International Journal of Medical Science and Clinical Invention 5(03): 3698-3703, 2018
DOI:10.18535/ijmsci/v5i3.25 **ICV 2016: 77.2**
e-ISSN:2348-991X, p-ISSN: 2454-9576

Research Article

The Effects of Body Mass Index on Lymph Node Dissection and Complications in Total Gastrectomy

Ebubekir Gündeş[1], Ulaş Aday[2], Hüseyin Çiyiltepe[2], Durmuş Ali Çetin[2], Aziz Serkan Senger[2], Selçuk Gülmez[2], Orhan Uzun[2], Emre Bozdağ[2],Kamuran Cumhur Değer[2],Erdal Polat[2], Mustafa Duman[2],

[1]Gazi Yaşargil Education And Research Hospital Gastroenterological Surgery Department, Diyarbakır, TURKEY

[2]Kartal Koşuyolu High Speciality And Training Hospital Gastroenterological Surgery Department, Kartal, İstanbul, TURKEY

Abstract:

Objective; The aim of this study was to investigate the effects of body mass index (BMI) on postoperative complications and on the total number of excised and metastatic lymph nodes in cases with total gastrectomy + D2 lymph node dissections because of gastric cancer.

Methods: The patients were divided into three groups according to their BMI: those with BMI of 24.9 (kg/m2) and less were normal (Group 1), those with BMI between 25 and 30 (kg/m2) were overweight (Group 2), and those with BMI greater than 30 (kg/m2) were obese (Group 3).

Results: There were 27 patients in Group I, 28 in Group 2 and 25 in Group 3. When the groups were examined, only Group 3 had a higher rate of comorbidity. Otherwise, the clinical characteristics and the rates of intraoperative and postoperative complications were similar among the groups. The pathological analyses conducted among the groups revealed that BMI had no effect on the number of excised lymph nodes, the number of metastatic lymph nodes, and the ratio of metastatic lymph nodes to excised lymph nodes.

Conclusion: We believe that BMI does not affect pathological outcomes in gastric cancer surgery and does not increase surgical complications.

Keywords: Gastric cancer, D2 lymph node dissection, total gastrectomy, body mass index.

Introduction

Gastric cancer is the fourth most common type of all cancers in the world and is the second most frequent cause of death related to cancer [1]. It is seen in males two to three times more frequently than in females; it is also more frequently seen after the 6th decade [2, 3]. The incidence of gastric cancer varies from country to country, and it even varies based on ethnic background and nutritional habits within the same country [4]. The current treatment for gastric cancer is still gastric resection and lymph node dissection; however, possible postoperative complications may lead to prolonged hospitalization and mortality.

Obesity is on the rise in the western world and it continues to be a growing problem for surgeons. The effect of BMI on the surgical technique, surgical complications, duration of hospitalization, and the rate of mortality in patients with gastric cancer who have had a gastrectomy and D2 lymph node dissection is still a controversial issue. In contrast to studies that have demonstrated that obesity increased the rate of postoperative complications, there are other studies that have concluded BMI was not related to such complications and, in fact, the results were even better in patients with higher BMIs [5- 7].

This study investigated the relationship between the intraoperative and postoperative clinical results of patients with gastric cancer who had a total gastrectomy and D2 lymph node dissection, and their preoperative clinical results.

Methods

Patients

The data for gastric cancer patients who had a total gastrectomy and routine D2 lymph node dissection at Kartal Koşuyolu Higher Specialty Training and Research Hospital's Gastroenterology Surgery Clinic between January 2010 and September 2016 were retrospectively studied. All the patients had been diagnosed with gastric adenocarcinoma proven by gastroscopic biopsy. In addition, all the patients had thoracoabdominal computerized tomography for preoperative staging. Exclusion criteria for the study were determined to be subtotal gastrectomy, palliative resection, inadequate file information, and patients who had hyperthermic intraperitoneal chemotherapy (HIPEC).

The study participants were selected from 220 patients who received surgical procedures after having been diagnosed with gastric cancer from January 2010 to September 2016. Out of those 220 patients, 80 patients who met the inclusion criteria were selected for the study.

