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ORIGINAL ARTICLE

Analysis of risk factors for concurrent pulmonary infection after operation for colon cancer

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Summary

Purpose: *To investigate the risk factors for concurrent pulmonary infection after radical operation for colon cancer, providing a reference for the prevention and treatment of this condition.*

Methods: *A total of 486 patients subjected to radical operation for colon cancer in Shanghai Hudong Hospital from December 2014 to December 2017 composed the study group. Their clinicopathologic data and postoperative follow-up were reviewed, including gender, age, body mass index (BMI), preoperative albumin (ALB), preoperative hemoglobin (Hb), hypertension (HBP), diabetes mellitus (DM), smoking history, preoperative pulmonary ventilation dysfunction, tumor size, lymph node metastasis, operative time, intraoperative blood loss, blood transfusion and surgical method. Univariate and multivariate analyses were applied to investigate the risk factors influencing concurrent pulmonary infection after radical operation for colon cancer. The severity of pulmonary infection was assessed using the Clavien-Dindo classification system, and the severity ≥ Grade II suggested that postoperative pulmonary infection (POPI) occurred.*

Results: *Among 486 patients, 20 (4.12%) patients suffered from POPI, including 17 (3.50%) cases of Grade II infection, 2 (0.41%) cases of Grade IIIa infection and 1 (0.21%) case of Grade IVa infection. Univariate analysis showed that POPI was associated with age (≥75 years), gender (male), DM, smoking history, preoperative pulmonary function impairment and blood transfusion. Multivariate analysis indicated that age, preoperative pulmonary ventilation dysfunction, DM and blood transfusion were independent risk factors for POPI.*

Conclusions: *Age, preoperative respiratory function impairment, DM and blood transfusion are considered as independent risk factors for pulmonary infection after radical operation for colon cancer.*

Key words: *colon cancer, postoperative pulmonary infection, risk factors*

Introduction

Colon cancer is one of the common malignant gastrointestinal cancers in China, with increasing incidence rate year by year and often occurs at the age of 41-65 years [1]. Cancer cells of most colon cancer patients have already invaded or metastasized to surrounding tissues when definitely diagnosed, making radical operation more difficult. With the continuous progress in neoadjuvant chemoradiotherapy, comprehensive treatment is more likely to be used in the treatment of colon cancer, but operation is still the preferred treatment method [2-4]. Furthermore, there are many complications after colon cancer operation, among which postoperative infection has become one of the major complications after major surgical procedures, seriously affecting the recovery of

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patients and becoming an important part of hospital acquired pneumonia [5,6]. At present, there are some studies on postoperative pulmonary infection (POPI) in China and other countries. Some related factors have been widely agreed, but some show differences in different studies. This study aimed to investigate the perioperative risk factors affecting the development of pulmonary infection after radical operation for colon cancer, so as to provide a theoretical basis for the prevention of this condition.

Methods

Subjects

A total of 486 patients undergoing radical operation for colon cancer in Shanghai Hudong Hospital from December 2014 to December 2017 composed the study group (Table 1). Among them, there were 343 (70.58%) males and 143 (29.42%) females. All patients enrolled were definitely diagnosed with colon cancer based on preoperative pathological examination or intraoperative biopsy. This study was approved by the ethics committee of Shanghai Hudong Hospital. Signed written informed consents were obtained from all participants before study entry. Exclusion criteria: 1) patients with pulmonary infection before operation, 2) patients with urgent surgery 3) patients who did not undergo routine bowel preparation before surgery, 4) patients with a history of abdominal surgery, 5) patients with widespread metastases detected during operation, 6) patients with multiple colon cancers and 7) patients with insufficient clinical data.

Methods

The clinicopathologic data and postoperative follow-up of all patients enrolled in this study were collected, including gender, age, body mass index (BMI), preoperative albumin (ALB), preoperative hemoglobin (Hb), hypertension (HBP), diabetes mellitus (DM), smoking history, preoperative pulmonary ventilation dysfunction, tumor size, lymph node metastasis, operative time, intraoperative blood loss, blood transfusion and surgical method. The severity of pulmonary infection was assessed via Clavien-Dindo classification system, and the severity of Grade II and above indicated that POPI occurred. Univariate and multivariate analyses were used to investigate the risk factors that affect POPI in radical operation for colon cancer.

Statistics

All statistics were performed using SPSS 19.0 software (Armonk, NY, USA). T-test was performed for the comparison of paired samples. Single factor analysis was used to evaluate the relationship between postoperative pneumonia and relevant risk factors. The statistically significant factors were screened by multivariate logistic regression analysis. $P<0.05$ suggested that the difference was statistically significant.

