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Original Article

Factors influencing the number of retrieved lymph nodes after colorectal resection: a retrospective study from a single institute

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Abstract: Accurate diagnosis of lymph node (LN) metastasis is important to determine the staging and consequent treatment of resected colorectal cancer. Therefore, factors influencing the number of retrieved LNs were explored. This study included 400 patients that underwent surgical resection for Stage 0-III colorectal cancer from 2009 to 2014 in Kochi Medical School. In all cases, surgeons retrieved the LNs within the resected mesentery immediately after the operation without fixation. Age, gender, body mass index (BMI), American Association Anesthesiologist (ASA) scores, tumor locations, maximum tumor diameters, nodal status, and pathological tumor types were extracted as patient and tumor factors. The extent of LN dissection and surgical approaches (laparoscopic or laparotomy) were extracted as operative factors. Multivariate regression analysis was performed to identify independent predictive factors for LN number retrieved, after potential influential factors were explored by univariate analysis. As results, we found that the median number of retrieved LNs was 13, ranging from 1 to 50. Approximately 60% of the patients thus received an adequate examination (LN number of 12 or more). Multivariate analysis using the remaining factors of univariate analysis identified BMI, tumor diameter, nodal status, and extent of dissection as independent predictive factors for the number of retrieved LNs ($P < 0.05$). If any or all these factors are present, a vigorous search for LNs using additional measures, such as visual enhancement and fat dissolution method, should be considered.

Keywords: Body mass index, lymph nodes, colorectal, 12

Introduction

Colorectal cancer is the third most common cancer and the fourth highest cause of cancer-related death worldwide [1]. Resection of the involved bowel and regional lymph nodes (LNs) provide the chance of cure. Furthermore, postoperative adjuvant chemotherapy for node-positive colon/rectal cancer improves disease-free survival rates [2, 3], highlighting the importance of accurate postoperative tumor staging.

According to the College of American Pathologists Consensus Statement 1999, surgeons/pathologists should aim to obtain 12 or more LNs to diagnose and predict regional node negativity [4]. Examining fewer LNs might result in underestimating the tumor stage and consequently preclude the opportunity for patients to receive adjuvant chemotherapy. From this viewpoint, guidelines recommend adjuvant chemotherapy for patients with Stage II colon/rectal cancer with inadequate nodal examination [5, 6]. Conversely, this recommendation suggests that inadequate examination could result in overtreatment for a certain proportion of patients, and an increased number of retrieved LNs might reduce such unnecessary treatment [7].

A wide range of minimal number for LN retrieval has been proposed. An outstanding study claimed that a vigorous search within resected specimens yielded an average higher than 50 LNs in 52 consecutive patients [8]. Based on

Table 1. Tumor and patient characteristics

Variable	n	
Gender (female/male)	400	179/221
Age, year (mean ± SD)	400	70.1 ± 11.9
BMI, kg/m^2 (mean ± SD)	399	22.8 ± 3.7
ASA (1/2/3)	400	52/283/65
Tumor location (right/left/transverse)	398	89/262/47
Tumor diameter, cm (mean ± SD)	397	37.6 ± 20.4
T factor (Tis/T1/T2/T3/T4)	398	14/82/80/166/56
Nodal status (negative/positive)	400	294/106
Pathological tumor type (well & mod/others*)	400	385/15
Surgical approach (laparoscopic/laparotomy)	398	322/76
Lymph node dissection (D1/D2/D3)	392	22/184/186

*others included poorly differentiated, mucinous, and signet ring cell carcinomas.

the numbers reported in this study, more than 40 nodes have to be examined in T1/T2 tumors to diagnose node-negativity with 85% probability [9], and the probability is only 25% when 18 LNs are retrieved in the setting of T1/T2 tumor. Despite the discussion of 'diminishing returns' to detect LN metastasis beyond 12 lymph nodes [10], these surprising estimations should not be neglected in attempts to further improve diagnostic accuracy.

