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ABOUT COVER

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WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

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META-ANALYSIS

Relationship between body mass index and short-term postoperative prognosis in patients undergoing colorectal cancer surgery

Ying Li, Ji-Jun Deng, Jun Jiang

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Abstract

BACKGROUND

Obesity is a state in which excess heat is converted into excess fat, which accumulates in the body and may cause damage to multiple organs of the circulatory, endocrine, and digestive systems. Studies have shown that the accumulation of abdominal fat and mesenteric fat hypertrophy in patients with obesity makes laparoscopic surgery highly difficult, which is not conducive to operation and affects patient prognosis. However, there is still controversy regarding these conclusions.

AIM

To explore the relationship between body mass index (BMI) and short-term prognosis after surgery for colorectal cancer.

METHODS

PubMed, Embase, Ovid, Web of Science, CNKI, and China Biology Medicine Disc databases were searched to obtain relevant articles on this topic. After the articles were screened according to the inclusion and exclusion criteria and the risk of literature bias was assessed using the Newcastle-Ottawa Scale, the prognostic indicators were combined and analyzed.

RESULTS

A total of 16 articles were included for quantitative analysis, and 15588 patients undergoing colorectal cancer surgery were included in the study, including 3775 patients with obesity and 11813 patients without obesity. Among them, 12 articles used BMI ≥ 30 kg/m^2 and 4 articles used BMI ≥ 25 kg/m^2 for the definition of obesity. Four patients underwent robotic colorectal surgery, whereas 12 underwent conventional laparoscopic colorectal resection. The quality of the literature was good. Meta-combined analysis showed that the overall complication rate of patients with obesity after surgery was higher than that of patients without obesity [OR = 1.35, 95%CI: 1.23-1.48, Z = 6.25, P < 0.0001]. The incidence of anastomotic leak after surgery in patients with obesity was not significantly different from that in patients without obesity [OR = 0.99, 95%CI: 0.70-1.41), Z = -0.06, P = 0.956]. The incidence of surgical site infection (SSI) after surgery in patients with obesity was higher than that in patients without obesity [OR = 1.43, 95%CI: 1.16-1.78, Z = 3.31, P < 0.001]. The incidence of reoperation in patients with obesity after surgery was higher than that in patients without obesity; however, the difference was not statistically significant [OR = 1.15, 95%CI: 0.92-1.45, Z = 1.23, P = 0.23]; Patients with obesity had lower mortality after surgery than patients without obesity; however, the difference was not statistically significant [OR = 0.61, 95%CI: 0.35-1.06, Z = -1.75, P = 0.08]. Subgroup analysis revealed that the geographical location of the institute was one of the sources of heterogeneity. Robot-assisted surgery was not significantly different from traditional laparoscopic resection in terms of the incidence of complications.

CONCLUSION

Obesity increases the overall complication and SSI rates of patients undergoing colorectal cancer surgery but has no influence on the incidence of anastomotic leak, reoperation rate, and short-term mortality rate.

Key Words: Coloretal rectum cancer; Body mass index; Short-term prognosis; Cancer surgery

Core Tip: Colorectal rectal cancer (CRC) is a common malignant tumor in gastroenterology, ranking the third in the global incidence rate of malignant tumors, second only to lung cancer and breast cancer, with a mortality rate of about 8% of all malignant tumors. Like other malignant tumors, the etiology of CRC is still unclear. It may occur in the colon or anywhere in the rectum, but it is most common in the rectum and sigmoid colon, and the rest are in the cecum, ascending colon, descending colon and transverse colon in turn. So far, the radical treatment of CRC is still surgical treatment. The definition of radical cancer resection is to remove tumors visible to the naked eye, including primary and drainage lymph nodes. Although lesions can be removed during surgery, complete removal is still not easy for patients with extensive local diseases. For patients with advanced CRC, the tumor size is relatively large, there are many vascular variations, the field of vision of laparotomy is poor, and the operation is difficult.

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INTRODUCTION

Colorectal rectal cancer (CRC) is a common malignant tumor and ranks third in the incidence of malignant tumors worldwide; it is second only to lung and breast cancers, with a mortality rate of approximately 8%[1] of all malignant tumors. Similar to other malignancies, the cause of CRC remains unclear and can occur anywhere in the colon or rectum; however, it is most common in the rectum and sigmoid colon, whereas the remainder is found sequentially in the cecum, ascending, descending, and transverse colon[2]. Surgical treatment still remains the radical treatment of CRC, and radical resection of intestinal cancer is defined as the removal of macroscopic tumors, including primary and draining lymph nodes. Although the lesion can be removed during surgery, complete removal is still difficult in patients with extensive local disease[3]. For patients with advanced CRC, the tumor size is relatively large, with high vascular variation, and the visual field of laparotomy is poor, making the surgery difficult. In recent years, laparoscopy has emerged as an auxiliary operation with the advantages of a small surgical wound, an open operation field, and rapid postoperative recovery. It has been gradually applied to radical resection of CRC and has achieved an ideal clinical effect[4]. Obesity is a state in which excess heat in the human body is converted into excess fat, which accumulates in the body and may cause damage to the circulatory, endocrine, and digestive systems[5]. Studies have suggested that abdominal fat accumulation and mesenteric fat hypertrophy in patients with obesity make laparoscopic surgery very difficult, which is not conducive to the operation and affects patient prognosis[6]. However, other studies have also shown that obesity is not associated with a short-term prognosis after surgery[7]. The controversial findings may be related to the sample size in the study, individual differences between patients and tumors, or time to evaluate body mass index (BMI). We conducted a meta-analysis to explore the relationship between BMI and short-term prognosis after surgery for CRC.

MATERIALS AND METHODS

Database

In January 2023, we retrieved the PubMed, Embase, Ovid, Web of Science, CNKI, and China Biology Medicine disc databases in the keyword-free search mode. Key words included: "*obesity*" or "*obese*" or "*BMI*" or "*laparoscopic colorectal resection*."

Literature inclusion criteria

(1) Study type: All studies were observational cohort studies (either retrospective or prospective); (2) Research participants: The primary disease of all the research participants was CRC, including all malignant tumors occurring in the colon or rectum. It was clarified in the study that the patients were treated by surgical resection, and the resection operations included but was not limited to the following common laparoscopic operations: Right hemicolectomy, expanded right hemicolectomy, ileocolic resection, and left hemicolectomy; (3) Grouping or cohort division: There must be two or more definite cohorts in the study. The cohorts were grouped such that patients were divided into obese and non-obese groups according to BMI ≥ 30 kg/m^2 or BMI ≥ 25 kg/m^2[8]; and (4) Outcome indicators: Short-term prognosis indicators of the two groups, such as complication rate, mortality after surgery, reoperation rate, and hospital stay, must be provided in the study.

