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Postoperative Infection after Colorectal Surgery: Subanalysis of Data from the 2015 Japan Postoperative Infectious Complications Survey

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Background: Most surveillance programs for postoperative infection focus on surgical site infections (SSI). However, postoperative remote infections are of emerging clinical importance. Using data from a multicenter survey administered to patients who underwent gastrointestinal surgery, we investigated the incidence of SSI and remote infection after colorectal surgery.

Methods: From September 2015 through March 2016, 1,724 patients underwent colorectal surgery in 28 affiliated centers in Japan. We retrospectively recorded patient age, sex, surgical site, surgical approach, wound classification, performance status at discharge, and postoperative infection status.

Results: Postoperative infection was noted in 236 (13.7%) patients; 150 and 86 patients underwent colon and rectal surgeries, respectively (incidence of postoperative infection: 13.7% and 14.8%). The incidence of postoperative infection was significantly lower after laparoscopic surgery than after open surgery, in colon and rectal surgery ($p < 0.001$). Among patients with postoperative infections, 211 (89.4%) had a single infection and 25 (10.6%) had multiple infections. Among patients with a single postoperative infection, SSI and remote infection occurred in 143 (60.6%) and 68 (28.8%) patients, respectively. The most common multiple postoperative infections were "incisional and organ/space SSIs" and "organ/space SSI and bacteremia of unknown origin" (n = 3 each).

Conclusions: This study revealed the prevalence distributions for postoperative SSI and remote infections. Because of the substantial effect of remote infections on patient quality of life and the associated social burden, prospective periodic surveillance for SSI and remote infection is necessary for careful evaluation and prevention. (J Nippon Med Sch 2020; 87: 204–210)

Key words: postoperative infection, surgical site infection, remote infection, colorectal surgery

Introduction

Studies of postoperative infection have predominantly investigated the incidence and factors associated with postoperative surgical site infection (SSI). In the United States and Japan, SSI incidence is gradually decreasing, particularly after colon and gastrointestinal surgeries[1–4]. However, remote infection at distant sites is also a concern, as it can affect outcomes and quality of life (QOL). Interest in remote infection is growing, and the incidence and factors associated with postoperative respiratory tract infection, a major remote infection, have been reported[5].

Remote infection after colorectal cancer surgery has also been studied[6]. SSI and remote infection may occur alone or at the same or different times; therefore, both must be considered when attempting to accurately determine patient prognosis and QOL and the associated so-

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cioeconomic burden. Thus, surveillance and feedback on the overall state of postoperative infections are essential. To address this need, the Japan Society of Surgical Infection created the Japan Postoperative Infectious Complications Survey, in 2015, to perform a multicenter joint study of the incidence of infection after digestive surgery[7]. The present report is a subanalysis of the data for colorectal surgery.

Materials and Methods

Patients and Data Registration

Patient data were obtained from 28 healthcare facilities affiliated with the member teaching institutions of the Japan Society of Surgical Infection, namely, 16 university hospitals, 11 general hospitals, and one cancer center (see Acknowledgements for list). The survey period was September 2015 through March 2016, and data for 6,582 patients who underwent digestive surgery in these centers were retrospectively collected. The data were encrypted to anonymize patient identities and then encoded online (https://entry3.eps.co.jp/infection_svlce/PasswardReSet.aspx). The date of surgery and patient age group were the only details entered directly; all other items were encoded by using a pulldown menu. This subanalysis evaluated data from patients who underwent colorectal surgery.

Definitions of Postoperative Infections

Remote infection was categorized as respiratory tract infection (RTI), urinary tract infection (UTI), catheter-related blood stream infection (CR-BSI), antibiotic-associated diarrhea (AAD), drain infection, and bacteremia of unknown origin (BUO), according to the National Healthcare Safety Network infection criteria[8]. RTI was defined as new onset of infiltration on chest radiography, fever and cough, and leukopenia (<4,000 cells/mm^3) or leukocytosis (≥12,000/mm^3). UTI was characterized by fever (>38°C) without other causes, urinary urgency, urinary frequency, dysuria, suprapubic tenderness, and urine culture with 10^5 colony-forming units/mL of bacteria, or a physician diagnosis of UTI. CR-BSI was defined as ≥1 positive blood culture, identification of a pathogenic organism in the catheter, and absence of infection by the organism detected in the blood culture in sites other than the catheter. AAD was characterized by diarrhea and *Clostridioides difficile* (C. difficile)toxin or positive stool culture with a virulent strain of *C. difficile* or pseudomembrane findings on colonoscopy[9]. Drain infection was defined as infection secondary to content reflux from drains, not residual abscesses, identified as drain infection in a general assessment by a physician. BUO was characterized by one or more of the following: fever (> 38°C) with no other cause, hypotension (systolic pressure ≤90 mm Hg) or oliguria (<20 mL/h), and physician diagnosis of sepsis, regardless of blood culture results.

