mucinous carcinomas, each comprising about one third of the series, had a relatively high incidence. The poorly to undifferentiated carcinoma group was found to have the highest incidence of lymph node metastases (72.4%) showing a statistically significant ($p < 0.01$) difference from the moderately to well-differentiated carcinoma group (52.6%). Table 9 shows a statistically significant difference of the 5-year survival rates between the moderately to well-differentiated carcinoma group (53.9%) and the signet-ring cell and mucinous carcinoma group (40.7%). A considerable improvement in the 5-year survival rates was chronologically noted in each group of histologic types, showing a statistically significant difference.

7. Sites of tumor growth and lymph node metastases:

Sites of tumor growth are indicated in Table 10. Of 1,724 patients, 47.3% were those with lesions involving the upper 2/3 of the stomach; in 41.2%, the lesions were situated in the lower 1/3. Significant chronological changes in the incidence of sites of tumor growth were noted in cases with lesions located in the A segment and those with lesions

Table 6. Incidence of Lesions & Lymph Node Metastases in Relation to Gross Classification
(1961-1985)

Gross classification	No. of cases	Incidence-%	Node metastases-%
0	303	18.5	13.9
I	35	2.1	31.4
II	510	31.1	66.5
III	485	29.6	83.7
IV	150	9.2	88.7
V	155	9.5	55.5
Total	1,638	100.0	62.1

Cases with multiple lesions are excluded.

Table 7. Gross Classification of Lesions & Five-Year Survival Rates

Gross classification	Overall		Periods			
	No. of Cases	5-YSR-%	A [334]	B [332]	C [269]	D [301]
0	181	94.5	85.7	95.7	93.3	96.1
I	25	68.0	60.0	(50.0)	(100.0)	66.7
II	420	46.4	44.0	44.4	48.7	53.0
III	397	29.2	25.6	28.6	25.7	38.6
IV	107	15.9	14.7	22.2	16.7	12.0
V	106	60.4	80.0	57.1	55.3	64.3
Total	1,236	46.9	37.1	45.5	48.0	58.5

Cases with multiple lesions are excluded.

Figures in parentheses are calculated from the negligible number of cases.

[] : effective number of cases.

Table 8. Incidence of Lesions & Lymph Node Metastases in Relation to Histologic Types

Histologic types	No. of cases	Incidence-%	Node metastases-%
Moderately to well-differentiated	620	36.3	52.6 ^a
Poorly to undifferentiated	387	22.6	72.4 ^a
Signet-ring cell and mucinous	551	32.2	65.2
Papillotubular	143	8.4	57.3
Miscellaneous*	9	0.5	55.6
Total	1,710	100.0	61.6

* Including 6 cases of squamous cell carcinoma, 2 cases of adenosquamous cell carcinoma, and one case of carcinoid.

^a: statistically significant difference ($p < 0.01$).

involving 2 segments, the former showing a considerable decrease from 48.2% in Period A to 27.0% in Period E and the latter a significant increase from 3.8% in Period A to 18.3% in Period E.

As expected, most patients (94.4%) with diffuse lesions involving all 3 segments of the

Table 9. Histologic Types & Five-Year Survival Rates

Histologic Types	Overall		Periods; 5-YSR-%			
	No. of cases	5-YSR-%	A [338]	B [346]	C [271]	D [312]
Moderately to well-differ- entiated	449	53.9 ^c	39.7 ^a	52.9	51.8	74.3 ^b
Poorly to undifferen- tiated	295	44.7	40.5 ^a	44.0	42.6	51.3 ^b
Signet-ring cell and mucinous	410	40.7 ^d	33.9 ^a	37.4	46.3	49.5 ^b
Papillotubular	105	49.5	23.1 ^a	53.8	53.3	52.6 ^b
Miscellaneous	8	(50.0)	(0)	(75.0)	(0)	(50.0)
Total/average	1,267	47.1	37.0 ^a	46.0	48.0	58.7 ^b

Figures in parentheses are calculated from the negligible number of cases.

[] : effective number of cases.

^a vs ^b, ^c vs ^d: statistically significant difference ($p < 0.01$).