BMI Evaluation and Grouping

According to the classifications set by the World Health Organization (WHO), individuals with BMI < 18.5 are considered underweight, those with a BMI of 18.5 - 24.9 are considered normal, those with a BMI of 25 - 29.9 are considered overweight, those with a BMI of 30 - 39.9 are considered obese, and those with a BMI of > 40.5 are considered morbidly obese [8]. All the patients' weights (kg) and heights (cm) were measured at the preoperative preparatory stage, and their BMIs were calculated. In our study, patients were divided into three groups: (a) Group 1: those with BMI of 24.9 (kg/m2) and less (i.e., normal), (b) Group 2: those with BMI between 25 and 30 (kg/m2) (i.e., overweight), and (c) Group 3: those with BMI greater than 30 (kg/m2) (i.e., obese).

The Data

The preoperative data on the study participants were obtained and recorded retrospectively, including: ages, sexes, BMI, left ventricular ejection fraction (EF), respiratory function tests, diabetes mellitus (DM), hypertension (HT), chronic obstructive pulmonary disease (COPD), chronic renal failure, preoperative laboratory tests, and history of smoking. Intraoperational duration (minutes), blood transfusions utilized during the procedures, and duration of hospitalization were recorded for each patient as well.

Mortality cases occurring during the first 30-day follow-up in the postoperative period were defined as surgery mortalities, while surgical complications occurring within the same period were defined as morbidity. Postoperative complications were staged according to the Clavien-Dindo classification [9].

Tumor size (mm), distal border (mm), proximal border (mm), invasion depth, the number of excised lymph nodes and detected metastatic lymph nodes, and the existence of lymphovascular and perineural invasion of the tumors were recorded according to pathology reports. The ratios of metastatic lymph nodes to excised lymph nodes (LNRs) were categorized into four groups: (a) 0; (b) $0 < LNR \leq 0.1$; (c) $0.1 < LNR \leq 0.4$; and (d) $LNR > 0.4$. The pathological staging of the tumors was conducted according to the American Joint Committee on Cancer's (AJCC) TNM staging system, 7th edition [10].

Patients' follow-up continued until their deaths. Patients who died due to gastric cancer were included in the group of related deaths. The time from surgery to the date of death was defined as survival time.

Research Questions

1. Primary question: Does body mass index (BMI) lead to technical challenges during surgical procedures and postoperative complications?

2. Secondary question: To what extent does body mass index (BMI) affect pathology results?

Statistical Analysis

The Statistical Package for Social Sciences (SPSS 21 Inc., Chicago, IL, USA) software was utilized to conduct biostatistical analyses. The mean (*M*), minimum, maximum, and standard deviation (±*SD*) values of the data obtained from the patients covered by the study were calculated. The distribution of data was checked using the Kolmogorov-Smirnov test. Data with a normal distribution were analyzed using an ANOVA test. Any statistically significant relationship between the groups was determined by the post hoc Tukey test. Non-parametric data were evaluated by Kruskal-Wallis analysis. Categorical groups were compared by the Chi-square. The Kaplan-Meier method was used for survival rates among the study groups, and the comparisons were made by the log-rank test. The results were evaluated at the 95% confidence interval (CI) and significance was set at the $p < 0.05$ level.

Results

Demographic Characteristics

In the initial sample, the 113 patients who had undergone a subtotal gastrectomy, 5 patients who had incomplete data in their files, and 2 patients who did not have D2 lymph node dissection between January 2010 and September 2016 were excluded from the study. The remaining cases of 80 patients who had a total gastrectomy and D2 lymph node dissection because of gastric cancer were analyzed within the scope of the study **(Figure 1).**

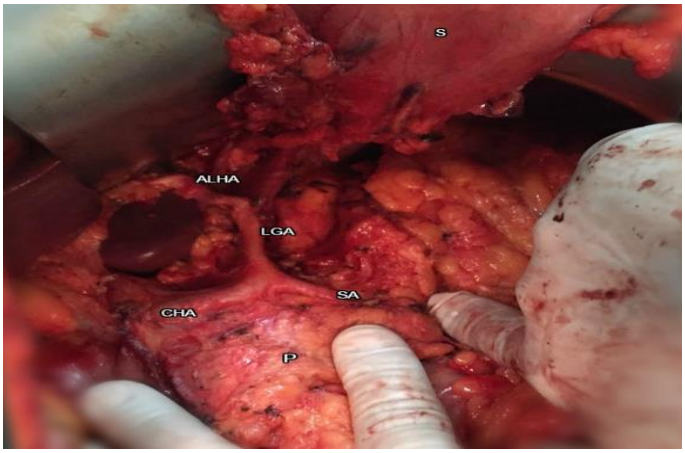

Figure 1. Operative view of D2 lymph node dissection (ALHA; accessory left hepatic artery, CHA; common hepatic artery, LGA; left gastric artery, P; pancreas, S; stomach, SA; splenic artery)