Despite recognition of its importance, the number of retrieved LNs is far from satisfactory as an indicative factor of tumor stage. According to a population-based study in the United States covering 116,995 colorectal cancer patients from 1988 to 2001 [11], only 37% received adequate nodal examinations, with a median harvested node number of 9. For specialized institutes, the mean or median numbers of the retrieved LNs could exceed 20 [12-14]. However, nearly 20% of the patients in those studies still underwent inadequate testing, revealing the difficulties in fulfilling this quality criterion.

In this study, as an initial step to improve nodal examination, we aimed to elucidate the factors influencing the number of examined LNs after colorectal cancer. Several such factors have been proposed, including the patients' age at operation, gender, ethnicity, body mass index (BMI), length of resected intestine, use of preoperative tattooing, and patients' general condition. However, these previous studies often failed to take into account the effect of confounders in statistical analyses. Consequently, the interpretation of individual results becomes difficult, especially when the results are inconsistent. Therefore, we selected a multivariate analysis approach for this retrospective study. Most of the previous studies were conducted in European countries and the United States, wherein LN retrieval is performed mainly by pathologists or technicians after formalin fixation. In contrast, the present study required all procedures for LN retrieval to be performed by surgeons immediately after the resection without fixation, resulting in fresh samples for analyses. We believe that these two characteristic features of the present study make the results and interpretation uniquely valuable.

Patients and methods

Enrolled patients and analyzed data

We retrospectively analyzed the clinical information of 400 patients who underwent surgical resection of colorectal adenocarcinoma with curative intent. The clinical information available included the patients' age, gender, body mass index (BMI), American Anesthesiology Association Scores (ASA scores), site of the tumor, T factors, nodal status, maximum tumor diameters, pathological types, the extent of lymph node resection according to the Japanese Classification of Colorectal Carcinoma (8th edition) [15], surgical approaches (laparotomy or laparoscopic), and the number of examined LNs.

Patients with metastatic cancer or synchronous colorectal cancers in different segments of the large intestine were excluded, because these factors significantly alter the surgical strategy. When patients lacked data for the number of harvested lymph nodes or the cases were missing more than two clinical variables, they were also excluded from the analysis. This study was approved by the Institutional Review Board in Kochi University (ID: 28-75).

Classification of lymph node dissection during surgery

According to the Japanese classification system, D3 dissection of lymph nodes is roughly

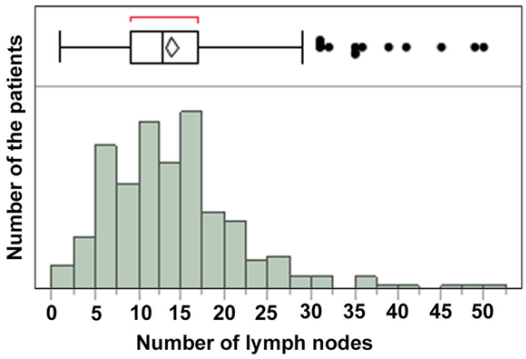

Figure 1. The number of retrieved lymph nodes after colorectal cancer resection. The median number of LNs retrieved from the resected specimen is 13 (range 1-50), and 58.5% (234 out of 400) of the patients had adequate lymph node retrieval. Because the histogram does not show the normal distribution, the value underwent logarithmic transformation.

defined as the removal of LNs along the tumor-feeding artery and further draining nodes around the superlative mesenteric vein or inferior mesenteric artery, depending on the tumor site. D2 dissection is defined as removal of LNs from the intestine to the root of the feeding artery (e.g. ileocolic artery, right colic artery), whereas D1 dissection is the removal of paracolic or pararectal LNs.

Method of lymph node retrieval

All the procedures for LN retrieval were performed immediately after the operation by surgeons. First, the mesentery was carefully removed from the intestine. Then the peritoneum of the mesentery was cut, the connective tissue was dissected, and the LNs within adipose tissue were collected. The identified nodes were fixed with 10% formalin and sent for pathological examination. Additional techniques to enhance LN retrieval were not applied during the study period.