Table 10. Sites of Tumor Growth; Incidence & Lymph Node Metastases

Sites of tumor growth*	Overall			Periods; Incidence-%				
	No. of cases	Incide- nce-%	Metast- ases-%	A [365]	B [371]	C [299]	D [344]	E [345]
C	291	16.9	66.7	15.3	18.3	16.7	17.2	16.8
M	524	30.4	51.0	31.8	25.6	26.8	34.6	33.0
A	711	41.2	59.8	48.2	50.4	46.2	34.0	27.0
Two segments	162	9.4	81.5	3.8	4.6	8.7	12.2	18.3
Three segments	36	2.1	94.4	0.8	1.1	1.7	2.0	4.9
Total	1,724	100.0	61.0	100.0	100.0	100.0	100.0	100.0

* Predominant sites of involvement.

C: upper 1/3. M: middle 1/3. A: lower 1/3.

[] : effective number of cases.

stomach were found to have lymph node metastases.

The rates of lymph node metastases were identical in both series employed in Table 10 (1,724 patients) and in Table 11 (1,343 patients). The relationship between the sites of tumor growth and the incidence of metastases in main lymph node groups is indicated in Table 11. A relatively high incidence of metastases was noted in lymph node group Nos. 1, 2, 3, 7, 10, 11 and 16 for lesions located in the C segment, in Nos. 3 and 7 for those in the M segment, and in Nos. 3, 5, 6, 8a and 12 for those in the A segment.

In general, noteworthy rates of lymph node metastases were noted in lymph node groups Nos. 1, 3, 6, 7, 10, 11 and 16.

8. Surgical procedures, 5-year survival rates, surgical mortality, and number of lymph

nodes histologically examined per specimen:

Concerning the chronological changes of surgical procedures employed, patients undergoing a total gastrectomy with splenectomy and caudal hemipancreatectomy (TSP) vs those receiving a subtotal gastrectomy (S) are respectively shown in Table 12. The incidence of the TSP group showed a considerable increase from 15.3% in Period A to 29.9% in Period E, while that of the S group exhibited no significant chronological difference ranging between 55.9% and 65.8%. It was apparent that the Billroth I with S procedure was rather representative in the later half period in comparison with the Billroth II that was predominant in the earlier half period. Among other procedures, proximal gastrectomy including so-called esophagocardiofundectomy, has definitely decreased in recent years.

The 5-year survival rates in relation to surgical procedures are shown in Table 13. The overall 5-year survival rates of patients treated during the 20-year period from 1961 to 1980 was 47.0% (602/1,280) on the average, 30.6% (76/248) for the TSP group, and 56.4% (462/819) for the S group, and exclusively for the curative resection group, 60.6% (572/944), 43.5% (73/168), and 65.8% (438/666), respectively. The 5-year survival rates showed a definite chronological increase from 37.0% in Period A to 57.2% in Period D on the average, 13.7% to 46.0% for the TSP group and 43.0% to 70.1% for the S group; likewise,

Table 11. Incidence of Metastases in Lymph Node Groups & Sites of Tumor Growth

Sites of tumor growth	Overall		Lymph node groups; Metastases: %											
	No. of cases	Metastases: %	1	2	3	5	6	7	8a	9	10	11	12	16
C	271	67.2	37.6	24.0	50.0	2.7	9.4	29.8	4.8	8.4	23.4	23.6	1.4	16.0
M	473	52.0	15.9	8.0	42.9	7.2	18.6	21.0	6.7	6.7	16.9	4.3	3.2	13.3
A	599	59.9	9.3	1.7	38.0	19.8	45.0	15.2	15.7	5.9	9.8	6.3	9.8	7.1
Total	1,343	58.6	17.3	14.4	41.9	12.6	29.7	20.0	10.4	6.7	20.2	11.2	5.9	13.0

Cases with multiple lesions or extensively involving two or more segments are excluded.

Table 12. Surgical Procedures; Chronological Changes

Surgical procedures	Overall		Periods											
	No. of Cases	%	A Cases	%	B Cases	%	C Cases	%	D Cases	%	E Cases	%		
Total gastrectomy + splenectomy + hemipancreatectomy (TSP)	379	22.0	56	15.3	61	16.4	63	21.1	96	27.9	103	29.9		
Subtotal	1,062	61.6	238	65.2	244	65.8	188	62.9	199	57.8	193	55.9		
gastrectomy B ₁	409		9		1		75		156		168			
(S) B ₂	652		229		243		113		43		25			
Others	283	16.4	71	19.5	66	17.8	48	16.1	49	14.2	49	14.2		
Total	1,724	100.0	365	100.0	371	100.0	299	100.0	344	100.0	345	100.0		

B₁: Billroth I procedure. B₂: Billroth II procedure.