SSI was classified as incisional SSI and organ/space SSI. The wound classification status of patients with postoperative infection was categorized as class I (clean), II (clean-contaminated), III (contaminated), or IV (dirty-infected), in accordance with the Centers for Disease Control and Prevention definitions and wound classifications[10]. Occurrence of postoperative infection was monitored for 30 postoperative days. Patient wound classification, sex, age group, and each incident postoperative infection were analyzed in relation to surgical site and whether affected patients underwent laparoscopic or open surgeries. Patient performance status[11] at discharge was considered an indicator of postoperative infection outcome.

This study was performed in accordance with the Helsinki Declaration and was approved by the ethics committee of the Nippon Medical School Tama Nagayama Hospital (Approval No. 625). All patients consented to the use and analysis of their data.

Statistical Analysis

Bell Curve for Excel (Social Survey Research Information Co., Tokyo, Japan) was used for all statistical analyses. We used the Fisher exact probability test, and a *P* value of <0.05 was considered to indicate statistical significance.

Results

Medical records indicated that 1,724 patients underwent colorectal surgery (1,143 colon surgeries and 581 rectal surgeries). Overall, postoperative infections occurred in 236 (13.7%) patients: 154 men and 82 women (65.3% and 34.7%, respectively). The median age for patients with postoperative infection was 60 years (range: 20-90 years). Regarding colon surgery, postoperative infection occurred in 75 (20.5%) patients who underwent open surgery and in 75 (9.7%) patients who underwent laparoscopic surgery. Regarding rectal surgery, postoperative infection occurred in 42 (23.1%) patients who underwent open surgery and in 44 (11.0%) patients who underwent laparoscopic surgery. The incidence of postoperative infection was significantly lower for laparoscopic surgery than for open surgery for both colon and rectal surgery ($p < 0.001$; **Table 1**).

Among the 236 patients with postoperative infection, class II was the most common category of wound contamination (210 [89.0%] patients), and the most common performance status score at discharge was 0 (132 [55.9%] patients); however, 5 (2.1%) patients died (performance status: 5) (**Table 2**).

Single postoperative infection occurred in 211 (89.4%) patients, and multiple postoperative infections occurred in 25 patients-10.6% of all patients with postoperative infection. The details of patients with single postoperative infections are shown in **Table 3**. SSI and remote infection occurred in 143 (60.6%) and 68 (28.8%) patients, respectively. Organ/space SSI was the most common single postoperative infection (75 [35.5%] patients), and incisional SSI was the second most common type (68 [32.2%] patients). Among 25 patients with multiple postoperative infections, most had two infections (21 [84.0%] patients); however, one patient (4.0%) had five postoperative infections (**Table 4**). **Table 5** shows the details of patients with multiple postoperative infections. The most common multiple postoperative infections were "incisional and organ/space SSIs" and "organ/space SSI and BUO" (n=3 each) (**Table 5**).

The incidence rates for individual postoperative infection in relation to surgical approach in colon and rectal

Table 1 Prevalence of postoperative infection according to surgical site and surgical approach

Surgical site and approach	Postoperative infection (%)	P value
Colon (n=1,143)		
Open (n=366)	75 (20.5)	<0.001
Laparoscopic (n=777)	75 (9.7)	
Rectum (n=581)		
Open (n=182)	42 (23.1)	<0.001
Laparoscopic (n=399)	44 (11.0)	
Total (n=1,724)	236 (13.7)	

Table 2 Wound classification and performance status at discharge in patients with postoperative infections

