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RESEARCH ARTICLE

Does Body Mass Index Affect the Number of Excised Lymph Nodes in Colorectal Cancer Surgery?

Kolorektal Kanser Cerrahisinde Vücut Kitle İndeksinin Çıkarılan Lenf Nodu Sayısına Etkisi Var mıdır?

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ABSTRACT

Aim: This study investigated the effect of body mass index (BMI) on the total number of excised and metastatic lymph nodes in patients undergoing elective surgery for colorectal cancer.

Method: The cases of 185 patients who were diagnosed with colorectal cancer were retrospectively analyzed. The patients were divided into three groups according to BMI: patients with BMI scores of 24.9 kg/m^2 and lower were designated as normal (group 1), those with BMI scores of 25-30 kg/m^2 were overweight (group 2), and those with BMI scores higher than 30 kg/m^2 were obese (group 3). Following classification, differences in variables between the groups and the effects of BMI on the total number of excised and metastatic lymph nodes were evaluated.

Results: There were 52 patients in group 1, 73 patients in group 2, and 60 patients in group 3. There were no statistically significant differences among the groups with regards to age, sex, tumor location, tumor invasion (T-stage), number of excised lymph nodes, number of metastatic lymph nodes, or tumor stage. The number of excised lymph nodes was found to be higher in right colon tumors than in left colon and rectal tumors (p=0.01). The results of the subgroup analyses revealed that rectal tumors were at a more advanced stage (p=0.02) and among patients with rectal tumors, significantly more lymph nodes were excised from patients in the non-neoadjuvant group (p=0.01).

Conclusion: Our results led us to conclude that obesity does not affect the total number of excised and metastatic lymph nodes in colorectal cancer surgery. Surgeons should not be concerned about not being able to excise a sufficient number of lymph nodes during colorectal cancer surgery in patients with high BMI.

Keywords: Colorectal cancer, body mass index, number of lymph nodes

ÖZ

Amaç: Bu çalışmada kolorektal kanser nedeniyle elektif cerrahi uygulanan hastalarda vücut kitle indeksinin (VKİ) çıkarılan toplam ve metastatik lenf nodu sayısına olan etkisi incelenmiştir.

Yöntem: Çalışmamızda kolorektal kanser tanısıyla opere edilen 185 hasta geriye dönük olarak incelendi. Hastalar VKİ'ye göre üç gruba ayrıldı: 24,9 (kg/m^2) ve altında olanlar normal (grup 1), VKİ 25-30 (kg/m^2) arasında olanlar kilolu (grup 2) ve 30 (kg/m^2) üzerinde olanlar ise aşırı kilolu (grup 3). Daha sonra gruplar arasındaki değişkenler ve VKİ'nin çıkarılan toplam ve metastatik lenf nodu sayısına etkileri değerlendirildi.

Bulgular: Grup 1'de 52 hasta, grup 2'de 73 ve grup 3'te ise 60 hasta mevcuttu. Gruplar arasında yaş, cinsiyet, tümör lokalizasyonu, tümör invazyonu (T evresi), çıkarılan lenf nodu sayısı, metastatik lenf nodu sayısı ve tümör evrelemesi açısından anlamlı farklılık saptanmadı. Çıkarılan lenf nodu sayısının sağ kolon tümörlerinde sol kolon ve rektum tümörlerine göre daha yüksek olduğu saptandı (p=0,01). Yapılan subgrup analizlerde rektum tümörlerinin daha ileri evrede olduğu (p=0,02) ve rektum tümörlerinde neoadjuvan almayan grupta çıkarılan lenf nodu sayısının anlamlı derecede yüksek olduğu bulundu (p=0,01).

Sonuç: Sonuç olarak; obezite kolorektal kanser cerrahisinde çıkarılan toplam ve metastatik lenf nodu sayısını etkilememektedir. Cerrahlar VKİ yüksek olan hastalarda kolorektal kanser cerrahisi sırasında yeterli sayıda lenf nodu çıkaramama endişesinde olmamalıdırlar.