Table 13. Surgical Procedures, Five-Year Survival Rates, Surgical Mortality & Number of Lymph Nodes Histologically Examined Per Specimen

Surgical procedures	Overall				Periods																		
					A				B				C				D				E		
	No. of cases	[1]	[2]	[3]	Cases	[1]	[2]	[3]	Cases	[1]	[2]	[3]	Cases	[1]	[2]	[3]	Cases	[1]	[2]	[3]	Cases	[2]	[3]
TSP	379 [259]	30.6 [43.5]	1.8 [1.5]	42.2	56 [34]	13.7 [23.3]	3.6	36.3	61	25.5	1.6	37.1	63	27.3	1.6	38.0	96 [72]	46.0 [55.9]	1.0	41.3	103	1.9	51.7
TS	52 [40]	29.4	1.9 [2.5]	34.4	14	21.4	0	32.0	15	33.3	0	35.5	4	33.3	(25.0)	37.5	5	(50.0)	0	23.4	14	0	35.1
T	68 [40]	33.3	7.4 [5.0]	27.2	16	14.3	6.3	29.8	7	16.7	0	28.6	11	62.5	9.1	20.5	17	42.9	11.8	23.1	17	5.9	32.8
S	1,062 [883]	56.4 [65.8]	1.4 [1.5]	29.3	238 [189]	43.0 [50.9]	3.4	26.2	244	56.2	1.6	29.9	188	59.1	0	28.5	199 [169]	70.1 [79.5]	1.5	30.0	193	0	32.5
Pr	53 [40]	35.6	5.7 [5.0]	26.5	18	26.7	11.1	26.8	19	38.9	0	31.4	8	16.7	(12.5)	14.5	6	66.7	0	26.8	2	0	25.5
Misc	110 [29]	26.1	1.8 [0]	11.2	23	60.9	0	11.0	25	20.8	4.0	14.6	25	8.0	0	7.8	21	15.0	4.8	9.1	16	0	15.3
Total	1,724 [1,291]	47.0 [60.6]	1.9 [1.7]	31.0	365 [269]	37.0 [48.0]	3.6	27.2	371	46.4	1.6	30.4	299	47.1	1.3	28.2	344 [264]	57.2 [72.0]	2.0	31.5	345	0.9	37.5

[1]: five-year survival rates. [2]: surgical mortality-%. [3]: number of lymph nodes per specimen.

Figures in [] indicate curative resection cases.

Figures in parentheses are calculated from the negligible number of cases.

Pr: proximal gastrectomy.

Table 14. Number of Lymph Nodes Histologically Examined Per Specimen & Sites of Tumor Growth

Sites of tumor growth	Lymph node groups																		
	Overall [1651]	1 [1519]	2 [703]	3 [1619]	4sa [288]	4sb [289]	4d [298]	5 [1556]	6 [1572]	7 [1484]	8a [1373]	9 [1334]	10 [525]	11 [898]	12 [504]	13 [364]	14 [290]	15 [78]	16 [71]
C	36.9 (116)	3.5	1.9	6.7	1.9	3.0	5.3	0.5	3.0	2.6	1.3	1.4	4.4	4.5	1.6	1.8	2.3	1.8	2.3
M	30.2 (93)	2.5	1.7	7.2	0.7	1.7	5.7	0.6	3.6	2.7	1.6	1.5	3.6	1.6	1.7	1.3	1.8	4.1	1.9
A	27.7 (87)	2.6	1.9	6.5	0.3	1.6	5.9	0.9	4.7	2.7	1.6	1.2	2.0	1.8	1.9	1.5	1.7	2.4	1.4
Two segments	35.9 (87)	3.4	1.8	7.0	1.5	2.6	6.6	0.7	4.0	2.4	1.7	1.5	4.8	3.9	2.1	1.6	1.9	1.6	2.2
Three segments	36.6 (90)	2.7	1.6	7.6	1.6	2.9	6.0	0.7	3.4	3.0	1.4	1.7	3.8	3.3	1.7	1.2	2.4	1.7	2.5
Total	31.0 (116)	2.8	1.8	6.8	1.1	2.1	5.9	0.7	4.0	2.7	1.5	1.3	4.1	2.8	1.8	1.5	1.9	2.5	2.0

(): maximum number of lymph nodes histologically examined per specimen.