Statistical analysis

To evaluate association between number of retrieved LNs and clinical/tumor characteristics, we first analyzed the number of retrieved LNs relative to each clinical/tumor characteristic by univariate linear regression. If a continuous variable was not normally distributed, we used the variable after log-transformation. Then, multiple regression analysis was performed to determine the independent predicting factors for the number of the retrieved LNs. Potential independent predicting factors were selected using a backward computational method with an exclusion criterion of $P > 0.20$. A two-sided P value of less than 0.05 was considered statistically significant. All statistical analysis was performed using JMP 11.2.1 (SAS Institute Inc., Cary, NC, USA).

Results

Patients and tumor characteristics

From 2009 to 2014, 425 patients underwent surgical resection for Stage 0-III colorectal adenocarcinoma in our institute. Among them, 400 patients were eligible for statistical analysis (**Table 1**). Stage II and III colorectal cancer was predominant and the laparoscopic surgery was chosen more than 80% of the cases. The median number of retrieved lymph node was 13, and approximately 60 percent of the patients received adequate LN examination in terms of the number (**Figure 1**). Since the number distribution of retrieved LNs was skewed to the right in this study, log-transformation for the number of the retrieved LNs was used when needing a dependent variable in the regression model.

Univariate and multivariate analysis

Factors influencing lymph node retrieval were explored via univariate analysis (**Table 2**). Patient age at diagnosis, ASA score, BMI, T factor, tumor diameter, nodal status, tumor location, and the extent of resection were identified as potential influential factors ($P < 0.05$). Patient gender and surgical approach were not significantly related to the number of retrieved LNs. Among the factors identified, we consider that T factor and tumor diameter were related to each other, thus only tumor diameter was included in further analysis. Multivariate analysis revealed that BMI, tumor diameter, nodal status, and the extent of resection were statistically significantly independent factors predicting the number of LNs retrieved after variable selection with a backward selection method. BMI was negatively associated with the number of retrieved LNs and its regression coefficient was -0.031, which means that the number of retrieved LNs was decreased by approximately 3.1% if the BMI increased by a mean of 1.0, while all other variables retained the same. Similarly, the unit change of tumor diameter, nodal status, and lymph node dissection was statistically significantly associated

Table 2. Univariate and multivariate analysis to identify predictive variables for influencing the number of retrieved lymph nodes

Variable	Univariate	Multivariate logistic regression analysis			
	P value		Coefficient	SE	*P* value
Gender	0.5963				
Age	0.0212		-0.0048	0.0027	0.073
ASA	0.0197	(2 vs. 1)	-0.13	0.089	0.14
		(3 vs. 1)	-0.16	0.11	0.15
BMI	< 0.0001		-0.031	0.0079	0.0001
Tumor location*	0.0026	(L vs. R)	-0.13	0.07	0.06
		(T vs. R)	-0.19	0.1	0.08
Pathological tumor type**	0.4487				
T factor***	0.0023				
Tumor diameter	0.0001		0.004	0.0015	0.0079
Nodal status	0.0002		0.18	0.064	0.0048
Surgical approach	0.9053				
Lymph node dissection	0.0001	(2 vs. 1)	0.34	0.13	0.00
		(3 vs. 1)	0.63	0.13	< 0.0001

*L: left side colorectal cancer, R: right side colon cancer, T: transverse colon cancer. **Well-, and Moderately differentiated adenocarcinoma vs. poorly differentiated, mucinous adenocarcinoma, and signet ring cell carcinoma. ***T factor was excluded in the present study because it is correlated with tumor diameter.

with increases of 0.4%, 20%, 40% (lymph node dissection, D2 vs. D1), and 88% (lymph node dissection, D3 vs. D1), respectively.