Results

Basic information

Among 486 patients, 20 (4.12%) had POPI, and 3 (0.62%) had Grade I infection based on the Clavien-Dindo classification. The above mentioned 3 patients with Grade I infection were self-healed without special treatment and classified as non-infected. Among the above mentioned 20 patients, 2 were subjected to closed drainage of the thoracic cavity, and the remaining were cured after being treated with sensitive antibiotics and nutritional support. After 3-16 days of comprehensive treatment, the condition of the above patients was improved, with an average of 5.3 days in terms of time to remission. As to the length of hospital stay, patients with concurrent pulmonary infection were discharged from hospital about 15 days after operation, which was obviously longer than the 7 days of patients without postoperative complications.

Table 1. Baseline characteristics of included patients

Characteristics	*n (%)*
Age(y), median (range)	64.47 (21-86)
Gender	
Male	343 (70.58)
Female	143 (29.42)
BMI(kg/m^2), median (range)	23.45 (15.27-38.96)
Preoperative albumin(g/L), median (range)	42.30 (26.89-45.07)
Preoperative hemoglobin(g/L), median (range)	110 (74-160)
Smoking	175 (36.01)
Hypertension	50 (10.29)
Diabetes mellitus	30 (6.17)
Preoperative pulmonary disease	62 (12.76)
Preoperative pulmonary ventilation dysfunction	96 (19.75)
Blood transfusion	43 (8.85)
Tumor size(cm), median (range)	3.2 (1.4-11.0)
TNM stage	
I	87 (17.90)
II	317 (65.23)
III	82 (16.87)
IV	0 (0)
Surgical method	
Right hemicolectomy	161 (33.13)
Transverse colectomy	73 (15.02)
Left hemicolectomy	29 (5.97)
Sigmoidectomy	223 (45.88)
Operative time (h), median (range)	3.48 (2.51-7.43)
Intraoperative blood loss (mL), median (range)	100 (50-350)

Relationships of general factors with concurrent pulmonary infection

Of POPI patients 18 were male and 2 female, and the difference was statistically significant between the two groups (5.25 vs. 1.40%, p<0.05, Table 2). Among 20 POPI patients, 9 were older than 75 years, and 11 were younger than 75 years (7.20 vs. 3.05%, p<0.05, Table 2). Among patients with BMI >25 kg/m^2, there were 3 patients with POPI, while among those with BMI ≤25 kg/m^2, 17 patients suffered from POPI (3.03 vs. 4.64%, p>0.05, Table 2). A total of 17 patients with preoperative ALB >35 g/L had POPI, and 3 with ALB ≤35 g/L were complicated with POPI (3.72 vs. 10.34%, p<0.05, Table 2). Among all patients with preoperative Hb >110 g/L and those with preoperative Hb ≤110 g/L, there were 18 and 2 patients with POPI (4.07 vs. 4.55%, p<0.05, Table 2). Five POPI patients had HBP and 15 did not have HBP (10.00 vs. 3.44%, p<0.05, Table 2). There were 5 patients with POPI in patients with DM and 15 in patients without DM, with statistically significant difference between the two groups (16.67 vs. 3.29%, p<0.05, Table 2). POPI was detected in 15 patients with smoking history and in 5 without smoking history (8.57 vs. 1.61%, p<0.05, Table 2). There were 11 patients with POPI among patients with preoperative pulmonary ventilation

Table 2. Correlations of general factors with concurrent pulmonary infection

Factors	*Concurrent pulmonary infection (Clavien-Dindo)*		*p*
	≤I stage n (%)	*≥II stage n (%)*	
Gender			0.001
Male	325 (94.75)	18 (5.25)	
Female	141 (98.60)	2 (1.40)	
Age, years			0.004
>75	116 (92.80)	9 (7.20)	
≤75	350 (96.95)	11 (3.05)	
BMI (kg/m^2)			0.623
>25	96 (96.97)	3 (3.03)	
≤25	349 (95.36)	17 (4.64)	
Preoperative albumin (g/L)			0.256
>35	440 (96.28)	17 (3.72)	
≤35	26 (89.66)	3 (10.34)	
Preoperative hemoglobin(g/L)			0.482
>110	424 (95.93)	18 (4.07)	
≤110	42 (95.45)	2 (4.55)	
Hypertension			0.374
Yes	45 (90.00)	5 (10.00)	
No	421 (96.56)	15 (3.44)	
Diabetes mellitus			0.006
Yes	25 (83.33)	5 (16.67)	
No	441 (96.71)	15 (3.29)	
Smoking history			0.037
Yes	160 (91.43)	15 (8.57)	
No	306 (98.39)	5 (1.61)	
Preoperative pulmonary ventilation dysfunction			<0.001
Yes	85 (88.54)	11 (11.46)	
No	381 (97.69)	9 (2.31)	
Tumor diameter, cm			0.741
>3	307 (96.24)	12 (3.76)	
≤3	159 (95.21)	8 (4.79)	
Lymph node metastasis			0.182
Yes	110 (94.02)	7 (5.98)	
No	356 (96.48)	13 (3.52)	