[]: effective number of cases for which lymph nodes are examined.

Cases with multiple lesions are excluded.

exclusively for the curative resection group, from 48.0% to 72.0%, 23.3% to 55.9%, and 50.9% to 79.5%, respectively.

Surgical mortality defined as postoperative death within 30 days¹⁾ occurred overall in 1.9% of the patients in the past 25 years. Surgical mortality showed a tendency to decrease from 3.6 % in Period A to 0.9% in Period E.

The number of lymph nodes histologically examined per specimen also showed a chronological increase, and the average number in the last 5-year period (Period E) indicated 37.5 for the entire series of 345 patients, 51.7 for the TSP group, and 32.5 for the S group,

9. Number of lymph nodes per specimen and sites of tumor growth:

Table 14 shows the number of lymph nodes histologically examined per specimen in relation to sites of tumor growth and main lymph node groups.¹⁾ Since these numbers of lymph nodes were recorded after histological examination, they were not greater than those grossly counted at surgery.

10. Evaluation of the prognosis of patients in the non-curative resection group:

Among an effective number of 358 patients belonging to the non-curative resection group during the 20-year period since 1961, 28 (7.8%) were found to be 5-year survivors: 18 (17.6%) of 102 patients in the relative non-curative resection (na) subgroup and 10 (3.9%) of 256 in the absolute non-curative (nb) subgroup (Table 15). Of 18 surviving patients belonging to the na subgroup, there were 5 with a positive resection margin, 3 with P₁, and 10 (including 2 with P₁) with a possibility of involved lymph nodes left behind at surgery. Nine of the 10 survivors belonging to the nb subgroup were recorded to have had involved lymph nodes left behind; among them were 2 patients with a positive resection margin and one with P₂.

Table 15. Non-curative Resection & Prognosis (1961 - 1980)

No. of patients		5-year survivors	5-YSR-%	Factors for noncurability
na	102	18	17.6	A=5, B ₁ =3, C=8 B ₁ +C=2
nb	256	10	3.9	A=1, A+C=1, C=5 B ₁ +C=2, B ₂ +C=1
Total	358	28	7.8	

A: positive resection margin. B₁: P₁ factor. B₂: P₂ factor. C: involved lymph nodes; thought to be, or recorded as, left behind.

DISCUSSION

1. The significance of evaluating the chronological changes in gastric cancer surgery during the past 25 years:

On the basis of our 25-year experience in gastric cancer surgery, the present investigation has pointed out definite improvements in many aspects of surgical results. The improvement in the 5-year survival rates is apparent when one compares our present analysis with our previous ones.^{2,3,4)} Such improvements are considered to have resulted from many factors, such as surgical techniques, pre- and post-operative non-surgical treatment, including intravenous nutritional management utilizing IVH and adjuvant anticancer chemotherapy along with immunopotential chemotherapy. In any event, it is definitely true that the improved surgical results of the preest days have been accomplished step by step on the basis of extraordinarily painful efforts with trial and error of the predecessor surgeons some having already demised. We surgeons in the present age should greatly appreciate this fact.