Discussion

Despite the importance of accurate tumor staging for decision-making around postoperative adjuvant chemotherapy, a significant proportion of resected colorectal cancers are inappropriately diagnosed in terms of the number of retrieved LNs [11]. To address this problem we sought to identify factors influencing the number of retrieved LNs based on known indicators of tumor stage and outcomes. The results suggest that BMI, tumor diameter, nodal status, and the extent of resection are independent predictive factors for the number of retrieved LN. In contrast, age, gender, tumor location, pathological tumor types, ASA, and surgical approaches showed no significant relationship with the number of retrieved regional LNs accompanying colorectal cancer resection.

There is no doubt that the extent of LN dissection influences the total number of retrieved LNs. In the present study, tumor diameter was also related to the number of retrieved LNs, consistent with previous studies [16]. It is therefore reasonable to suggest that larger tumors could provoke stronger inflammatory responses, causing lymph node enlargement, resulting in easier detection of larger LNs within the connective tissue. Similarly, LN metastasis could induce node swelling, and consequently easier detection of LNs.

Whether age predicts fewer retrieved LNs has been controversial [11, 17], and physiological involution of LNs or diminished immune responses with aging has been associated with fewer retrieved LNs in elderly patients [16]. Meanwhile, older patients generally undergo less aggressive surgery compared to younger patients [18], which could be a major contributor to the lower number of resected LNs observed in the elderly. Our study results more strongly support the latter hypothesis because we included surgical variables in the analysis.

Our finding that patient BMI correlates with the number of yielded lymph nodes accords with the proposal that finding lymph nodes is more difficult when the mesentery is thick with adipose tissue, although few studies have focused on this association or its impact (**Table 3**). Linebarger et al. [13] retrospectively studied 401 patients who underwent surgical resection of colon cancer in their institute, with the number of retrieved lymph node analyzed according to patient BMIs. Different from our study, their results revealed no differences in retrieved lymph node number among different BMI groups, although the surgical time was significantly longer in higher BMI patients. The authors claimed that the same quality of surgery was possible even in the patients with higher BMIs, although technical difficulties increased with increased BMIs [13]. Damadi et al. [19] produced similar findings of comparable numbers of retrieved nodes between the patients with BMI more and less than 30. In contrast, Kuo et al. [12] associated patient BMIs less than 18.5 with an increased number of retrieved LNs in Asian patients with Stage III

Table 3. Studies focusing on patient BMI and number of LNs retrieved after resection of colon/rectal cancer

Reference	n	Tumor	Method of LN retrieval	Statistical analysis	Findings
Linebarger et al.	401	Colon	Fat cleaning solution after manual procedure	Comparison of LN number among 6 groups divided according to BMIs	No relationship between BMI and LN number Longer operation time in patients with higher BMI
Damadi et al.	191	Colon	Visual enhancement (Carnoy's solution)	Pearson's product moment coefficient	No relationship between BMI and LN number
Kuo et al.	645	Colon	Manual procedure	Logistic regression analysis to identify the predictive factors for the adequacy of LN retrieval	Underweight is related to increased LN number. Tumor location, histological grade, and extent of nodal involvement are important variables
Gorog et al.	141	Colorectal	Manual procedure	Univariate analysis after stratification according to length of resected bowel	BMI ≥ 25 is a risk factor for the lower LN number in patients with shorter resected specimens
Present study	400	Colorectal	Manual procedure before fixation	Logistic regression analysis	BMI, tumor diameter, nodal status, and extent of LN dissection are associated with LN number

colon cancer, and revealed tumor location, histological grade, and extent of nodal involvement (Stage IIIC) as important variables for adequate LN retrieval. Similarly, through the retrospective study of 181 patients with rectal cancer, Görög et al. [20] identified BMIs over 25 as a risk factor for fewer numbers of retrieved LNs [20].