There were 27 patients with normal BMI of < 24.9 kg/m2 in Group I, 28 overweight patients with a BMI of 25 - 30 kg/m2 in Group 2, and 25 obese patients with a BMI of > 30 kg/m2 in Group 3. The rates of HT and DM in Group 3 were significantly higher than those in Groups 1 and 2. The clinical characteristics of the patients have been summarized in **Table 1**.

Table 1. Demographic characteristics of patients according to BMI group

		Group 1 (n:27)	Group 2 (n:28)	Group 3 (n:25)	P- value
Age (mean ± standart deviation)		58,96 (± 11,9)	63,8 (± 1,1)	60,8 (± 11,5)	0,257
Sex	Male	21	21	16	0,504
	Famale	6	7	9	
Laboratory	Hematocrit	35,7(± 4,6)	37,1 (± 5,03)	35,1 (± 6,36)	0,293
	Albumin	3,75(± 0,51)	4,06(± 0,43)	3,92(± 0,43)	0,061
	CEA	5,3 (± 12,1)	4,08(± 6,76)	22,2 (± 68,22)	0,375
	CA 19-9	17,8 (± 27,3)	41,23(± 72,5)	120(± 425,09)	0,613
	CA 125	15,51(± 14,5)	49,5 (± 92,1)	13,3 (± 9,01)	0,930
Comorbidities	DM	4	6	11	**0,044***
	COPD	6	2	5	0,263
	CRF	1	0	0	0,370
	CAD	1	4	5	0,194
	HT	3	6	11	**0,020***
Smoking history		16	15	17	0,561
Weight Loss (>10%)		10	10	6	0,670
ASA Score	1	0	1	0	0,05
	2	19	17	6	
	3	8	10	19	
Left Ventricul Ejection Fraction		63,15(± 2,82)	61,4 (± 5,06)	60,8 (± 7,1)	0,513
Pulmonary function tests	FVC	90,89(± 15,73)	97,2(± 17,23)	97,2(± 12,76)	0,254
	FEV1	91,52 (± 17,3)	98,8 (± 18,55)	99,32 (± 15,09)	0,317
	FEV1/FVC	100,1 (± 14,21)	105, 42 (± 13,22)	103,72 (± 8,28)	0,261

(* Differences between the groups with Chi-square test is statistically significant p<0,05) (Group 1: BMI ≤ 24.9 (kg/m2), Group 2: BMI 25-30 (kg/m2), Group 3: BMI > 30 (kg/m2), CEA: Carcinoembryonic antigen, CA 19-9: Carbohydrate antigen 19-9, CA 125: Carbohydrate Antigen 125, DM: Diabetes mellitus, COPD: Chronic obstructive pulmonary disease, CRF: Chronic renal failure, CAD: Coronary artery disease, HT: Hypertension, ASA: American Society of Anesthesiologists, FVC: Functional vital capacity, FEV1: Functional expiratory volume)

Intraoperative Characteristics and Postoperative Complications

When the duration of surgical procedures and the intraoperational blood transfusions were investigated, no differences were found among the groups. Within the first postoperative 30-day period, mortality occurred in a total of three patients, one from each group. Although the duration of hospitalization was determined to be higher in Group 3, this difference was not statistically significant. Intraoperative characteristics, and surgical and non-surgical postoperative complications are presented in **Table 2.**

Table 2. Intraoperative characteristics and postoperative complications

		Group 1	Group 2	Group 3	P- value
Operations time		337,4 ± 68,8	346 ± 118,2	336 ± 73,4	0,971
İntraoperative blood transfusion		6	4	4	0,720
Abdominal Comlications	Wound İnfection	4	3	4	0,839
	Abdominal abscess	3	2	3	0,818
	Anastomotic fistula	3	6	4	0,584
	İntraabdominal Hemorrhage	1	1	3	0,358
	Chylous ascites	1	1	0	0,627
	Evisceration or eventratıon	0	3	1	0,183
	Pancreatic Fistula	0	2	0	0,149