Total (n=236) (%)		Colon (n=150)		Rectum (n=86)	
		Open (n=75)	Laparoscopic (n=75)	Open (n=42)	Laparoscopic (n=44)
Wound classification					
II	210 (89.0)	58	72	37	43
III	7 (3.0)	3	2	2	0
IV	19 (8.1)	14	1	3	1
Performance status at discharge					
0	132 (55.9)	32	52	18	30
1	69 (29.2)	20	17	21	11
2	11 (4.7)	5	3	3	0
3	11 (4.7)	6	2	0	3
4	8 (3.4)	8	0	0	0
5	5 (2.1)	4	1	0	0

Table 3 Details of patients with single postoperative infection

Total (n=211) (%)		Colon (n=135)		Rectum (n=76)	
		Open (n=68)	Laparoscopic (n=67)	Open (n=37)	Laparoscopic (n=39)
SSI 143 (67.8)					
Organ/space SSI	75 (35.5)	23	20	18	14
Incisional SSI	68 (32.2)	22	24	9	13
RI 68 (32.2)					
AAD	18 (8.5)	3	9	4	2
UTI	17 (8.1)	2	5	5	5
CR-BSI	13 (6.2)	5	5	1	2
RTI	12 (5.7)	8	3	0	1
Drain	4 (1.9)	1	1	0	2
BUO	4 (1.9)	4	0	0	0

SSI: surgical site infection, RI: remote infection, AAD: antibiotic-associated diarrhea, UTI: urinary tract infection, CR-BSI: catheter-related blood stream infection, RTI: respiratory tract infection, Drain: drain infection, BUO: bacteremia of unknown origin

Table 4 Details of patients with multiple postoperative infections

	Total	Colon (n=15)		Rectum (n=10)	
	(n=25) (%)	Open (n=7)	Laparoscopic (n=8)	Open (n=5)	Laparoscopic (n=5)
Two PIs	21 (84.0)	3	8	5	5
Three PIs	2 (8.0)	2	0	0	0
Four PIs	1 (4.0)	1	0	0	0
Five PIs	1 (4.0)	1	0	0	0

PI: postoperative infection

Table 5 Detailed combination in patients with multiple postoperative infections

Two PIs (n=21)	
Organ/space SSI + Incisional SSI	3
Organ/space SSI + BUO	3
Organ/space SSI + UTI	2
Organ/space SSI + CR-BSI	2
Organ/space SSI + AAD	2
Incisional SSI + CR-BSI	2
Incisional SSI + UTI	2
Incisional SSI + AAD	2
Incisional SSI + RTI	1
CR-BSI + RTI	1
RTI +AAD	1
Three PIs (n=2)	
Organ/space SSI + CR-BSI + RTI	1
Organ/space SSI + incisional SSI + UTI	1
Four PIs (n=1)	
Organ/space SSI + Incisional SSI + CR-BSI + UTI	1
Five PIs (n=1)	
BUO + CR-BSI + UTI + RTI + AAD	1

PI: postoperative infection, SSI: surgical site infection, RI: remote infection, AAD: antibiotic-associated diarrhea, UTI: urinary tract infection, CR-BSI: catheter-related blood stream infection, RTI: respiratory tract infection, Drain: drain infection, BUO: bacteremia of unknown origin

surgeries are shown in **Figure 1, 2**. Regarding colon surgery, the prevalence of all postoperative infections was lower for laparoscopic surgery than for open surgery; the differences were significant for incisional SSI, organ/space SSI, RTI, and BUO (P = 0.04, 0.008, <0.001, and 0.01, respectively) (**Fig. 1**). Regarding rectal surgery, laparoscopic surgery was associated with a lower incidence of postoperative infection for incisional SSI, organ/space SSI, UTI, and AAD, but the difference was significant only for organ/space SSI (P = 0.002) (**Fig. 2**).

Discussion

This subanalysis of data from the 2015 Japan Postoperative Infectious Complications Survey is, to our knowledge, the first report to clarify the overall prevalence of postoperative infection, including SSI and remote infection, after colorectal surgery, in a large sample (N=1,724). The overall incidence of postoperative infection was 13.7%. Among the 236 patients with postoperative infection, 211 (89.4%) had a single infection and 25 (10.6%) had multiple infections. SSI and remote infections in patients with single postoperative infection occurred in 143 (60.6%) and 68 (28.8%) patients, respectively. The incidence of postoperative infection was significantly lower for laparoscopic surgery than for open surgery.