Table 3. Correlations of surgical factors with concurrent pulmonary infection

Factors	*Concurrent pulmonary infection (Clavien-Dindo)*		*p*
	≤I stage n (%)	*≥II stage n (%)*	
Operation time (hrs)			0.06
>3.5	232 (94.69)	13 (5.31)	
≤3.5	234 (97.10)	7 (2.90)	
Intraoperative blood loss (mL)			0.32
>150	230 (95.04)	12 (4.96)	
≤150	236 (96.72)	8 (3.28)	
Blood transfusion			0.002
Yes	24 (85.71)	4 (14.29)	
No	442 (96.51)	16 (3.49)	
Surgical method			0.41
Right hemicolectomy	155 (96.27)	6 (3.73)	
Transverse colectomy	69 (94.52)	4 (5.48)	
Left hemicolectomy	28 (96.55)	1 (3.45)	
Sigmoidectomy	214 (95.96)	9 (4.04)	

Table 4. Multivariate logistic regression analyses

	OR (95%CI)	*p*
Gender (male)	3.78 (0.79-19.43)	0.061
Age (male)	2.46 (1.27-5.12)	0.034
Diabetes mellitus	2.39 (1.33-6.04)	0.025
Smoking history	1.57 (0.42-4.98)	0.716
Preoperative pulmonary ventilation dysfunction	2.52 (1.48-5.96)	0.012
Blood transfusion	3.19 (1.51-6.07)	0.017

dysfunction and 9 patients with POPI among those without preoperative pulmonary ventilation dysfunction (11.46 vs. 2.31%, p<0.05, Table 2). Among patients with tumor diameter >3 cm, 12 patients had POPI, and among those with tumor diameter ≤3 cm, there were 8 patients with POPI (3.76 vs. 4.79%, p>0.05, Table 2). Among patients with lymph node metastasis, 7 patients were complicated with POPI, and among those without lymphatic metastasis, 13 patients suffered from POPI (5.98 vs. 3.52%, p>0.05, Table 2).

Correlations of surgical factors with concurrent pulmonary infection

Among all patients with operative time >3.5 h, 13 (5.31%) had POPI, and among those with operative time ≤3.5 h, there were 7 (2.90%) patients with POPI. There was no statistical difference between the two groups (p>0. 05, Table 3). POPI was discovered in 12 (4.96%) patients with intraoperative blood loss >150 mL and in 8 (3.28%) patients with intraoperative blood loss ≤150 mL, without statistical difference between the two groups (p>0.05, Table 3). In patients receiving blood transfusion, POPI was found in 4 (14.29%) patients, and in patients not receiving blood transfusion, POPI was observed in 16 (3.49%) patients, showing a statistically significant difference between the two groups (p<0.05, Table 3). Among all surgical patients, 6 (3.73%) subjected to right hemicolectomy developed POPI, 4 (5.48%) undergoing transverse colectomy had POPI, 1 (3.45%) patient subjected to left hemicolectomy suffered from POPI, and 9 (4.04%) patients undergoing sigmoidectomy had POPI. There was no statistical difference among the four groups (p>0.05, Table 3).

Univariate and multivariate logistic regression analyses

Univariate analysis on the clinicopathologic data and postoperative follow-up of patients indicated that age (≥75 years), gender (male), DM, smoking history, preoperative pulmonary function impairment and blood transfusion were significantly related to POPI (p<0.05). Postoperative pulmonary infection was used as a dependent variable (with =1 and without =0), and indicators with statistical significance in the univariate analysis were included in the multivariate logistic regression analysis. The results suggested that age, DM, preoperative ventilation dysfunction and blood transfusion were independent risk factors for POPI (p<0.05, Table 4).

Discussion

In this study, the incidence rate of POPI in Chinese colon cancer patients was 4.12%, which is basically similar to that reported in other countries [7,8]. Currently, there are many studies on risk factors for POPI in China and other countries, but the research on the incidence rate of POPI in colon cancer patients is still sparce. This study revealed that age, preoperative ventilation dysfunction, DM and blood transfusion were independent risk factors for POPI. Factors with statistical significance or large variation included in this study were analyzed, so as to provide a reference for the prevention of colon cancer POPI, thus reducing the incidence rate this condition.