Systemic Complications	Atelectasis	3	0	3	0,173
	Pneumonia	5	1	6	0,094
	Renal Failure	1	0	2	0,310
	ARDS	1	1	1	0,997
	Catheter infection	0	2	2	0,339
Postoperative fever		12	12	11	0,993
Length of stay in hospital		14(± 8,04)	15(± 9,39)	21(± 24,6)	0,214
30-day mortality		1	1	1	0,997

(Group 1: BMI ≤ 24.9 (kg/m2), Group 2: BMI 25-30 (kg/m2), Group 3: BMI > 30 (kg/m2), ARDS: Acute respiratory distress syndrome)

The comparison of complications according to the Clavian-Dindo classification is summarized in **Table 3.**

Table 3. Comparison of complications by Clavian Dindo Classification

		Group 1	Group 2	Group 3	P- value
Non complicated		18 (% 66,6)	15 (% 53,5)	13 (% 52)	0,818
Clavian Dindo Classification	I	1	1	0	
	II	5	8	9	
	III	2	3	1	
	IV	0	0	1	
	V	1	1	1	

Group 1: BMI ≤ 24.9 (kg/m2), Group 2: BMI 25-30 (kg/m2), Group 3: BMI > 30 (kg/m2)

Pathological Evaluation

Table 4. Pathological characteristics

			Group 1	Group 2	Group 3	P- value
Maximum tumor diameter (mm)			66,96 ± 29,4	54,50 ±27,4	60,96 ± 28,294	0,252
Proximal Margin (mm)			23,04 ±17,6	36,3 ± 32,2	33,2 ±30,9	0,194
Distal Margin (mm)			61,6 ± 34,9	73,6 ±31,5	69,44 ±36,7	0,424
Number of lymph nodes retrieved			25,03 ± 11,2	26,3 ± 8,3	28,6 ± 12,4	0,451
Number of pathologic lymph node			5,1 ± 9,1	4,1 ± 5,4	6,6 ±8,6	0,521
LNR	(a) LNR: 0		9	8	7	0,645
	(b) 0< LNR ≤ 0,1		3	7	3	
	(c) 0,1< LNR ≤ 0,4		11	9	8	
	(d) LNR> 0,4		4	4	7	
Depth of infiltration	T1		2	3	1	0,405
	T2		2	2	1	
	T3		7	14	13	
	T4		16	9	10	
Lmph node İnvolvement		N0	9	8	7	0,573
		N1	2	7	3	
		N2	9	7	6	
		N3	7	6	9	
Vascular Invasion			16	15	17	0,561
Perineural Invasion			18	22	19	0,577

(Group 1: BMI ≤ 24.9 (kg/m2), Group 2: BMI 25-30 (kg/m2), Group 3: BMI > 30 (kg/m2), LNR: The ratio of metastatic lymph nodes to excised lymph nodes)

Table 4 presents the correlation analyses between BMI and the pathological features of tumors. The analyses clearly show no correlation between BMI and proksimal margin (p=0.194), distal margin (p=0.424), tumor size (p=0.252), depth of infiltration (T-stage) (p=0.405), and vascular (p=0.561) and perineural invasion (p=0.577). BMİ did not affect the total number of excised (p=0.451), metastatic lymph nodes (p=0.521), lmph node involvement (N-stage) (p=0.573) and LNR (p=0.645).

Long-Term Survival

Kaplan-Meier survival curves for BMI groups after total gastrectomy are presented in **Figure 2.**

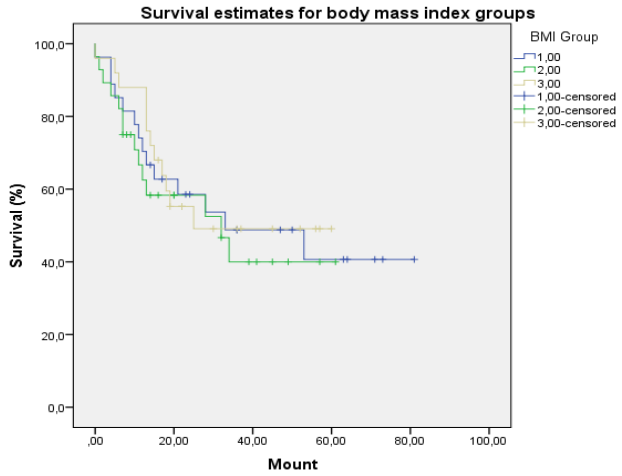

Figure 2. Overall survival of patients grouped by change in BMI status. No significant difference was found between the groups (Log rank; P:0,797).