2. Criteria for “curative resection”:

The criteria for curability and non-curability are described in the guidelines for gastric cancer surgery¹⁾ which have been widely employed in most authorized hospitals in Japan. It would be noteworthy to recognize that of 358 patients with a non-curative resection of gastric lesions, 28 or 7.8% are 5-year survivors (Table 15). Furthermore, the fact that, among these, 10 (3.9%) of 256 patients with absolute non-curative resection of lesions have survived 5 years suggests the possibility of revision of the criteria in present usage. Gastric cancer surgery is one of the fields of practical medicine, and all criteria or concepts, therefore, should be practical. Our previous works^{2,3)} have suggested practical criteria for curative resection of gastric cancers. In the 10 patients of the non-curative resection of lesions in Table 15, factors for non-curability are analyzed: the N-factor as involved lymph nodes left behind and the P₂ factor are two main descriptions, both decided on the basis of gross observation at surgery but apparently misjudged on most occasions. The criteria for cancer involvement at resection margins of specimen, also defined in the same guidelines,¹⁾ are likewise worth reevaluating. Cases with histologic evidence of cancer cells found within 5mm of the resection lines are all defined as involving resection margins and recorded as belonging to the non-curative resection group. There should be certain difference between lesions with cancer cell involvement within 5mm to the resection lines but not reaching the lines and those with cancer cells actually reaching the resection lines. Furthermore, our experience suggests that occasional cases with histologic cancer cell involvement of resection lines evident on the available tissue preparation may well be the result of technical procedures; for instance, removal of staples with marginal tissue with a width of more or less than 5mm free of cancer involvement might have been done before preparing the tissue for histologic

examination.

Relative non-curative resection (na) is referred to as a resection without leaving grossly visible cancer tissue and the possibility of both incomplete and complete removal of secondary lesions, including remote ones. Thus many cases of relative non-curative resection may have a good chance to belong to the curative resection group.

3. Chronological increase of early-stage carcinoma:

A yearly increase of early-stage carcinoma of the stomach is apparent in the past 25 years, and in the curative resection groups, the ratio of early-stage carcinoma to all resections has increased from 9.7% in the first 5-year period of 1961 to 1965 (Period A) to 47.6% in the last 5-year period from 1981 to 1985 (Period E) (Table 1). This fact and another that patients with early-stage carcinoma have a 5-year survival rate of 95% (Table 5), have both undoubtedly contributed to the amazing improvement of the overall 5-year survival rates in the last 5-years (Period D; 1976-1980): 58.7% for all resections and 72.0% exclusively for the curative resection group (Table 5).

A large number of recent works have dealt with early gastric cancer with special emphasis on lymph node involvements^{2,5-13)}, the majority referring to the prognosis⁸⁻¹³⁾ (Table 16). The incidence of lymph node metastases ranges between 1% and 7% for the intramucosal carcinoma group, between 15% and 25% for the submucosal carcinoma group, and between 9% and 15% for the total average of early-stage carcinoma. The 5-year survival rates for patients with an early-stage carcinoma range between 81% for the worst group with lymph node involvements, and 100% for the intramucosal group, and between 87% and 98% for the total average.

4. Surgical results in patients with advanced lesions; Patients with positive nodes:

In order to know whether or not the surgical results have really improved without the contribution resulting from the increased number of early-stage carcinoma cases, we have to select cases with advanced lesions. Improvement is apparent in cases with lesions invading the muscular coat and those with lesions exposed on the serosal surface, particularly in cases with positive nodes (Table 5).

The representative reports dealing with postoperative surgical results in gastrectomy patients with gastric cancer have described a 5-year survival rate of 24.7%,¹⁴⁾ 42.6%¹⁵⁾ 65.6%¹⁶⁾ and 65.9%³⁾ for the curative resection group. In our present series, the 5-year survival rate during the last 20 years is 47.0% for the entire series and 60.6% for the curative resection group, the latter figure being greatly improved to show 72.0% exclusively in patients belonging to the last 5-year period of D (Table 13).

5. Surgical deaths:

Surgical death is defined as a death within 30 postoperative days.¹⁾ The overall surgical death rate is 1.9% for the entire series in the past 25 years in comparison with

Table 16. Early Gastric Cancer: Lymph Node Metastases & Five-Year Survival Rates (List from literature)