Literature exclusion criteria

(1) Patients with non-primary CRC; (2) Patients who did not provide the grouping criteria for obesity or for whom cohort data of obese and non-obese were not available; the patient type was visceral obesity; (3) The study type was a non-observational cohort study, such as a case study; and (4) Studies with missing outcome indicators and for which data were not available, such as studies with only long-term prognostic survival analysis and no short-term prognostic survival indicators.

Literature screening

After literature retrieval, repetitive literature was excluded using software. The titles and abstracts were read by two researchers, and screening was conducted according to the inclusion and exclusion criteria. After the final literature was determined, the full text of the literature was obtained individually from the Internet. If the original text was not obtained, the author of the original text was contacted by phone or email to obtain the full text. The full texts of the articles were read for data extraction and further screening to remove articles with no data or incomplete indicators.

Literature quality and bias risk assessment

Literature quality and bias risk assessment were performed using the Newcastle-Ottawa Scale[9] for quality analysis of the included literature. The scale was used to evaluate the object selection, comparability, and outcome indicators in the literature. The maximum score was 9 points, and the quality was good, with a score of > 5 points. Higher scores indicated better literature quality and less bias, with a score of 5–7 indicating medium quality and 8–9 indicating high quality. Articles with scores < 5 were excluded.

Data extraction

Two researchers independently extracted literature data: Study type, date of publication, study location, age of the patient, tumor type, tumor stage, BMI, intraoperative indicators, postoperative indicators, and prognosis indicators. After the two researchers completed data extraction, they cross-examined each other's results and discussed and finalized the differences generated.

Statistical methods

(1) The discrete variables were reported as effect quantity with OR and 95%CI; (2) Statistical comparisons were described using forest plot; (3) Literature heterogeneity was analyzed using I^2 method and Q-test, and $I^2 > 50\%$ or $P < 0.1$ indicated the heterogeneity of the results; (4) In case of no heterogeneity between the articles, the fixed-effects model (Mantel–Haenszel) was used; in case of heterogeneity between the articles, the Dersimonian–Laird method was used; (5) Survey of heterogeneity: Subgroup analysis was used to investigate heterogeneity; (6) Meta-regression analysis was used to investigate factors that were significant for effect size; (7) Sensitivity analysis: Diagnostic tests were used to analyze studies that might have influenced the pooled results; literature was culled one by one and the combined effects of the remaining articles were calculated to identify the articles that most affected the results; and (8) Publication bias was detected using the Egger's test and results of

publication bias were presented using a trim-filled plot.

RESULTS

Literature screening results

As shown in Figure 1, which is a flow chart of the literature selection process, 873 articles were initially retrieved. After initial deduplication and screening, 18 articles[6,10-26] were included in the final screening. However, articles[16] lacking a short-term prognosis indicator and articles[19] whose data could not be obtained were excluded; finally, 16 articles were included. A total of 15588 patients (3775 with obesity and 11813 without obesity) were included in the study. Among them, 12 articles used BMI ≥ 30 kg/m^2 and 4 articles used BMI ≥ 25 kg/m^2 for the definition of obesity. Four patients underwent robotic colorectal surgery and 12 underwent conventional laparoscopic resection. The basic characteristics, grouping information, and outcome indicator lists of all articles and patients are listed in Table 1.

Literature quality and bias assessment

Among the 16 included articles, 10[6,10-15,17,18,26] had a quality score of 8–9, with little bias and high quality. A total of six articles[20-25] were scored 6–7, with a small amount of bias and medium quality. The overall quality was good (Table 2).

Meta-analysis results

Total complication rate after surgery for CRC (Obese *vs* Non-obese): All articles[6,10-15,17,18,20-26] reported the total complication rates of patients with obesity and those without obesity after surgery. There was no statistical heterogeneity between the articles (I^2 = 41%, P = 0.05). According to the fixed-effects model and meta-analysis, the complication rate of patients with obesity after surgery was higher than that of patients without obesity [OR = 1.35, 95%CI: 1.23-1.48, Z = 6.25, P < 0.0001] (Figure 2).

Incidence of postoperative anastomotic leak in patients with CRC (Obese vs Non-obese): Twelve articles[10-15,17,20-23,26] reported the incidence of anastomotic leak in patients with obesity and those without obesity after surgery. There was no statistical heterogeneity between the articles (I^2 = 0%, P = 0.63). A fixed-effects model was used. The incidence of anastomotic leak in patients with obesity after surgery was not statistically different from that in patients without obesity according to the meta-analysis [OR = 0.99, 95%CI: 0.70-1.41, Z = -0.06, P = 0.956] (Figure 3).

Incidence of SSI in patients with CRC after surgery (Obese vs Non-obese): The incidence of surgical site infection (SSI) between patients with obesity and those with obesity after surgery was reported in 13 articles[6,10-15,17,20-23,26]. There was no statistical heterogeneity between the articles (I^2 = 11%, P = 0.33). According to the fixed-effects model and meta-analysis, the incidence of SSI in patients with obesity after surgery was higher than that in patients without obesity [OR = 1.43, 95%CI: 1.16-1.78, Z = 3.31, P < 0.001] (Figure 4).

Reoperation rate after surgery for CRC (Obese vs Non-obese): Nine articles[6,10,11,13,14,17,24-26] reported the postoperative reoperation rates of patients with obesity and those without obesity. There was no statistical heterogeneity between the articles (I^2 = 1%, P = 0.43). According to the fixed-effects model and meta-analysis, the reoperation rate of patients with obesity after surgery was higher than that of patients without obesity, but the difference was not statistically significant [OR = 1.15, 95%CI: 0.92-1.45, Z = 1.23, P = 0.23] (Figure 5).

Postoperative mortality of patients undergoing CRC surgery (Obese vs Non-obese): Eleven articles[6,10,11,13,14,17,18,20,22,24,25] reported the short-term mortality rates of patients with obesity and those without obesity after surgery. There was no statistical heterogeneity between the articles (I^2 = 0%, P = 0.46). Using a fixed-effects model and meta-analysis, it was found that the mortality rate of patients with obesity after surgery was lower than that of patients without obesity. However, the differences were not statistically significant [OR = 0.61, 95%CI: 0.35-1.06, Z = -1.75, P = 0.08], as shown in Figure 6.