Anahtar Kelimeler: Kolorektal kanser, vücut kitle indeksi, lenf nodu sayısı

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Introduction

Colon and rectum cancers account for a significant portion of cancer-related morbidity and mortality rates all over the world. In patients with colorectal cancer, lymph node involvement is a poor prognostic factor and the number of lymph nodes involved also affects survival.[1,2] Adequate lymph node dissection and excision of a sufficient number of lymph nodes are the leading factors affecting survival.[3] The National Comprehensive Cancer Network guideline and the 2000 meeting conducted under the auspices of the National Cancer Society have both emphasized that at least 12 lymph nodes should be excised for colon cancer staging.[4,5] Apart from its benefits for staging, demonstration of lymph node involvement requires adjuvant treatment.[5]

It has been reported that there were many factors that affected the number of excised lymph nodes. Tumor-related characteristics, anatomical characteristics of the patients, surgical technique performed, preoperative neoadjuvant therapy, and pathological techniques can be listed among the factors affecting the number of lymph nodes.[6] Body mass index (BMI) is an index commonly used to define obesity. Obesity is classified according to BMI. There are a limited number of studies investigating the effects of obesity on the number of excised lymph nodes in literature.[7,8,9] Therefore, our aim in this study was to investigate the effects of BMI on the number of excised lymph nodes in colorectal cancer surgery.

Materials and Methods

Study Design and Population

The cases of 360 patients, who had undergone colorectal cancer surgery between January 2010 and December 2015 in Kartal Koşuyolu Higher Specialty Training and Research Hospital's Gastroenterology Surgery Clinic, were retrospectively screened. Approval of the board of ethics for the study was obtained (approval no: 89513307/1009/506). Approval of the board of ethics for the study was obtained. Patients with missing data and file records, those with emergency surgical procedures, those who had undergone surgery for colorectal cancer recurrence, those with laparoscopic surgical procedures, those who had subtotal colectomy, total colectomy, and total proctocolectomy for malignities on base of ulcerative colitis and polyposis coli, those with synchronous colon tumor, familial adenomatous polyposis were excluded from the study. Data of the remaining 185 patients were recorded.

Body Mass Index Evaluation and Classification

Patients were divided into 6 groups according to the World Health Organization's (WHO) BMI classification.[10] Group 1 had underweight patients with BMI below 18.5, group 2 had normal weighing patients with BMI between 18.5 and 24.9, group 3 had overweight patients with BMI between 25 and 29.9, group 4 had obese class I patients with BMI between 30 and 34.9, group 5 had obese class II patients with BMI between 35 and 39.9, and group 6 had obese class III (morbid) patients with BMI 40 and over.

BMI of all patients was calculated by measuring weight (kg) and height (cm) in the preoperative preparation phase. In our study, however, the patients were divided into three groups according to their BMI as follows: normal patients with BMI of 24.9 (kg/m^2) or lower (group 1), overweight patients with BMI of 25-30 (kg/m^2) (group 2), and obese patients with BMI higher than 30 (kg/m^2) (group 3).

Data

Colonoscopy was performed preoperatively in all patients and all were diagnosed by biopsy. An informed consent form was obtained from each patient for surgical intervention prior to surgery. Postoperative resection specimens of the patients were examined and their diagnoses were verified by histopathological evaluation. The patients' data on age, sex, height, weight, BMI, tumor localization, history of preoperative neoadjuvant treatment, surgical procedures undergone, tumor invasion depth, number of excised lymph nodes, number of metastatic lymph nodes, and tumor stages were recorded.

Tumor localization, total number of excised lymph nodes, number of excised metastatic lymph nodes, invasion depth of the tumor, and tumor stages were recorded from the surgical and pathology reports of the patients. All patients were staged according to the American Joint Committee on Cancer's (AJCC) seventh edition tumor-node-metastasis staging system.[11] Adequate lymphadenectomy was defined as having an excised or analyzed lymph node count of 12 or more according to AJCC criteria. The parameters among the groups and the effects of BMI on the total number of excised and metastatic lymph nodes were investigated.

I. Primary endpoint of the study; Investigation of the effects of BMI on the number of excised and metastatic lymph nodes.

Statistical Analysis

SPSS (Statistical Package for Social Sciences, Inc., Chicago, IL, USA) for Windows 21.0 program was used for the statistical analyses of the collected data. The data collected from the patients covered by the study were given as mean, standard deviation, and in percentages, where necessary. The distribution of the data was checked by the Kolmogorov-Smirnov test. Normally distributed data were analyzed by the

ANOVA test and the Mann-Whitney U test. The relationships among the groups, shown to have statistical significance by the ANOVA test, were demonstrated by Tukey's post hoc test. The results were evaluated at a 95% confidence interval and the significance level was set at $p<0.05$.

Results

Out of a total of 185 patients covered by the study, 72 (38.9%) were females while 113 (61.1%) were males and their mean age was 61.032±12.6 years. There were 52 (28.1%) patients with normal BMI (<24.9 kg/m^2) in group 1, 73 (39.4%) overweight patients with BMI of 25-30 (kg/m^2) in group 2, and 60 (32.4%) obese patients with BMI of >30 (kg/m^2) in group 3. There was no statistically significant relationship among the groups regarding age and sex.