Authors	Year	Lymph node metastases-%				5-year survival-%						Remarks
		No.Cases	m	sm	Total	No. Cases	n(—)	n(+)	m	sm	Total	
Yoshino ⁵⁾	1979	215	6.5	20.3	14.4							
Iwanaga ⁶⁾	1986	1,178	3.8	20.0	11.8							
Sakakibara ⁷⁾	1986	148	6.0	19.8	13.5							
Oohara ⁸⁾	1985	384	4.4	15.3	10.2	200					98.0	
Majima ⁹⁾	1982	209	1.2	19.2	12.0	152			91.9	85.6	86.8	
Habu ¹⁰⁾	1986	272	5.0	15.9	10.3	270	97.1	83.3				
Fujita ¹¹⁾	1986	290	0.8	15.5	9.0	210	90.5	81.0	94.4	86.0	89.5	
Soga ²⁾	1988	364	3.9	23.9	14.0	220	96.7	86.5	98.1	92.1	95.0	Curative cases only
Hirota ¹²⁾	1981	800	2.6	17.2	9.6	[732	(97.5	83.1)	100.0	95.3	97.7]	Actuarial survival
Jpn Series ¹³⁾	1986	1,323	2.7	17.3	10.1	1,225	91.9	83.5	93.8	88.4	91.1	() : sm cases only
P r e s e n t Series	1988	370	4.4	24.3	14.6	223	96.7	84.6	97.2	92.2	94.6	Jpn series in 1978
<hr/>												
Range			1	15	9	90		81	92	86	87	
			—7	—25	—15	—97		—86	—100	—96	—98	

m:intramucosal. sm:submucosal. n(—):without node metastases. n(+):with node metastases.

Table 17. Surgical Deaths after Gastrectomy for Gastric Cancer

Authors	Year	Curative group					Not specified			Periods of evaluation
		No. Cases	S	T	Others	Total-%	No. Cases	T	Total-%	
Fujimaki ¹⁸⁾	1972						124	1.6		1951-1968
Hassler ¹⁹⁾	1986						72	11.1		1973-1982
Soga ⁴⁾	1979						1,492		3.2	1951-1970
Yamada ¹⁶⁾	1980	1,502	1.4	1.7	0.9	1.4	2,166		1.9	1957-1964
Hollender ²⁰⁾	1983						384	27.2**	14.3**	1969-1982
Battezzati ¹⁴⁾	1985	234	14.1	42	30.4	20.5	400		24.2	1965-1979
Jpn series ¹³⁾	1986	3,507				0.9	5,003		1.6	1978
Soga ²⁾	1988	476	0.9	0	6.7	1.1				1971-1980
Present	1988	1,291	1.5	2.1***	3.0***	1.7	1,724		1.9	1961-1985
series							345		0.9	1981-1985
							499***	2.6		1961-1985

S: subtotal gastrectomy. T: total gastrectomy.

* Cases in 1978 registered and computerized.

** Postoperative deaths within 2 months.

*** Calculated from Table 13.

0.9% in Period E, 1.8% for the TSP group and 1.4% for the subtotal gastrectomy group (Table 13). The chronological decrease in the surgical death rate in the TSP group is evident by showing 3.6% in Period A, down to 1.0% in Period D, but high up to 1.9% in Period E. Our emphasis is, however, that the reasonable surgical death rate after total gastrectomy these days would be more or less 1.0%. Our results indicate, contrary to some other commentators,¹⁷⁾ that TSP with extensive lymphadenectomy can be successfully performed with a relatively low mortality rate.³⁾ Japanese series in 1986,¹³⁾ indicating the most recent information on registered and computerized cases in 1978 has reported surgical death rates of 1.6% for 5,003 cases of resection and 0.9% for 3,507 cases of the curative resection group. Our previous work dealing with 2,227 cases of gastric cancer in an earlier period of 20 years between 1951 and 1970 has described the overall surgical death rate of 3.2% (48/1,492) for the resection group regardless of curability.⁴⁾ On the other hand, even recent literature discussing death rates shows a wide range of incidence in surgical death between 1.4%¹⁶⁾ and 20.5%¹⁴⁾ for the overall curative resection group, between 1.7%¹⁶⁾ and 42%¹⁴⁾ for the curative total gastrectomy group, and 1.4%¹⁶⁾ and 14.4%¹⁴⁾ for the curative distal subtotal gastrectomy group (Table 17). In patients with total gastrectomy for gastric cancer regardless of curability, the surgical death rate ranges between 1.6%¹⁸⁾ and 11.1%¹⁹⁾ in representative reports.

The surgical death rates in the subtotal gastrectomy group in our series show excellent improvement, 3.4% in Period A down to 0% in Period E (Table 13). The surgical death after subtotal gastrectomy for gastric cancer should be considered to be exceptional in the present situation.