Generally, 40 (50%) patients died within the study period. The mean overall survival time of the patients was 45,8±6,7 months in Group 1, 33,2±5,1 months in Group 2, and 37,9±4,8 months in Group 3. No significant difference was found between the groups (Log rank; P:0,797).

Discussion

Surgeons should determine preoperative risks in order to optimize patient care and to avoid preventable complications. Many factors, however, can increase the risk of complications. Obesity is one of these factors, and it may be a significant problem in almost all medical procedures. All surgeons may have to operate on obese patients at some point in their careers.

Obesity refers to a condition where the current body weight is more than the ideal body weight. BMI is used to determine obesity, and is calculated by dividing the body weight by the height in meters, squared. The WHO has classified adults according to their BMI values as: < 18.5 underweight; 18.5 - 24.99 normal; 25 - 29.99 overweight (pre-obese); 30 - 39.99 obese; and > 40 morbidly obese [8].

Coronary artery disease, diabetes mellitus, obstructive sleep apnea, hyperlipidemia, hypertension, degenerative osteoarthritis, gallbladder diseases, and steatohepatitis are among the diseases frequently associated with obesity. These comorbidities lead to a dramatic decrease in the quality of life and life expectancy of patients with a high BMI [11]. When the demographic data were investigated in our study, both DM and HT were significantly high in the obese group.

There is an increased risk of gastric cancer in individuals with a BMI equal to or more than 25 kg/m2. There are studies in literature which have shown that an increase in BMI was directly proportional to the risk of gastric cancer [12, 13].

Comorbidities generally increase the risk of intraoperative and postoperative complications. Although there are published studies that have investigated the relationship between BMI and complications, the results of these studies have been inconsistent [5-7, 14]. Moreover, in their meta-analysis, Wu et al. [15] demonstrated that obesity only increased the risk of postoperative complications and prolonged the duration of hospitalization, but obesity did not affect the total number of excised lymph nodes. Intra-operational time, the need for blood transfusions, and the number of excised lymph nodes were determined to be surgical challenges within the scope of our study; no differences, however, were found among the groups. Intra-abdominal and systemic complications were listed among the postoperative complications in our study; again, there were no differences among the groups.

Japanese surgeons routinely utilize extended lymphadenectomy (D2) [16]. The National Comprehensive Cancer Network (NCCN) has, in its latest panel, suggested that perigastric (D1) and celiac axis lymph nodes (D2) should be excised on the condition that a minimum of 15 lymph nodes are excised [17-19]. The German Gastric Carcinoma Study Group proposed that if the number of excised lymph nodes was higher than 25, it would refer to D2 dissection; if the number was between 15 and 25, it would refer to D1 dissection; and if the number of excised lymph nodes was lower than 15, it would not refer to a radical surgical procedure [20]. There are various studies in literature which have investigated the effects of obesity on the total number of excised lymph nodes and the number of metastatic lymph nodes [6, 7, 21].

The results of the present studies, however, are different. When the patients in our study were evaluated, we found that 15 or more lymph nodes were excised from 77 (96.2%) patients out of 80. Further, when the mean number of excised lymph nodes was evaluated, the mean was higher than 25 in all three groups. In our study, pathology results were not affected by BMI. The results of our study showed that BMI had no effect on the total number of excised lymph nodes, the number of metastatic lymph nodes, and the ratio of metastatic lymph nodes to excised lymph nodes, resection magrin, tumor size, T-stage, and vascular and perineural invasion were similar between BMI groups.

The relationship between obesity and challenges in gastric cancer surgery is only estimated, and the effects of obesity and its significance are still controversial. Studies on the subject have presented different results. This study investigated the

effects of BMI on the intraoperative and postoperative clinical results of patients who had a total gastrectomy and D2 lymph node dissection at a single center. The results of our study demonstrated that BMI, contrary to popular belief, did not aggravate the difficulties of surgical techniques, did not affect pathological results, and did not increase the rate of postoperative complications.

References

[1] Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A. Global Cancer Statistics, 2012. Ca Cancer J Clin. 2015; 65 : 87-108.