Source survey of heterogeneity

Although there was no statistical heterogeneity between the articles in the analysis of the overall complication incidence index after surgery (I^2 = 41%, P = 0.05), there was still some heterogeneity. We conducted subgroup analysis according to the "*geographical location*", "*surgery approach*," and "*obese BMI* " and found that after the articles were grouped according to the study site and "*geographical location*," the inter-group heterogeneity test between subgroups was P < 0.05, indicating that the "*geographical location*" of the study site was one of the sources of heterogeneity in this study, as shown in Table 3.

Meta-regression analysis

In the analysis of the overall complication incidence index after surgery, to understand the factors that

Table 1 Basic characteristics, patient characteristics, grouping information, surgical measures, and prognosis indicators of included articles

Ref.	Country	Patient's age (years)	Obesity definition	Overall number of people	Grouping number (O/N)	Surgical measures	Outcome indicators
Hannan *et al*[10], 2022	Ireland	67	BMI: 30 kg/m^2	107	34/73	Robotic colorectal surgery	a, b, c, d, e
Lagares-Garcia *et al* [11], 2016	United States	59.9 ± 13.8	BMI: 30 kg/m^2	67	34/33	Robotic colorectal surgery	a, b, c, d
Akiyoshi *et al*[12], 2011	Japan	63.9 (23–91)	BMI: 25 kg/m^2	1,169	243/926	Laparoscopic colorectal resection	a, b, e
Merkow *et al*[13], 2009	United States	68.02 ± 6.18	BMI: 30 kg/m^2	1,679	607/1072	Laparoscopic colorectal resection	a, c, d, e
Choi *et al*[14], 2017	Korea	66.7 ± 11.2	BMI: 25 kg/m^2	313	80/233	Laparoscopic colorectal resection	a, b, c, d, e
Zhang *et al*[15], 2021	China	55 (36–78)	BMI: 30 kg/m^2	356	48/308	Laparoscopic colorectal resection	a, b, c, d, e
Yamashita *et al*[16], 2021	Japan	70 (24–96)	BMI: 25 kg/m^2	1,648	313/1335	Laparoscopic colorectal resection	a, b, e
Bège *et al*[18], 2009	France	62 ± 10.7	BMI: 30 kg/m^2	210	24/186	Laparoscopic colorectal resection	a, b, c, d, e
Hede *et al*[19], 2015	Sweden	72.7 ± 13.1	BMI: 30 kg/m^2	6,675	1528/5147	Laparoscopic colorectal resection	a, d
Makino *et al*[21], 2014	United States	67.5 ± 11.7	BMI: 30 kg/m^2	152	76/76	Laparoscopic colorectal resection	a, b, d, e
Bamboat *et al*[22], 2012	United States	65	BMI: 30 kg/m^2	245	68/177	Laparoscopic colorectal resection	a, b, e
Miyamoto *et al*[23], 2014	Japan	65.9 ± 9.6	BMI: 25 kg/m^2	561	140/421	Laparoscopic colorectal resection	a, b, d, e
Bayraktar *et al*[24], 2018	Turkey	60 ± 11	BMI: 30 kg/m^2	101	30/71	Robotic colorectal surgery	a, b, e
Poulsen *et al*[25], 2012	Denmark	69 (37–97)	BMI: 30 kg/m^2	425	93/332	Laparoscopic colorectal resection	a, c, d
Bell *et al*[26], 2018	Australia	71.6	BMI: 30 kg/m^2	1464	299/1165	Laparoscopic colorectal resection	a, c, d
Peacock *et al*[27], 2020	United States	54.1 ± 12.5	BMI: 30 kg/m^2	533	161/372	Robotic colorectal surgery	a, b, c, e

O/N: Obese/Non-obese; SSI: Surgical site infection; a: Postoperative complication rate; b: Anastomotic leak rate; c: 30-d reoperation rate; d: 30-d mortality rate; e: SSI rate.

may affect the results of Pooled ES, we used the "*year of publication*," "*sample size*," and "*patient's age*" to regression pooled ES, and found that none of the three factors had a statistically significant effect on the results (P > 0.05), which indicates that none of the three factors was able to affect the results Figure 7.

Sensitivity analysis

The results of the analysis of the postoperative complication rate indicators were verified using sensitivity diagnosis, and it was found that the literature significantly affected the results, which might be related to the fact that the sample size of the literature was much larger than that of other studies [18]. After literature[18] was excluded, the remaining 15 studies were excluded individually, and no significant deviations were found, indicating that the final pool result was stable, as shown in Figure 8.

Analysis of publication bias

In the analysis of the incidence indicators of postoperative complications, publication bias was detected using Egger's t-test, with t = 0.43 and P = 0.20, indicating no significant left-right asymmetry in the funnel plot, as shown in Figure 9.

Table 2 Quality Assessment Based on New Castle–Ottawa Scale

Ref.	Case selection (/4)	Comparability (/2)	Outcome indicators (/3)	Total score (/9)
Hannan *et al*[10], 2022	4	2	3	9
Lagares-Garcia *et al*[11], 2016	4	2	2	8
Akiyoshi *et al*[12], 2011	4	2	2	8
Merkow *et al*[13], 2009	4	2	3	9
Choi *et al*[14], 2017	4	2	2	8
Zhang *et al*[15], 2021	4	2	2	8
Yamashita *et al*[16], 2021	4	2	3	9
Bège *et al*[18], 2009	4	2	2	8
Hede *et al*[19], 2015	4	2	3	9
Makino *et al*[21], 2014	3	2	2	7
Bamboat *et al*[22], 2012	3	2	2	7
Miyamoto *et al*[23], 2014	2	2	2	6
Bayraktar *et al*[24], 2018	2	2	2	6
Poulsen *et al*[25], 2012	3	2	2	7
Bell *et al*[26], 2018	2	2	2	6
Peacock *et al*[27], 2020	4	2	2	8

Table 3 Subgroup analysis of indicators of overall complication incidence after surgery

Grouping number	Subgroup grouping method	Subgroup	Number of articles	Effect size	Heterogeneity	
					I^2 (%)	tau^2
1	Geographical location	Europe	6	OR = 1.59, (1.40, 1.80)	0	0
		North America	5	OR = 1.14, (0.94, 1.37)	0	0
		Asia	5	OR = 1.13, (0.84, 1.52)	35.4	0.04
2	Surgery approach	Robotic colorectal surgery	4	OR = 1.18, (0.85, 1.64)	0	0
		Laparoscopic colorectal resection	12	OR = 1.28, (1.08, 1.51)	53.3	0
3	Obese body mass index	30 kg/m^2	12	OR = 1.34, (1.14, 1.57)	21.8	0.02
		25 kg/m^2	4	OR = 1.14, (0.81, 1.58)	51.3	0.06

DISCUSSION

Over the past few years, overweight and obesity have gradually become widespread epidemics. Obesity is related to the occurrence of several diseases. In addition to cardiovascular and cerebrovascular diseases, obesity is closely related to the occurrence of many cancers, including colorectal, endometrial, and breast cancers[27,28]. However, studies on obesity and surgical prognosis of these tumors are rare and controversial.