The discrepancy among studies in the factors related to the adequacy of LN retrieval might stem from how the confounders were treated, based on the multitude of related factors shown by this study to play a role. Another cause could be differences in methods for searching the LNs. Some studies applied the visual enhancement or fat cleaning technique [13, 19], while others used solely manual techniques [12, 20]. In the former case, it is possible that LN retrieval could have been performed more thoroughly in patients with high BMI compared to the latter study types, resulting in the equivalent number of LNs between low and high BMI patients. Such a scenario should therefore be considered and additional techniques might need to be used to retrieve LNs following resection to overcome the problem of 'small numbers of LNs in patients with higher BMI'.

When considering the clinical importance of the four factors identified herein within the context of tumor prognosis, negative lymph node status and less tissue invasion are related to better prognosis. Accordingly, a lower extent of LN dissection (D2) is often used in patients with a preoperative diagnosis of T1, N0 colorectal cancer. In contrast, obesity or high BMI could also influence the biology of colon cancer. Obesity increases the risk of colon cancer [21], is associated with a more advanced stage at diagnosis [22], and predicts poor prognosis in patients receiving adjutant chemotherapy for Stage II and III colon cancer [23]. In the present study, we found that the number of retrieved LNs decreased by approximately 3.1% with a BMI increase of 1.0, suggesting that patients with higher BMIs have more chance of stage migration and thus miss the opportunity of adjuvant chemotherapy. Thus, in the broader discussion, higher BMI might hamper the accurate estimation of prognosis, leading possibly to inappropriate treatment and a worse prognosis, highlighting patient BMI as a major factor to consider in the treatment for colorectal cancer.

This study has several limitations. First, information concerning tattooing was not recorded in our database. Preoperative submucosal tattooing near the tumor is applied when laparoscopic surgery is planned for relatively early-stage colorectal cancer so that the tumor is readily identified during laparoscopic surgery. This technique is also applied to identify the sentinel lymph nodes and could thus influence the number of retrieved lymph nodes. Including this information could potentially alter the results of the present study [24, 25]. Second, we could not include information about the surgeons who performed the studied resections, however the influence of this type of data should be minimal because two experienced surgeons performed > 75% of the cases and the remaining procedures were carried out under their direct supervision. In addition, the

extent of the surgical resection was determined according to the Classification of Colorectal Carcinoma widely used in Japan, which further lessens the surgeons' factor influence.

In conclusion, our study is quite unique in that all LN retrieval was performed immediately after the resection by the responsible surgeons. The current study reveals that adequate LN examination was performed in approximately two thirds of similar patients in our institute, and this rate should be further improved. The findings indicate that smaller tumor diameter, less extensive surgery, node-negative tumor, and higher BMI are risks for a lower extent of LN retrieval, and in these cases, additional approaches should be considered to maximize the LN yield.

Disclosure of conflict of interest

None.

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References

[1] Global Burden of Disease Cancer Collaboration, Fitzmaurice C, Dicker D, Pain A, Hamavid H, Moradi-Lakeh M, MacIntyre MF, Allen C, Hansen G, Woodbrook R, Wolfe C, Hamadeh RR, Moore A, Werdecker A, Gessner BD, Te Ao B, McMahon B, Karimkhani C, Yu C, Cooke GS, Schwebel DC, Carpenter DO, Pereira DM, Nash D, Kazi DS, De Leo D, Plass D, Ukwaja KN, Thurston GD, Yun Jin K, Simard EP, Mills E, Park EK, Catalá-López F, deVeber G, Gotay C, Khan G, Hosgood HD 3rd, Santos IS, Leasher JL, Singh J, Leigh J, Jonas JB, Sanabria J, Beardsley J, Jacobsen KH, Takahashi K, Franklin RC, Ronfani L, Montico M, Naldi L, Tonelli M, Geleijnse J, Petzold M, Shrime MG, Younis M, Yonemoto N, Breitborde N, Yip P, Pourmalek F, Lotufo PA, Esteghamati A, Hankey GJ, Ali R, Lunevicius R, Malekzadeh R, Dellavalle R, Weintraub R, Lucas R, Hay R, Rojas-Rueda D, Westerman R, Sepanlou SG, Nolte S, Patten S, Weichenthal S, Abera SF, Fereshtehnejad SM, Shiue I, Driscoll T, Vasankari T, Alsharif U, Rahimi-Movaghar V, Vlassov VV, Marcenes WS, Mekonnen W, Melaku YA, Yano Y, Artaman A, Campos I, MacLachlan J, Mueller U, Kim D, Trillini M, Eshrati B, Williams HC, Shibuya K, Dandona R, Murthy K, Cowie B, Amare AT, Antonio CA, Castañeda-Orjuela C, van Gool CH, Violante F, Oh IH, Deribe K, Soreide K, Knibbs L, Kereselidze M, Green M, Cardenas R, Roy N, Tillmann T, Li Y, Krueger H, Monasta L, Dey S, Sheikhbahaei S, Hafezi-Nejad N, Kumar GA, Sreeramareddy CT, Dandona L, Wang H, Vollset SE, Mokdad A, Salomon JA, Lozano R, Vos T, Forouzanfar M, Lopez A, Murray C, Naghavi M. The global burden of cancer 2013. JAMA Oncol 2015; 1: 505-27.