Since the publication of the Guidelines for the Prevention of Surgical Site Infections by the Centers for Disease Control and Prevention[10], SSI surveillance systems have been implemented, and nationwide SSI surveillance has been performed, in the United States and Japan. Mortality after colorectal cancer differs greatly between the United States (3.3%)[12] and Japan (0.4%)[13]. Although the current cohort included a larger proportion of high-risk patients with benign diseases, such as diverticular perforation, than did the above-mentioned report, the mortality rate of 0.3% was consistent. The greater number of advanced centers registered as postoperative infection prevention programs might have contributed to the low mortality rate.

Studies frequently classify and compare outcomes of postoperative surveillance in relation to surgical site and surgical approach because these variables could greatly affect outcomes and social burdens. The results might aid in development of detailed preventive measures against postoperative infection. A previous report confirmed the superiority of laparoscopic surgery in relation to SSI occurrence[14]; however, the association of laparoscopic surgery with the incidence of remote infection is unknown. An advantage of laparoscopic surgery in relation to SSI occurrence was also noted in the current study. Furthermore, consistent advantages were seen in the incidence of remote infection, especially after colon surgery.

The present incidence rate for remote infection was lower than that for SSI (3.9% vs. 8.3%, respectively);

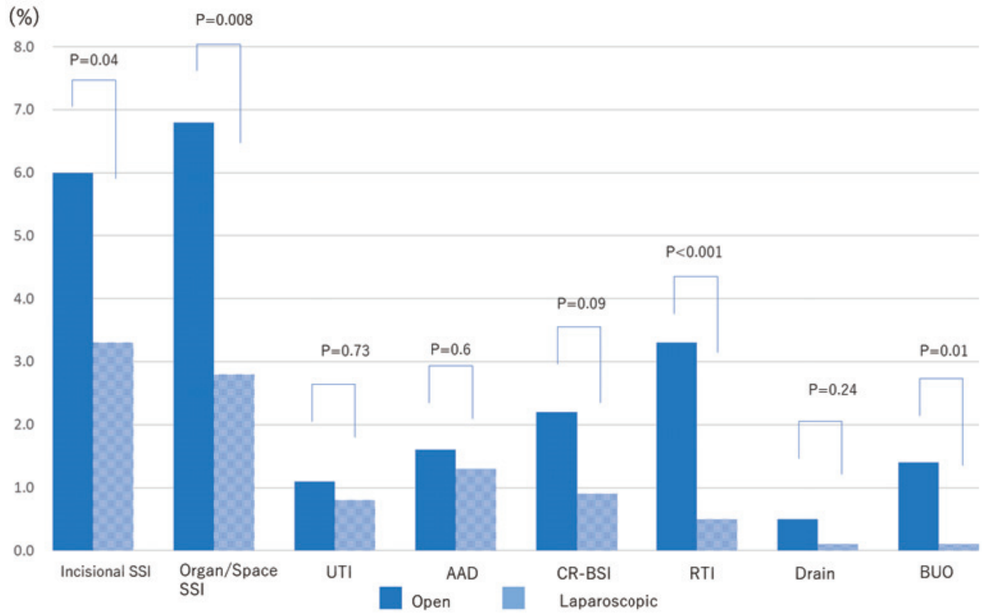

Fig. 1 Details of postoperative infection in patients undergoing colon surgery, by surgical approach.