CONCLUSION AND SUMMARY

1. A statistical analysis of 1,786 patients with gastric cancer resected during the past 25 years from 1961 to 1985 was carried out.
2. Excluding 28 patients with synchronous dual malignancies and 34 with remnant stomach cancer, the remaining 1,724 patients consisted of 1,098 males with age averaging 57.5 years and 626 females with ages averaging 54.6, the overall average age being 56.5 years and the male/female ratio 1.8.
3. Among the 1,724 patients, 1,291 (74.9%) underwent curative resection.
4. Of 373 patients with early-stage carcinoma, 6 had lesions resected not for cure (non-curative resection). In the curative resection group, the ratio of the early-stage carcinoma to all resections increased from 9.7% in the first 5 years between 1961 and 1965 to 47.6% in the last 5 years from 1981 to 1985. The average 5-year survival rates in patients with early-stage carcinoma of curative resection were 97.2% for patients with m-lesions and 92.9% for those with sm-lesions.
5. The overall rate of lymph node metastases in 1,710 patients excluding those with an unfavorable histology, was 61.5%, ranging between 69.9% and 49.0%, apparently decreasing chronologically in accordance with the increase in the number with early-

stage carcinoma.

6. The overall 5-year survival rate was 47.1%: 79.1% for patients with negative nodes and 29.9% for those with positive nodes. In 243 patients with lesions curatively resected during the last 5 years from 1976 to 1980, the overall 5-year survival rate was 72.0%: 91.9% for those with negative nodes and 51.7% for those with positive nodes. It is important to emphasize that the 5-year survival rates in patients with advanced lesions and positive nodes have been improved.

7. As for gross configurations of lesions, Types II and III were frequently encountered, both comprising 60.7% (31.1% and 29.6%, respectively) of the series, and the incidence of lymph node metastases showed a gradual increase in the order of Types I, II, III, and IV, the last type exhibiting 88.7%. Favorable 5-year survival rates were found, as expected, in Types 0 (94.5%) and I (68.0%).

8. As for histologic types, there was a statistically significant difference ($p < 0.01$) in the incidence of lymph node metastases between lesions of moderate to high differentiation (52.6%) and those of low differentiation (72.4%). There is, however, no significant difference in the 5-year survival rates among patients with lesions showing different histologic types.

9. Concerning the sites of tumor growth, an overall 41.2% of the lesions were located in the lower 1/3 (A), but this incidence showed a tendency to chronologically decrease from 48.2% to 27.0% while that of lesions in the other two segments (C and M) showed constant values (16.9% and 30.4%, respectively). Instead, the increase in the number of lesions involving two segments exhibited a definite increase from 3.8% to 18.3% in accordance with the increase of early-stage carcinoma.

10. An analysis of lymph node metastases in each lymph node group in relation to the site of tumor growth was performed and the results indicated the reasonability of R_2 resection for cure in most cases, but at least partial removal of the third lymph node group (additionally in some cases, lymph nodes belonging to No. 16 of the fourth group) was necessitated in some cases.

11. Surgical procedures consisted mainly of subtotal gastrectomy (61.6%) and total gastrectomy with splenectomy and caudal hemipancreatectomy (TSP; 22.0%), the latter showing a steady chronological increase up to 29.9%, the former a decrease down to 55.9%. The overall 5-year survival rate in the TSP group was 30.6% (43.5% for curative resections), thus exhibiting an amazing improvement from 13.7% in Period A up to 46.0% (55.9% for curative resections) in Period D.

12. The overall rate of surgical deaths within 30 postoperative days was 1.9%: 1.5% for both the subtotal gastrectomy group and the TSP group in curative resection series. This has improved a great deal in the last 5 years of Period E, showing an overall 0.9%; no surgical deaths occurred in the subtotal gastrectomy group.

13. The criteria for curative and non-curative resections defined in the guidelines, "The General Rules for Gastric Cancer Study in Surgery and Pathology, 11th Ed., 1985",

which are widely employed in Japan, were critically reevaluated on the basis of 5-year survivors in the non-curative resection group, and the possibility of “relative non-curative cases” belonging to the curative resection group was especially emphasized from a practical point of view.

ACKNOWLEDGEMENT

The authors are greatly grateful to Dr. Jun Soga, Professor of Surgery, College of Biomedical Technology, Niigata University, for having kindly supplied us with helpful suggestions and computerized data in this investigation.

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