To explore the impact of being overweight on the short-term prognosis of CRC surgery, 16 observational cohort studies with 15588 participants were included in this meta-analysis. The results showed that being overweight can increase the overall incidence of complications after CRC surgery and the incidence of SSI. However, the impact on the incidence of anastomotic leak, reoperation rate, and mortality was not obvious. In recent years, laparoscopic colorectal cancer resection has been widely used in clinical colorectal cancer radical surgery because of its small wound, open operation field, few complications, rapid postoperative recovery, and other advantages, and its short-term and long-term efficacy has been widely recognized worldwide[29]. However, for some patients with CRC, the tumor size is relatively large and the visual field during laparotomy is poor. As the operation involves the anatomy and root treatment of multiple important blood vessels, such as ileocolic and colonic vessels, the difficulty of completing the operation under laparoscopy is greatly increased. In addition, with changes in the dietary habits of people, an increasing number of people are becoming obese. Obesity is

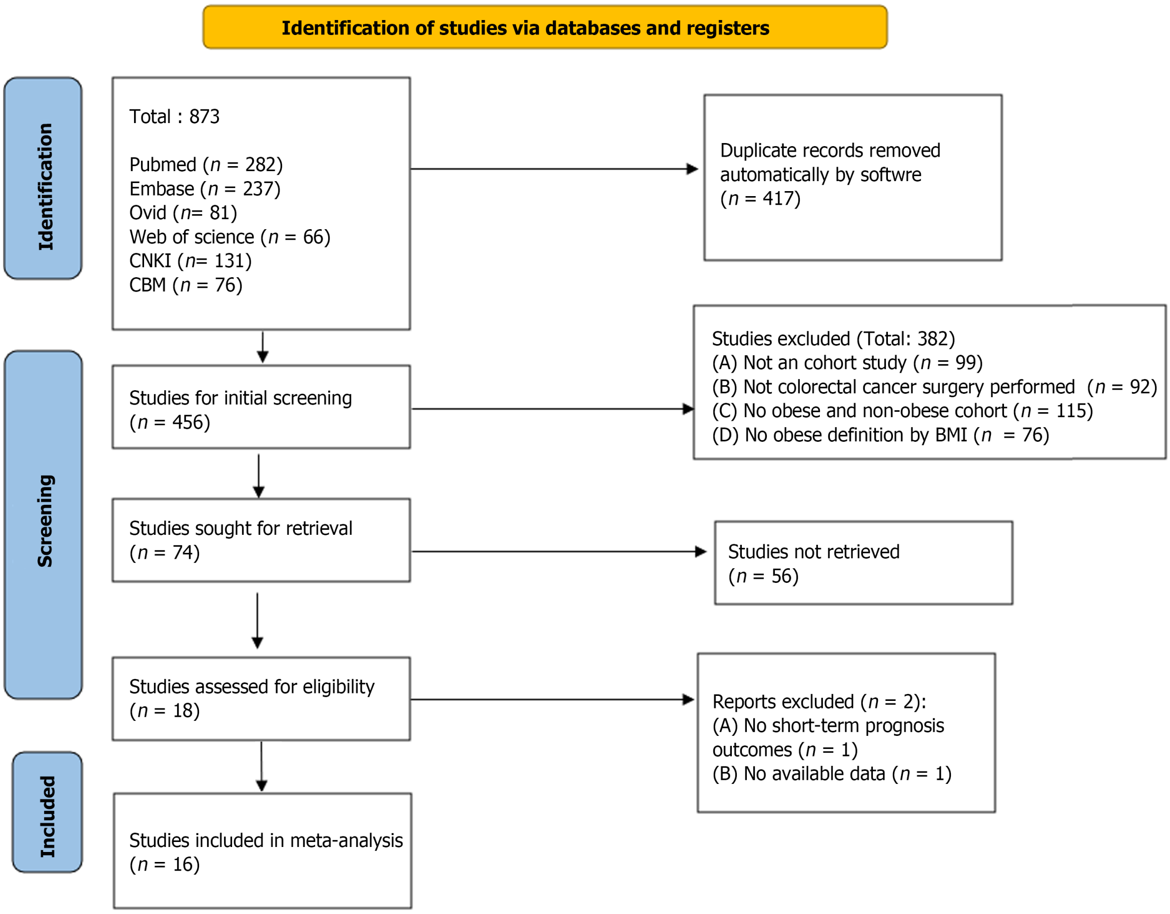
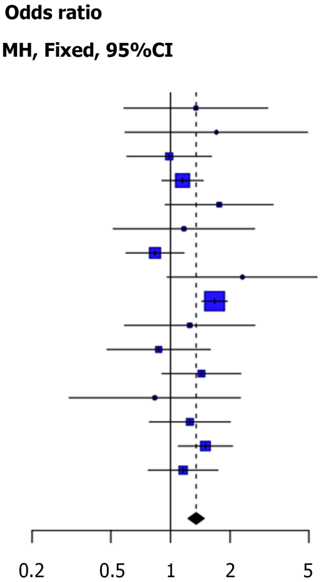


Figure 1 Literature selection flow chart.