When the tumor localization in the patients included in the study was examined, it was found that 47 (25.4%) were in the right colon, 58 (31.3%) were in the left colon, and 80 (43.2%) were in the rectum. There were no significant differences among the groups regarding tumor localization, tumor invasion (T-stage), number of excised lymph nodes, number of metastatic lymph nodes and tumor staging. The demographic and pathological characteristics of the groups have been summarized in Table 1.

When the cases were evaluated according to the tumor location, the number of excised lymph nodes was found to be higher in the right colon tumors than those of the left colon and rectal tumors. The mean number of lymph nodes was 23.1±9.1 in right colon tumors, 18.1±9.3 in left colon tumors, and 16±7.6 in rectal tumors, while it was found to be statistically significant (p=0.01). No significant difference, however, was found in the number of metastatic lymph nodes. When tumor stage was evaluated according to tumor localization, rectal tumors were found to be in a more advanced stage than right and left colon tumors and it was found to be statistically significant (p=0.02). The comparison of pathological features according to tumor localization has been summarized in Table 2.

It was seen that 24 (30%) out of 80 patients diagnosed with rectal tumors had received neoadjuvant treatment. The subgroup analysis performed according to neoadjuvant therapy status in rectal tumors revealed that the number of excised lymph nodes was significantly higher in the non-neoadjuvant group (p=0.01). Conversely, no significant difference was found in the number of metastatic lymph nodes. There was no difference among the groups in the comparison of BMI either (Table 3).

Discussion

Lymph node involvement is a poor prognostic factor and affects survival in patients with colorectal cancer. Sufficient lymph node dissection and excision of the

Table 1. The demographic and pathological comparison of the groups

Variable		Group 1 (n=52)	Group 2 (n=73)	Group 3 (n=60)	p
Age (year) (mean ± SD)		59.5±14.8	60.1±12.1	63.3±10.8	0.209
Sex (n, %)	Male	32 (61.5%)	45 (61.6%)	36 (60%)	0.978
	Female	20 (38.5%)	28 (38.4%)	24 (40%)	
Tumor localization	Right colon	14 (7.6%)	18 (9.7%)	15 (8.1%)	0.952
	Left colon	18 (9.7%)	22 (11.9%)	18 (9.7%)	
	Rectum	20 (10.1%)	33 (17.8%)	27 (14.6%)	
Tumor invasion (T)	T1	5 (2.7%)	1 (0.5%)	1 (0.5%)	0.139
	T2	9 (4.9%)	11 (5.9%)	8 (4.3%)	
	T3	29 (15.7%)	52 (28.1%)	38 (20.5%)	
	T4	9 (4.9%)	9 (4.9%)	13 (7%)	
Total number of lymph nodes (mean ± SD)		18.6±10.3	18.2±9.1	18.8±7.5	0.932
Number of metastatic lymph nodes (mean ± SD)		1.2±2	2.6±5.1	1.9±4.1	0.198
Tumor stage	Stage 1	11 (5.9%)	9 (4.9%)	8 (4.3%)	0.602
	Stage 2	20 (10.1%)	28 (15.2%)	24 (13%)	
	Stage 3	20 (10.1%)	29 (15.7%)	24 (13%)	
	Stage 4	1 (0.5%)	7 (3.8%)	4 (2.2%)	

SD: Standard deviation

appropriate number of lymph nodes are the leading factors that affect survival. Chang et al.[2] reported that adequate lymphadenectomy in patients with stage 2-3 colon cancer provided survival advantage.

Obesity refers to the condition that the current body weight is greater than the ideal body weight. BMI is used to determine obesity. BMI is an individual's weight in kilograms divided by the square of height in meters. According to WHO's BMI adult values, individuals with BMI below 18.5 are underweight, those with BMI between 18.5 and 24.9 are normal, those with BMI between 25 and 29.9 are overweight, those with BMI between 30 and 34.9 are class I obese, those with BMI between 35 and 39.9 are class II obese, and those with BMI 40 and higher are class III (morbid) obese.10 There are many factors that affect the number of excised lymph nodes. Tumor-related characteristics, anatomical characteristics of the patients, surgical techniques performed, preoperative neoadjuvant therapy and pathological techniques can be listed among the factors affecting the number of lymph nodes.[6]