[2] Ferlay J, ShinHr, Bray F, Forman D, Mathers C, Parkin DM. Estimates of world wide burden of cancer in 2008: Globocan 2008. Int J Cancer. 2010; 127: 2893– 2917.

[3] Brown LM, Devesa SS. Epidemiologic trends in esophageal and gastric cancer in the United States. Surg Oncol Clin N Am. 2002; 11: 235– 256.

[4] Forman D, Burley V. Gastric Cancer: Global pattern of the disease and an overview of environmental risk factors. Best Pract Res Clin Gastroenterol. 2006; 20: 633–649.

[5] Tsujinaka T, Sasako M, Yamamoto S, Sano T, Kurokawa Y, Nashimoto A, Kurita A, Katai H, Shimizu T, Furukawa H, Inoue S, Hiratsuka M, Kinoshita T, Arai K, Yamamura Y; Gastric Cancer Surgery Study Group of Japan Clinical Oncology Group. Influence of overweight on surgical complications for gastric cancer: results from a randomized control trial comparing D2 and extended para-aortic D3 lymphadenectomy (JCOG9501) Ann Surg Oncol. 2007; 14: 355– 361.

[6] Gretschel S, Christoph F, Bembenek A, Estevez-Schwarz L, Schneider U, Schlag PM. Body mass index does not affect systematic D2 lymph node dissection and postoperative morbidity in gastric cancer patients. Ann Surg Oncol. 2003; 10: 363- 368.

[7] Nozoe T, Kohno M, Iguchi T, Mori E, Maeda T, Matsukuma A, Ezaki T. Analysis of the impact of the body mass index in patients with gastric carcinoma. Surg Today. 2012 ;42: 945- 949.

[8] WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004; 363: 157– 163.

[9] Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004; 240: 205– 213.

[10] Edge SB, Compton CC. The American Joint Committee on Cancer: The 7th edition of the AJCC cancer staging manual and the future of TNM. Ann Surg Oncol. 2010; 17: 1471-1474.

[11] Kopelman PG. Obesity as a medical problem. Nature. 2000; 404: 635- 643.

[12] Yang P, Zhou Y, Chen B, Wan HW, Jia GQ, Bai HL, Wu XT. Overweight, obesity and gastric cancer risk: Results from a meta-analysis of cohort studies. Eur J Cancer. 2009; 45: 2867- 2873.

[13] Turati F, Tramacere I, La Vecchia C, Negri E. A meta-analysis of body mass index and esophageal and gastric cardia adenocarcinoma. Ann Oncol. 2013; 24: 609- 617.

[14] Yasuda K, Inomata M, Shiraishi N, Izumi K, Ishikawa K, Kitano S. Laparoscopy-assisted distal gastrectomy for early gastric cancer in obese and nonobese patients. Surg Endosc. 2004; 18: 1253– 1256.

[15] Wu XS, Wu WG, Li ML, Yang JH, Ding QC, Zhang L, Mu JS, Gu J, Dong P, Lu JH, Liu YB. Impact of being overweight on the surgical outcomes of patients with gastric cancer: A meta-analysis. World J Gastroenterol. 2013; 19: 4596- 4606.

[16] Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2010 (ver. 3). Gastric Cancer. 2011 ;14 : 113-123.

[17] Schwarz RE, Smith DD. Clinical impact of lymphadenectomy extent in resectable gastric cancer of advanced stage. Ann Surg Oncol. 2007; 14: 317- 328.

[18] Songun I, Putter H, Kranenbarg EM, Sasako M, van de Velde CJ. Surgical treatment of gastric cancer: 15-year follow-up results of the randomised nationwide Dutch D1D2 trial. Lancet Oncol. 2010; 11: 439- 449.

[19] Karpeh MS, Leon L, Klimstra D, Brennan MF. Lymph node staging in gastric cancer: Is location more important than number? An analysis of 1,038 patients. Ann Surg. 2000; 232: 362- 371.

[20] Siewert JR, Böttcher K, Stein H, Roder JD. Relevant prognostic factors in gastric cancer: Ten-year results of the German Gastric Cancer Study. Ann Surg. 1998; 228: 449–461.

[21] Dhar DK, Kubota H, Tachibana M, Kotoh T, Tabara H, Masunaga R, Kohno H, Nagasue N. Body mass index determines the success of lymph node dissection and predicts the outcome of gastric carcinoma patients. Oncology. 2000; 59: 18– 23.