Study	Experimental Event	Experimental Total	Control Event	Control Total	Weight	Odds ratio MH, Fixed, 95%CI
Hannan E *et al.* (10)	14	34	25	73	1.3 %	1.3440 [0.5821; 3.1031]
Lagares-Garcia J *et al.* (11)	12	34	8	33	0.7 %	1.7045 [0.5892; 4.9315]
Akiyoshi T *et al.* (12)	22	243	85	926	4.4 %	0.9849 [0.6024; 1.6104]
Merkow RP *et al.* (13)	139	607	220	1072	16.9 %	1.1502 [0.9044; 1.4629]
Choi BJ *et al.* (14)	19	80	35	233	1.9 %	1.7621 [0.9404; 3.3017]
Zhang Q *et al.* (15)	8	48	45	308	1.4 %	1.1689 [0.5136; 2.6601]
Yamashita M *et al.* (16)	48	313	238	1335	10.5 %	0.8349 [0.5955; 1.1705]
Bege T *et al.* (18)	15	24	78	186	0.9 %	2.3077 [0.9608; 5.5426]
Hede P *et al.* (19)	305	1528	669	5147	33.7 %	1.6693 [1.4376; 1.9384]
Makino T *et al.* (21)	19	76	16	76	1.7 %	1.2500 [0.5861; 2.6660]
Bamboat ZM *et al.* (22)	21	68	60	177	3.2 %	0.8713 [0.4776; 1.5896]
Miyamoto Y *et al.* (23)	34	140	77	421	4 %	1.4330 [0.9059; 2.2667]
Bayraktar O *et al.* (24)	7	30	19	71	1.2 %	0.8330 [0.3077; 2.2550]
Poulsen M *et al.* (25)	38	93	118	332	4.2 %	1.2530 [0.7827; 2.0060]
Bell S *et al.* (26)	66	299	185	1165	8.1 %	1.5005 [1.0948; 2.0566]
Peacock O *et al.* (27)	49	161	102	372	5.9 %	1.1581 [0.7719; 1.7375]
Total (95%CI)		**3778**		**11927**	**100.0%**	**1.3473 [1.2269; 1.4794]**



Heterogeneity: Tau^2 = 0.0298; χ^2 = 25.34, df = 15 (*P* = 0.05); I^2 = 41%

Figure 2 Comparison of total complication rates after surgery in patients with colorectal rectal cancer (Obese VS Non-obese).

not only an induction factor for multiple internal medicine diseases but also has many negative effects on surgery[30]. Patients with obesity and CRC are very likely to suffer from severe vascular injury during surgery due to abdominal fat accumulation, mesenteric fat hypertrophy, and narrow space in the abdominal cavity, which makes laparoscopic radical resection difficult. Obesity may also result in

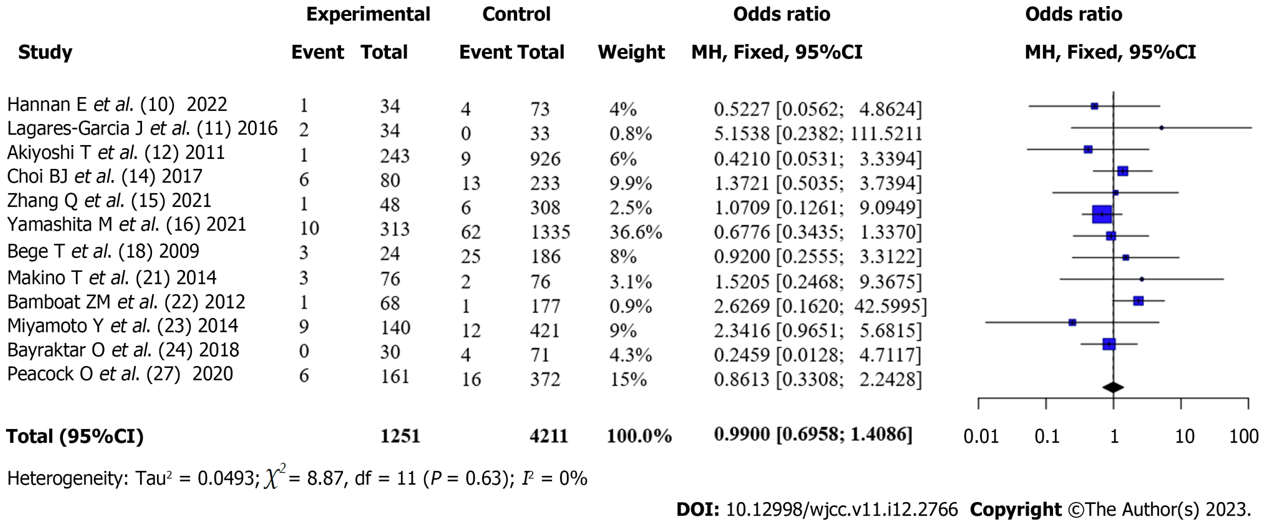


Figure 3 Comparison of the incidence of anastomotic leak after surgery in patients with colorectal rectal cancer (Obese VS Non-obese).

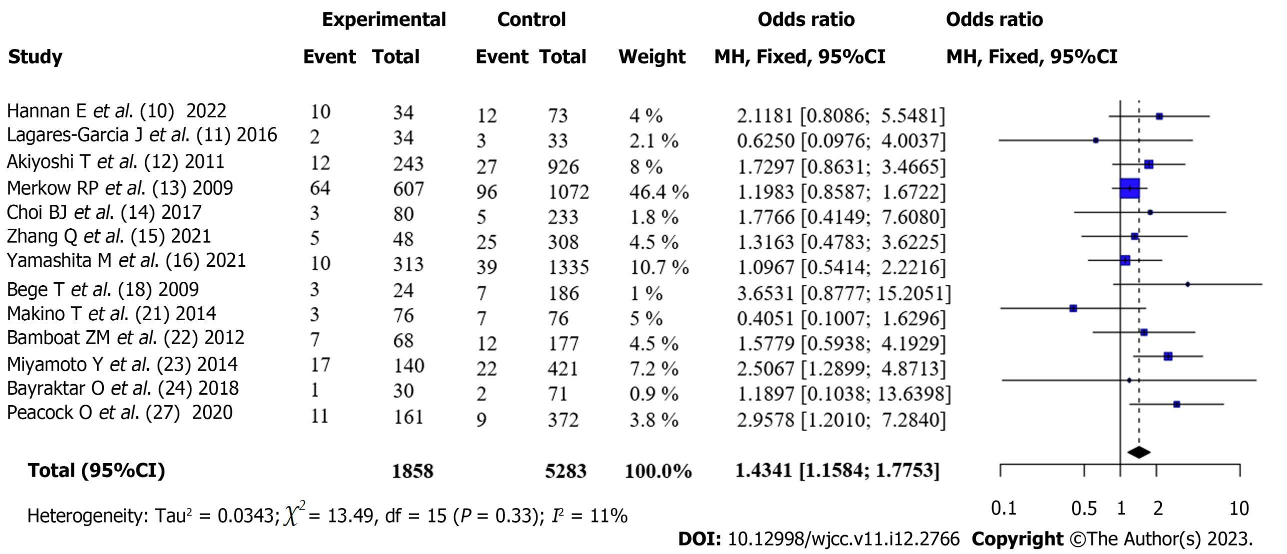


Figure 4 Comparison of surgical site infection incidence in patients with colorectal rectal cancer after surgery (Obese VS Non-obese).

reduced oxygen circulation in wounds, insufficient collagen synthesis, insufficient antibiotic concentration, and impaired immune function, which make patients vulnerable to infection, causing complications, such as incision infection, intestinal obstruction, and anastomotic leak, which prolong the hospitalization time of patients and increase reoperation and mortality rates[4].