In this study, the incidence rate of POPI in males was overtly higher than that in females, but the multivariate logistic regression analysis showed that gender was not an independent risk factor for POPI. Authors from China and other countries have reported that obesity is one of the independent risk factors for POPI [8,9]. However, there was no statistically significant difference in the incidence rate of POPI between patients with BMI >25 kg/m^2 and those with BMI ≤25 kg/m^2 in this study, which differs from the findings of previous studies [8,9]. This may be due to the fact that this study was a retrospective analysis on clinical cases, the sample size was relatively small, and the number of subgroups was not matched, with a certain bias. A study by Liu et al. [10] reported that preoperative hypoproteinemia is an independent risk factor for postoperative complications of patients undergoing abdominal surgery. In this study, the infection rate was not statistically significant among different ALB and Hb subgroups. It is deemed that research bias may be caused by nutritional support before elective operation.

Postoperative expectoration and weakness are more likely to occur in elderly patients due to surgical trauma, making the elderly more susceptible to secretion-induced airway obstruction and aspiration. Surveys and studies have numerically stated that the incidence rate of postoperative pulmonary complications in patients aged ≥60 years is evidently increased, and some non-Chinese studies have proved that advanced age is a risk factor for postoperative pulmonary complications [11,12]. In this study, the incidence rate of POPI in patients aged >75 years was clearly higher than that in those aged ≤75 years, and the multivariate logistic regression analysis indicated that age was an independent risk factor for POPI. This is consistent with the above analysis.

A number of studies [13,14] on the impact of DM on postoperative complications have revealed that poor blood glucose control may increase the risk of postoperative infections [13]. Another study [15] stated that strict blood glucose control can effectively reduce postoperative complications, but the range of blood glucose control is not standardized. In our study, the incidence rate of POPI was clearly increased in patients with DM compared with that in patients without DM, and the multivariate logistic regression analysis further confirmed that DM was an independent risk factor for POPI in colon cancer patients.

Smoking causes changes in the pathophysiology of the lungs and increases the possibility of pulmonary infection. It is now believed that the mechanism of smoking-induced postoperative complications is related to the effect of long-term smoking on lung tissue and the acute toxicity of toxic substances produced by smoking in the body [16]. In this study, the incidence rate of POPI in smokers was significantly higher compared to non-smokers, but the multivariate logistic analysis did not prove that smoking was an independent risk factor for POPI. This may be due to the fact that in this study, the sample size was small, specific statistics on the age of smoking were not performed, and the definition of smoking was relatively ambiguous. In this study, the incidence rate of POPI was significantly elevated in patients with preoperative pulmonary ventilation dysfunction ($p<0.05$), and the multivariate logistic regression analysis also suggested that preoperative ventilation impairment was an independent risk factor for POPI.

For gastrointestinal surgery, the operation itself is closely related to the occurrence of postoperative pulmonary complications. In this study, comparison of surgical site, intraoperative blood loss and operative time was carried out. However, emergency surgery was excluded from this study because there were many factors affecting the postoperative complications and relatively large biases in emergency surgery. The comparison of anesthesia method was not performed in this study since the elective colon cancer surgery in our hospital was done using general anesthesia with tracheal cannula. The results of this study indicated that there was no significant difference in the incidence rate of POPI among subgroups with different operative times (3.5 h), intraoperative blood losses (150 mL) and surgical sites (right hemicolon/transverse colon/left hemicolon/sigmoid colon).

Blood transfusion is closely related to the occurrence of postoperative concurrent infections. A study has suggested that blood transfusion is an independent risk factor for postoperative infections

[17]. In this study, the incidence rate of POPI in patients with blood transfusion was overtly higher than that in patients without blood transfusion, and the multivariate logistic regression analysis revealed that blood transfusion was an independent risk factor for POPI, which is consistent with the findings of previous studies.

This study was a retrospective clinical analysis based on previous cases and had certain limitations. In the future, a prospective study with a large sample size and more relevant research indicators will be designed to increase the credibility and guide clinical practice better.

Conclusions

Age, DM, preoperative pulmonary dysfunction and blood transfusion are independent risk factors for concurrent pulmonary infection after radical operation for colon cancer. Therefore, close attention should be paid to patients with the above factors in clinical practice, so as to prevent and treat POPI in early stage.

Conflict of interests

The authors declare no conflict of interests.

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