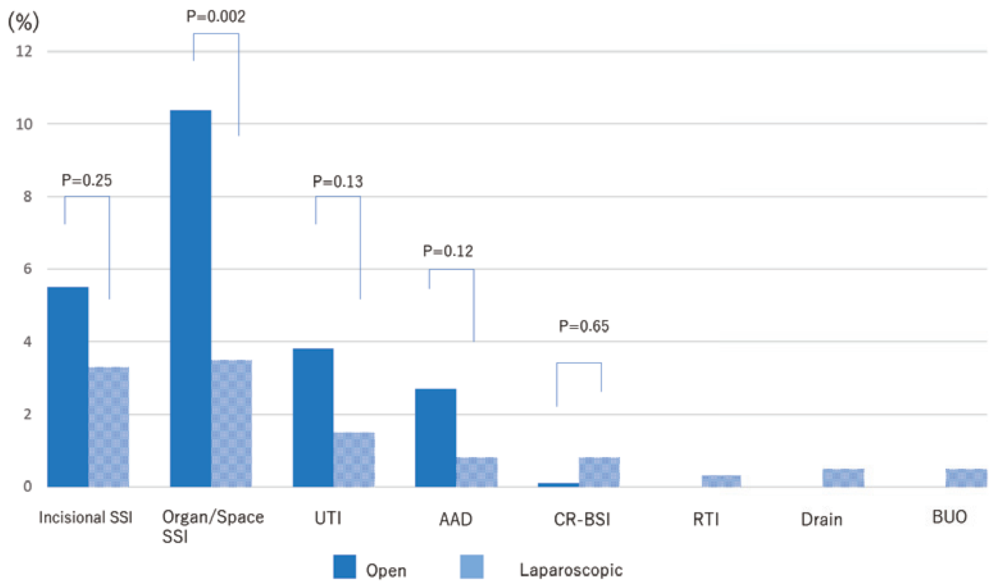

Fig. 2 Details of postoperative infection in patients undergoing rectal surgery, by surgical approach.

however, some remote infections, such as pneumonia[15] and sepsis, can adversely affect patient QOL and increase medical expenses to an extent equal to or greater than SSI[16]. Therefore, surveillance for SSI only is not sufficient when analyzing the overall burden of postoperative infection.

Studies of the characteristics of individual remote infections in colorectal surgery indicate that AAD occurs primarily as a *C. difficile* infection of the gastrointestinal tract and, among gastrointestinal surgeries, incidence was reported to be higher after colorectal surgery[17–22]. Yamamoto et al.[21] reported a 4.3% *C. difficile* infection incidence rate, and Yasunaga et al.[18] reported an incidence of 0.37% after colorectal cancer surgery. The present *C. difficile* infection incidence was lower (0.3%; n=6), perhaps because our data were collected from member teaching institutions of the Japan Society of Surgical Infection, where preventive and symptomatic measures regarding infection are likely more rigorous. The risk of *C. difficile* infection associated with colorectal surgery was reported to significantly higher with diarrhea, particularly in patients with leakage in rectal surgery[21]; thus, precautions are necessary to prevent development of secondary organ/space SSI.

RTI in colorectal surgery is a risk factor for operative mortality[15]. Previous studies of the relationships between RTI incidence and associated risk factors in colorectal surgery[6,22,23] reported RTI incidences of 2.9%[6], 5.2%[22], and 6.2%[23]. In these reports, RTI appeared be related to decreased perioperative nutrition, immunity, and respiratory function. RTI was noted in 13 (0.9%) of the present patients, and RTI incidence was significantly lower in patients who underwent laparoscopic colon surgery than in those who underwent open colon surgery. Although few high-quality studies have investigated RTI in colorectal surgery, a study of 384 patients[24] reported that postoperative pulmonary infection occurred in only 1.8% of patients who underwent laparoscopic surgery and 3.5% of those who underwent open surgery. Schwenk[25] reported that laparoscopic surgery was not superior in relation to RTI incidence in a meta-analysis. Clinical guidelines have shown that use of anesthetics to control pain and respiration via transnasal gastric tubes can inhibit RTIs[26].

UTIs occurred in 24 (1.4%) of the present patients and was more frequent after rectal surgery than after colon surgery. These UTIs were presumably caused by nerve dissection around the pelvic viscera, which can cause nerve disorders that result in incontinence, long-term urinary catheter placement, and reflux. Although the difference was not significant in the present study, UTIs were more frequent after open colon and rectal surgery; thus, early removal of catheters in less-invasive laparoscopic surgeries may prevent UTIs.

The following are limitations in our study: (1) The data may have been biased because they were provided by educational institutions that emphasize the importance of measures against postoperative infection. (2) The data collected from patients were limited. The absence of detailed information on patient background and surgical variables hampered our ability to identify plausible mechanisms leading to postoperative infection.

In conclusion, this study revealed the overall distribution of postoperative infection prevalence, including both SSI and remote infection. Because of the substantial adverse effects of remote infection on patient QOL and the associated social burdens, prospective periodic surveillance focused on SSI and remote infection is necessary for detailed evaluation and prevention.

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Conflict of Interest: The authors declare no conflicts of interest.

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