In this study, we conducted a regression analysis of the three factors that may affect the results of the meta-analysis, including "*year of publication*," "*sample size*," and "*patient's age*" and found that none of the three factors could affect the results of the meta-analysis. In the stability analysis, we removed the large sample literature that may have affected the results and found that the results were not fundamentally reversed. Publication bias analysis showed that there was no statistically significant asymmetry on either side of the funnel, which indicated that the results of this study were stable and reliable, and the evidence was sufficient.

In this study, we adopted a subgroup analysis approach to explore the sources of heterogeneity in the meta-analysis. As some included studies adopted BMI ≥ 30 kg/m² as the definition of obesity, while others adopted BMI ≥ 25 kg/m² as the definition of obesity, it is very likely that the different BMI definitions of obesity increased the heterogeneity between the articles. The World Health Organization defines grade I obesity as BMI of 30 kg/m² and above, grade II obesity as BMI 35.00–39.99 kg/m², and grade III obesity as BMI ≥ 40.00 kg/m². However, due to the prevalence of obesity among different populations and different understandings of obesity, it is also common to adopt BMI ≥ 25 kg/m² as the definition of obesity in regions (such as some countries in East Asia)[31]. However, in this subgroup analysis, it was found that the heterogeneity between the two standard groups was not statistically significant, which indicates that regardless of which definition standard was adopted, it had little

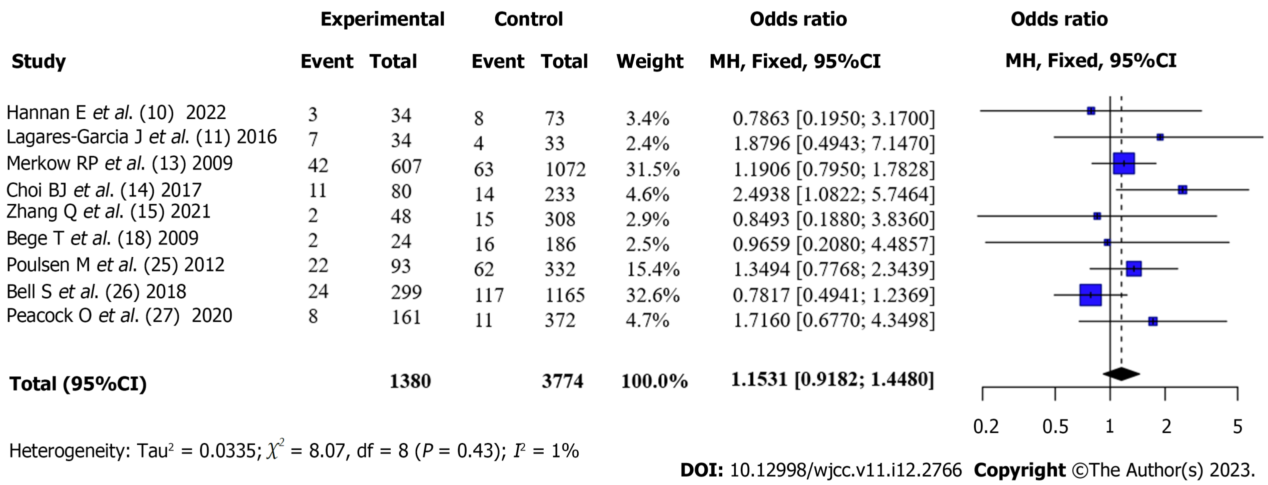


Figure 5 Comparison of the incidence of reoperation after operation in patients with colorectal rectal cancer (Obese VS Non-obese).

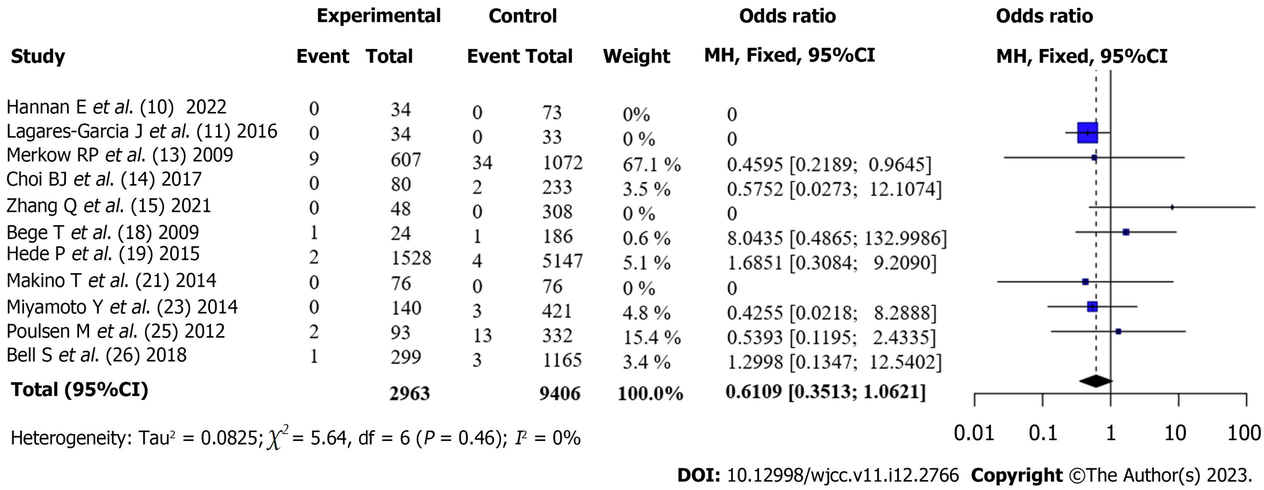


Figure 6 Comparison of mortality rates after surgery in patients with colorectal rectal cancer (Obese VS Non-obese).