There is only a limited number of studies in literature investigating the effects of BMI on the number of excised lymph nodes in colorectal cancer surgery.[7,8,9,12,13] In general, the majority of studies have shown that BMI had no effect on the number of excised lymph nodes. Pimiento et al.[7] concluded in their 127 patients retrospective study that BMI had no effect on the number of excised lymph nodes. Linebarger et al.[8] in their study investigating the effects of obesity and tumor localization, tumor stage and pathological examination on the number of excised lymph nodes in patients who underwent surgery for colon cancer, reported that BMI did not affect the number of excised lymph nodes as well. In their 191 patients study. Damadi et al.[9] demonstrated that obesity did not affect the total number of excised lymph nodes and the number of metastatic lymph nodes in colon cancer surgery. In this study, patients were classified as obese or non-obese according to their BMI. Unlike this study, however, we classified patients as normal, overweight and obese. In our country, Zeren et al.[12] in their study, classified 71

Table 2. The pathological comparison of the groups regarding tumor localization

		Right colon (n=47)	Left colon (n=58)	Rectum (n=80)	p
Total number of lymph nodes (mean ± SD)		23.1±9.1	18.1±9.3	16±7.6	0.01*
Number of metastatic lymph nodes (mean ± SD)		1.6±3.9	2±5.5	2.1±3	0.807
Tumor invasion (T)	T1	0	4 (2.2%)	3 (1.6%)	0.338
	T2	5 (2.7%)	10 (5.4%)	13 (7%)	
	T3	33 (17.8%)	32 (17.3%)	54 (29.2%)	
	T4	9 (4.9%)	12 (6.5%)	10 (5.4%)	
Tumor stage	Stage 1	5 (2.7%)	10 (5.4%)	13 (7%)	0.02
	Stage 2	26 (14.1%)	26 (14.1%)	20 (10.8%)	
	Stage 3	14 (7.6%)	20 (10.8%)	39 (21.1%)	
	Stage 4	2 (1.1%)	2 (1.1%)	8 (4.3%)	

*Tukey's post hoc analysis demonstrated that the number of excised lymph nodes in right colon tumors was higher than those of left colon and rectal tumors

SD: Standard deviation

Table 3. The subgroup analyses of rectal tumors according to neoadjuvant therapy

		Neoadjuvant therapy (+) (n=24)	Neoadjuvant therapy (-) (n=56)	p
Total number of lymph nodes (mean ± SD)		11.7±5.9	17.9±7.6	0.01
Number of metastatic lymph nodes (mean ± SD)		1.33±2	2.5±3.3	0.172
BMI (kg/m^2)	Group 1	6 (7.5%)	14 (17.5%)	0.824
	Group 2	11 (13.8%)	22 (27.5%)	
	Group 3	7 (8.8%)	20 (25%)	

SD: Standard deviation, BMI: Body mass index

patients who underwent colorectal surgery as normal and obese according to their BMI. The authors concluded that there was no relationship between BMI and tumor size and the total number of excised and metastatic lymph nodes.

Bilimoria et al.[14] reported in their 142009 patients study that the number of excised lymph nodes in right colon tumors was higher in patients who had resections for colon cancer. Linebarger et al.[8] also stated in their study that the number of excised lymph nodes was higher in right colon tumors when they compared the cases of right colectomy and left colectomy. The results of our study revealed that the number of excised lymph nodes in right colon tumors was higher than in the left colon and rectal tumors, and this was statistically significant (p=0.01).

Several studies have been conducted previously on the effects of neoadjuvant treatment on the number of excised lymph nodes in rectal cancer.[15,16,17,18] The cases of patients with long-term preoperative chemoradiotherapy and patients without radiotherapy were compared in these studies and a significant decrease in the number of excised lymph nodes was observed. The number of lymph nodes detected ranged from 4 to 14 on average. In addition, Wijesuriya et al.[16] reported in their study that neoadjuvant therapy did not affect the number of metastatic lymph nodes. In our study, the number of excised lymph nodes in patients with rectal cancer treated with neoadjuvant therapy was found to be low and statistically significant (p=0.01). The number of excised lymph nodes, however, was not significant. The results of our study generally support these studies in literature. The limitations of our study, on the other hand, are as follows: The study was retrospectively designed and the number of patients is limited.

Consequently, obesity does not affect the total number of excised and metastatic lymph nodes in colorectal cancer surgeries although it is a risk factor for the development of colon cancer. Prospective large-scale studies conducted on this issue are needed in literature to support the findings of our study. Surgeons should not be anxious about not being able to excise an adequate number of lymph nodes during colorectal cancer surgery in patients with high BMI.