[2] Shah MA, Renfro LA, Allegra CJ, André T, de Gramont A, Schmoll HJ, Haller DG, Alberts SR, Yothers G, Sargent DJ. Impact of patient factors on recurrence risk and time dependency of oxaliplatin benefit in patients with colon cancer: analysis from modern-era adjuvant studies in the adjuvant Colon Cancer end points (ACCENT) database. J Clin Oncol 2016; 34: 843-53.

[3] Shimada Y, Hamaguchi T, Mizusawa J, Saito N, Kanemitsu Y, Takiguchi N, Ohue M, Kato T, Takii Y, Sato T, Tomita N, Yamaguchi S, Akaike M, Mishima H, Kubo Y, Nakamura K, Fukuda H, Moriya Y. Randomised phase III trial of adjuvant chemotherapy with oral uracil and tegafur plus leucovorin versus intravenous fluorouracil and levofolinate in patients with stage III colorectal cancer who have undergone Japanese D2/D3 lymph node dissection: final results of JCOG0205. Eur J Cancer 2014; 50: 2231-40.

[4] Compton CC, Fielding LP, Burgart LJ, Conley B, Cooper HS, Hamilton SR, Hammond ME, Henson DE, Hutter RV, Nagle RB, Nielsen ML, Sargent DJ, Taylor CR, Welton M, Willett C. Prognostic factors in colorectal cancer. College of American pathologists consensus statement 1999. Arch Pathol Lab Med 2000; 124: 979-94.

[5] Benson AB 3rd, Schrag D, Somerfield MR, Cohen AM, Figueredo AT, Flynn PJ, Krzyzanowska MK, Maroun J, McAllister P, Van Cutsem E, Brouwers M, Charette M, Haller DG. American society of clinical oncology recommendations on adjuvant chemotherapy for stage II colon cancer. J Clin Oncol 2004; 22: 3408-19.

[6] Schmoll HJ, Van Cutsem E, Stein A, Valentini V, Glimelius B, Haustermans K, Nordlinger B, van de Velde CJ, Balmana J, Regula J, Nagtegaal ID, Beets-Tan RG, Arnold D, Ciardiello F, Hoff P, Kerr D, Köhne CH, Labianca R, Price T, Scheithauer W, Sobrero A, Tabernero J, Aderka D, Barroso S, Bodoky G, Douillard JY, El Ghazaly H, Gallardo J, Garin A, Glynne-Jones R, Jordan K, Meshcheryakov A, Papamichail D, Pfeiffer P, Souglakos I, Turhal S, Cervantes A. ESMO consensus guidelines for management of patients with colon and rectal cancer. A personalized approach to clinical decision making. Ann Oncol 2012; 23: 2479-516.