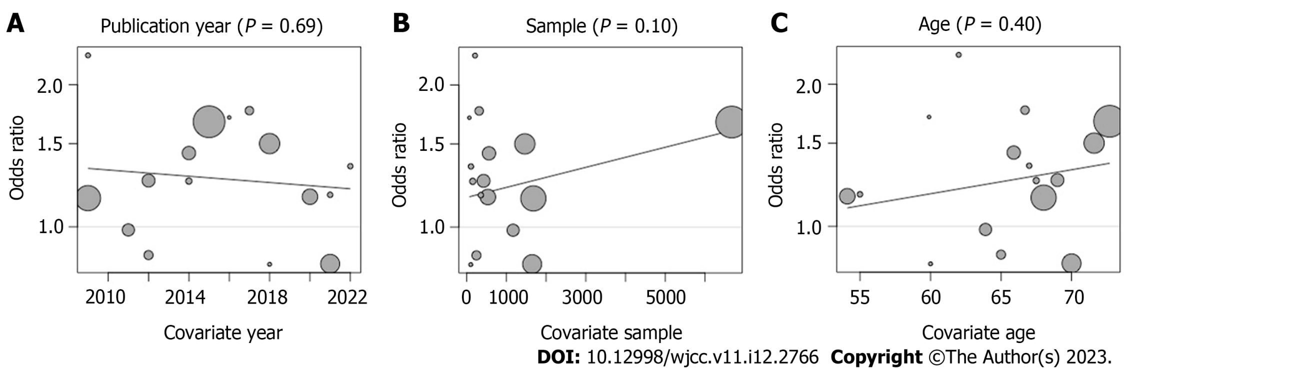


Figure 7 Meta-regression analysis of indicators of postoperative complication rate: Publication year (*P* = 0.69), sample size (*P* = 0.10), and patient age factors (*P* = 0.40).

impact on the results.

We further divided the 16 articles into three regions, namely Europe, America, and Asia, according to the regions where the research was conducted. The subgroup analysis found that the heterogeneity among the groups in the three regions was statistically significant and that the ethnic groups in the three regions had significant effects on the results of the meta-analysis. Studies have suggested that East Asian populations are highly vulnerable to obesity and cardiovascular diseases, which may be related to the surgical prognosis of CRC. However, the specific mechanisms require further investigation.

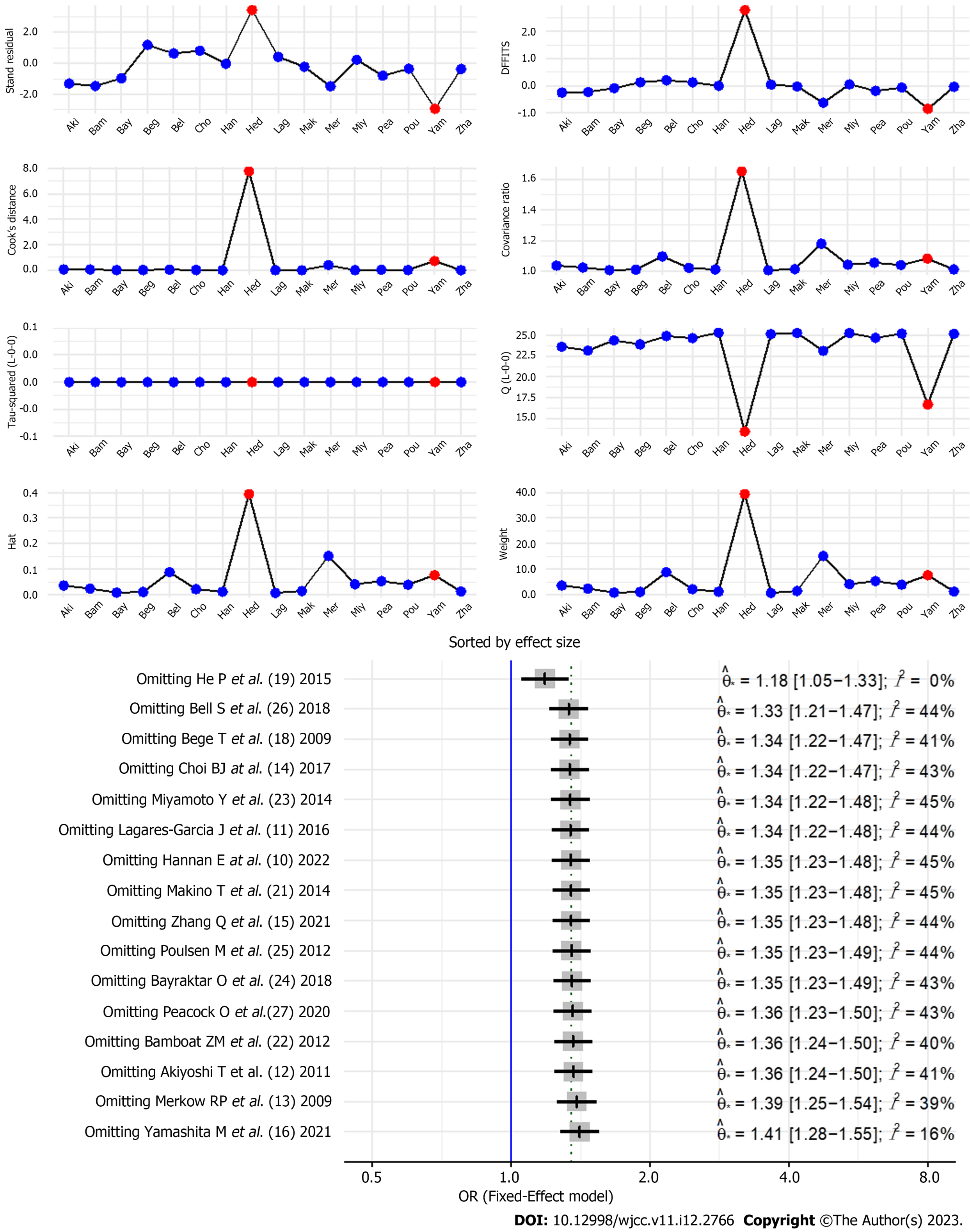


Figure 8 Sensitivity analysis of postoperative complication incidence index.