Ethics

Ethics Committee Approval: The study was approved by the Kartal Dr. Lütfi Kırdar Training and Research Hospital Local Ethics Committee (Approval no: 89513307/1009/506), Informed Consent: Consent form was filled out by all participants.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Durmuş Ali Çetin, Concept: Ebubekir Gündeş, Design: Durmuş Ali Çetin, Ulaş Aday, Data Collection or Processing: Durmuş Ali Çetin, Hüseyin Çiyiltepe, Aziz Serkan Senger, Analysis or Interpretation: Durmuş Ali Çetin, Orhan Uzun, Selçuk Gülmez, Literature Search: Durmuş Ali Çetin, Emre Bozdağ, Kamuran Cumhur Değer, Writing: Durmuş Ali Çetin.

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References

1. Compton CC. Optimal pathologic staging: defining stage II disease. Clin Cancer Res 2007;13:6862-6870.
2. Chang GJ, Rodriguez-Bigas MA, Skibber JM, Moyer VA. Lymph node evaluation and survival after curative resection of colon cancer: systematic review. J Natl Cancer Inst 2007;99:433-441.
3. Parnaby CN, Scott NW, Ramsay G, MacKay C, Samuel L, Murray GI, Loudon MA. Prognostic value of lymph node ratio and extramural vascular invasion on survival for patients undergoing curative colon cancer resection. Br J Cancer 2015;113:212-219.
4. Nelson H, Petrelli N, Carlin A, Couture J, Fleshman J, Guillem J, Miedema B, Ota D, Sargent D; National Cancer Institute Expert Panel. Guidelines 2000 for colon and rectal cancer surgery. J Natl Cancer Inst 2001;93:583-596.
5. NCCN Clinical Practice Guidelines in Oncology. Colon cancer. Vol. 3. 2015. Available at: http://www.nccn.org. Accessed: June 18, 2015.
6. Ostadi MA, Harnish JL, Stegienko S, Urbach DR. Factors affecting the number of lymph nodes retrieved in colorectal cancer specimens. Surg Endosc 2007;21:2142-2146.
7. Pimiento JM, Cristancho MA, Aboulhosn K, Fancher T, Palesty JA, Dudrick SJ. Does body mass index affect lymph node retrieval in colon resection for cancer? J Clin Oncol 2006;24:13571.
8. Linebarger JH, Mathiason MA, Kallies KJ, Shapiro SB. Does obesity impact lymph node retrieval in colon cancer surgery? Am J Surg 2010;200:478-482.
9. Damadi AA, Julien L, Arrangoiz R, Raiji M, Weise D, Saxe AW. Does obesity influence lymph node harvest among patients undergoing colectomy for colon cancer? Am Surg 2008;74:1073-1077.
10. World Health Organization. "Obesity: preventing and managing the global epidemic: report of a WHO consultation on obesity, Geneva, 3-5 June 1997." (1998).
11. American Joint Committee on Cancer. Colon, rectum. In: AJCC Cancer Staging Manual. 7th ed. Springer; New York NY. 2010.
12. Zeren S, Bayhan Z, Koçak C, Ekici MF, Düzgün ŞA. The Effect of Overweight Status on Total and Metastatic Number of Harvested Lymph Nodes During Colorectal Surgery. Dicle Medical Journal 2016;43:135-140.
13. Kuo YH, Lee KF, Chin CC, Huang WS, Yeh CH, Wang JY. Does body mass index impact the number of LNs harvested and influence long-term survival rate in patients with stage III colon cancer? Int J Colorectal Dis 2012;27:1625-1635.
14. Bilimoria KY, Palis B, Stewart AK, Bentrem DJ, Freel AC, Sigurdson ER, Talamonti MS, Ko CY. Impact of tumor location on nodal evaluation for colon cancer. Dis Colon Rectum 2008;51:154-161.

15. Wichmann MW, Müller C, Meyer G, Strauss T, Hornung HM, Lau-Werner U, Angele MK, Schildberg FW. Effect of preoperative radiochemotherapy on lymph node retrieval after resection of rectal cancer. Arch Surg 2002;137:206-210.
16. Wijesuriya RE, Deen KI, Hewavisenthi J, Balawardana J, Perera M. Neoadjuvant therapy for rectal cancer down-stages the tumor but reduces lymph node harvest significantly. Surg Today 2005;35:442-445.
17. de la Fuente SG, Manson RJ, Ludwig KA, Mantyh CR. Neoadjuvant chemoradiation for rectal cancer reduces lymph node harvest in proctectomy specimens. J Gastrointest Surg 2009;13:269-274.
18. Rinkus KM, Russell GB, Levine EA. Prognostic significance of nodal disease following preoperative radiation for rectal adenocarcinoma. Am Surg 2002;68:482-487.