[7] Norderval S, Solstad ØB, Hermansen M, Steigen SE. Increased lymph node retrieval decreases adjuvant chemotherapy rate for stage II colon cancer. Scand J Gastroenterol 2016; 51: 949-55.
[8] Herrera-Ornelas L, Justiniano J, Castillo N, Petrelli NJ, Stulc JP, Mittelman A. Metastases in small lymph nodes from colon cancer. Arch Surg 1987; 122: 1253-6.
[9] Joseph NE, Sigurdson ER, Hanlon AL, Wang H, Mayer RJ, MacDonald JS, Catalano PJ, Haller DG. Accuracy of determining nodal negativity in colorectal cancer on the basis of the number of nodes retrieved on resection. Ann Surg Oncol 2003; 10: 213-8.
[10] 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: 433-41.
[11] Baxter NN, Virnig DJ, Rothenberger DA, Morris AM, Jessurun J, Virnig BA. Lymph node evaluation in colorectal cancer patients: a population-based study. J Natl Cancer Inst 2005; 97: 219-25.
[12] 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: 1625-35.
[13] Linebarger JH, Mathiason MA, Kallies KJ, Shapiro SB. Does obesity impact lymph node retrieval in colon cancer surgery? Am J Surg 2010; 200: 478-82.
[14] Lewis A, Akopian G, Carillo S, Kaufman HS. Lymph node harvest in emergent versus elective colon resections. Am Surg 2012; 78: 1049-53.
[15] Japanese Society for Cancer of the Colon and Rectum. Japanese Classification of Colorectal Carcinoma. 8th edition. Tokyo, Japan: Kanehira-Syuppan; 1998.
[16] Wood P, Peirce C, Mulsow J. Non-surgical factors influencing lymph node yield in colon cancer. World J Gastrointest Oncol 2016; 8: 466-73.
[17] Sinan H, Demirbas S, Ersoz N, Ozerhan IH, Yagci G, Akyol M, Cetiner S. Who is responsible for inadequate lymph node retrieval after colorectal surgery: surgeon or pathologist? Acta Chir Belg 2012; 112: 200-8.
[18] Shiga M, Maeda H, Oba K, Okamoto K, Namikawa T, Fujisawa K, Yokota K, Kobayashi M, Hanazaki K. Safety of laparoscopic surgery for colorectal cancer in elderly patients aged ≥80 years: a propensity score matching study. Surg Today 2017; 47: 951-958.
[19] 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: 1073-7.
[20] Görög D, Nagy P, Péter A, Perner F. Influence of obesity on lymph node recovery from rectal resection specimens. Pathol Oncol Res 2003; 9: 180-3.
[21] Moghaddam AA, Woodward M, Huxley R. Obesity and risk of colorectal cancer: a meta-analysis of 31 studies with 70,000 events. Cancer Epidemiol Biomarkers Prev 2007; 16: 2533-47.
[22] Brändstedt J, Wangefjord S, Nodin B, Gaber A, Manjer J, Jirström K. Gender, anthropometric factors and risk of colorectal cancer with particular reference to tumour location and TNM stage: a cohort study. Biol Sex Differ 2012; 3: 23.
[23] Sinicrope FA, Foster NR, Yothers G, Benson A, Seitz JF, Labianca R, Goldberg RM, Degramont A, O'Connell MJ, Sargent DJ; Adjuvant Colon Cancer Endpoints (ACCENT) Group. Body mass index at diagnosis and survival among colon cancer patients enrolled in clinical trials of adjuvant chemotherapy. Cancer 2013; 119: 1528-36.
[24] Feo CV, Portinari M, Zuolo M, Targa S, Matarese VG, Gafà R, Forini E, Lanza G. Preoperative endoscopic tattooing to mark the tumour site does not improve lymph node retrieval in colorectal cancer: a retrospective cohort study. J Negat Results Biomed 2015; 14: 9.
[25] Kang J, Park HS, Kim IK, Song Y, Baik SH, Sohn SK, Lee KY. Effect of preoperative colonoscopic tattooing on lymph node harvest in T1 colorectal cancer. Int J Colorectal Dis 2015; 30: 1349-55.