In recent years, great progress has been made in the robot-assisted radical resection of CRC. Panteleimonitis *et al*[32] in their research compared it with conventional laparoscopic surgery and found that for patients with obesity, robot-assisted colorectal cancer surgery compared with laparoscopic surgery had a shorter hospital stay and a lower readmission rate of 30 d; however, the operation time was longer. This suggests that robot-assisted colorectal cancer surgery may have a better prognosis than laparoscopic surgery for patients with obesity; however, the heterogeneity between the two surgeries was not statistically significant in this subgroup analysis, and there was no significant difference between the total complication rates of the two surgeries. Therefore, the advantages of robot-assisted colorectal surgery require further studies and validation using different research indicators.

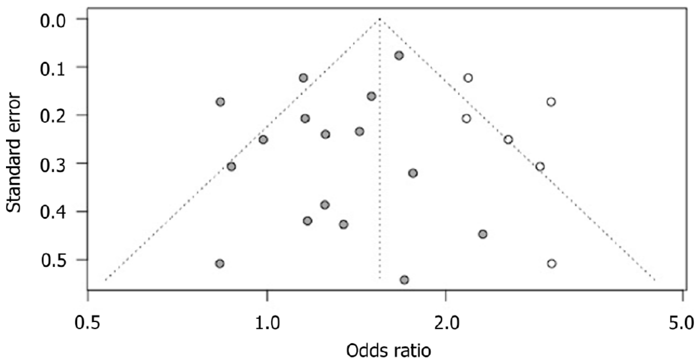


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Figure 9 Trim-filled funnel plot of complication incidence after surgery.

Although the sample size included in this study was sufficient and the results of the sensitivity analysis were stable, there were still some limitations. First, the prognostic indicators were not complete enough, and there were no informative indicators, such as the patient's hospital stay, postoperative urinary tract infection, and acute renal failure; Second, the included studies were observational cohort studies, and process control for the studies was insufficient. Some patients who switched to laparotomy when laparoscopic surgery was ineffective were considered to have undergone laparoscopic surgery; and Third, some patients with benign tumors in some studies were included in this meta-analysis, and there may be some bias. Thus, further research on this topic is warranted.

CONCLUSION

Obesity (excessive BMI) can increase the overall complication and SSI rates of patients with CRC after radical surgery but has no significant effect on the incidence of anastomotic leak, reoperation rate of patients, and short-term mortality rate.

ARTICLE HIGHLIGHTS

Research background

Obesity is a state in which excess heat is converted into excess fat, which accumulates in the body and may cause damage to multiple organs of the circulatory, endocrine, and digestive systems. Studies have shown that the accumulation of abdominal fat and mesenteric fat hypertrophy in patients with obesity makes laparoscopic surgery highly difficult, which is not conducive to operation and affects patient prognosis. However, there is still controversy regarding these conclusions.

Research motivation

Research on the state of obese patients converting excess heat into excess fat, which can accumulate in the body and cause damage to multiple organs of the circulatory, endocrine, and digestive systems. Abdominal fat accumulation and mesenteric fat in obese patients make laparoscopic surgery difficult, detrimental to surgery, and affecting patient prognosis.

Research objectives

To explore the relationship between body mass index (BMI) and short-term prognosis after surgery for colorectal cancer.

Research methods

PubMed, Embase, Ovid, Web of Science, CNKI, and China Biology Medicine Disc databases were searched to obtain relevant articles on this topic. After the articles were screened according to the inclusion and exclusion criteria and the risk of literature bias was assessed using the Newcastle-Ottawa Scale, the prognostic indicators were combined and analyzed.

Research results

A total of 16 articles were included for quantitative analysis, and 15588 patients undergoing colorectal cancer surgery were included in the study, including 3775 patients with obesity and 11813 patients without obesity. Among them, 12 articles used BMI ≥ 30 kg/m^2 and 4 articles used BMI ≥ 25 kg/m^2 for the definition of obesity. Four patients underwent robotic colorectal surgery, whereas 12 underwent conventional laparoscopic colorectal resection. The quality of the literature was good. Meta-combined analysis showed that the overall complication rate of patients with obesity after surgery was higher than that of patients without obesity [OR = 1.35, 95%CI: 1.23-1.48, Z = 6.25, P < 0.0001]. The incidence of anastomotic leak after surgery in patients with obesity was not significantly different from that in patients without obesity [OR = 0.99, 95%CI: 0.70-1.41), Z = -0.06, P = 0.956]. The incidence of surgical site infection (SSI) after surgery in patients with obesity was higher than that in patients without obesity [OR = 1.43, 95%CI: 1.16-1.78, Z = 3.31, P < 0.001]. The incidence of reoperation in patients with obesity after surgery was higher than that in patients without obesity; however, the difference was not statistically significant [OR = 1.15, 95%CI: 0.92-1.45, Z = 1.23, P = 0.23]; Patients with obesity had lower mortality after surgery than patients without obesity; however, the difference was not statistically significant [OR = 0.61, 95%CI: 0.35-1.06, Z = -1.75, P = 0.08]. Subgroup analysis revealed that the geographical location of the institute was one of the sources of heterogeneity. Robot-assisted surgery was not significantly different from traditional laparoscopic resection in terms of the incidence of complications.

Research conclusions

Obesity increases the overall complication and SSI rates of patients undergoing colorectal cancer surgery but has no influence on the incidence of anastomotic leak, reoperation rate, and short-term mortality rate.

Research perspectives

Colorectal rectal cancer (CRC) is a common malignant tumor and ranks third in the incidence of malignant tumors worldwide; it is second only to lung and breast cancers, with a mortality rate of approximately 8% of all malignant tumors. Similar to other malignancies, the cause of CRC remains unclear and can occur anywhere in the colon or rectum; however, it is most common in the rectum and sigmoid colon, whereas the remainder is found sequentially in the cecum, ascending, descending, and transverse colon. Surgical treatment still remains the radical treatment of CRC, and radical resection of intestinal cancer is defined as the removal of macroscopic tumors, including primary and draining lymph nodes. Although the lesion can be removed during surgery, complete removal is still difficult in patients with extensive local disease. For patients with advanced CRC, the tumor size is relatively large, with high vascular variation, and the visual field of laparotomy is poor, making the surgery difficult. In recent years, laparoscopy has emerged as an auxiliary operation with the advantages of a small surgical wound, an open operation field, and rapid postoperative recovery. It has been gradually applied to radical resection of CRC and has achieved an ideal clinical effect.

FOOTNOTES

Author contributions: Li Y conceptualized and designed the study, and collected and compiled the data; Jiang J provided administrative support; Li Y provided the research materials and patients; Deng JJ and Jun Jiang analyzed and interpreted the data; and all authors wrote and approved the final version of the manuscript.

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