

Surgical site infection among patients after colorectal cancer surgery

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Zbigniew Banaszekiewicz^{1ABCDE}, Katarzyna Cierzniańska^{2BF}, Krzysztof Tojek^{1BE},
Elżbieta Kozłowska^{2BE}, Arkadiusz Jawień^{1ABF}

¹Oddział Kliniczny Chirurgii Ogólnej, Gastroenterologicznej, Kolorektalnej i Onkologicznej Katedry i Kliniki Chirurgii Naczyniowej i Angiologii, Wydział Lekarski Collegium Medicum w Bydgoszczy, niwersytet Mikołaja Kopernika w Toruniu, Kierownik: prof. dr hab. n. med. Arkadiusz Jawień

²Zakład Pielęgniarstwa Chirurgicznego i Leczenia Ran Przewlekłych, Wydział Nauk o Zdrowiu Collegium Medicum w Bydgoszczy, Uniwersytet Mikołaja Kopernika w Toruniu, Kierownik: prof. dr hab. Maria Szewczyk

Article history: Received: 08.08.2016 Accepted: 06.12.2016 Published: 28.02.2017

ABSTRACT:

Introduction: Operative field infection appears among 2,5–22,3% of patients after surgery. It is an indicator of a quality of treatment on operative wards and has significant influence on its cost.

Material and methods: The analysed group were patients, who had operative field infection in 30-days observation with colorectal cancer in one clinic. The criteria, that were excluded from the survey were: lack of trustworthy treatment documentation and the death of patient before 30th day after the surgery without operative field infection. The statistic analysis was carried with the usage of Statistica 10.

Results: Postoperative complications appeared among 262/16,6% of patients. The most common complication was operative field infection (198/12,52%). It was stated that appearance of this complication depended on how advanced the cancer was, age, comorbidities (diabetes, and cardiological diseases). Moreover, it was stated that this complication appeared significantly more often among patients with surgery in a matter of urgency and among which stoma had to be revealed. However, there was no dependence stated on appearance of this complication with patients' sex and the localisation of a tumour.

Conclusion: Among patients after colorectal surgery, the biggest threat of surgical site infection was among patients over 75 years, with diabetes and cardiological diseases, with advanced cancer, with surgery in a matter of urgency and among patients with stoma (especially colostomy).

KEYWORDS:

surgical site infection, colorectal cancer

INTRODUCTION:

Surgical site infection (SSI) is one of the most common hospital-acquired infections among surgical patients. The proportion of SSI reflects the quality of surgical treatment and greatly impacts its total cost [1]. Such complication occurs in 2.5-22.3% of cases and is more frequently observed in patients who underwent surgery of the colon [2-9]. With the Implementing Decision no 2012/506/UE of 08.08.2012 the European Commission defined infection of a surgical site (SSI) as: superficial incisional surgical site infection (SSI-S), deep incisional surgical site infection (SSI-D), or surgical site infection - organ/space (SSI-O). Superficial incisional surgical site infection (SSI-S) develops within 30 days from surgery and involves the

skin and subcutaneous tissue at the site of incision alone. Diagnostic criteria include: presence of one of the signs of infection (tenderness, swelling, reddening, elevated skin temperature), purulent discharge from the incision site, positive result of microbiological examination of material collected or after surgical opening of the incision site [10,11].

The incidence of SSI depends on patient-related factors (biological age, general condition, nutritional status, comorbidities), environmental factors (conditions at the hospital, quality of surgical equipment and instruments, length of hospital stay), as well as factors related to the surgical procedure itself. The most important factors associated with surgical procedure include its type (urgent vs. elective) and the type of operating field. Depending on the type

of operating field we may distinguish various types of wounds: clean, clean-contaminated, contaminated, and dirty. A wound after colorectal cancer surgery is always considered contaminated due to opening of gastrointestinal tract. In elective surgery the wound is usually clean-contaminated, while in patients operated on due to complications of the disease it is often contaminated or dirty [12]. SSI was observed in 30-60% of patients after colorectal surgery, but implementation of antibiotic prophylaxis reduced the rate of this complication by about 75% [13,14]. Recent reports describe the benefits of using surgical sutures impregnated with antibacterial agents and perioperative use of probiotics to reduce the rate of infectious complications among patients after colorectal cancer surgery by restoring microbiological balance that had been disrupted by the cancer and perioperative stress [8,15,16,17,18].

AIM

The aim of the paper was to identify the risk factors and their impact on the incidence of SSI based on a retrospective analysis of patients who had undergone surgery due to colorectal cancer in a single center between 1994 and 2016.

MATERIAL AND METHODS

Retrospective analysis encompassed the procedures and postoperative courses of consecutive patients operated on due to the first diagnosis of colorectal cancer in a single center between February 1994 and February 2016. This group did not include patients undergoing neoadjuvant chemotherapy, while 32/2.02% of patients were subject to neoadjuvant radiotherapy (5 fractions, 5Gy each). Large bowel was mechanically prepared for elective surgery one day prior to the procedure. Study end point consisted of SSI up to 30th day of follow-up or earlier for those patients who died while presenting signs of SSI. Diagnosis of SSI was consistent with the definition of healthcare associated infection (HAI) established by a group of experts from the European Centre for Disease Prevention and Control (ECDC) in 2009 [19]. Patients who died within 30 days after surgery without signs of SSI as well as patients with incomplete hospital or ambulatory documentation were excluded from the study. Patients were divided into two groups depending on age: < 75 years old and > 75 years old. Comorbidities diagnosed before surgical treatment were allotted into four groups: cardiovascular disease, chronic pulmonary disease, chronic kidney disease, and diabetes. Patients were divided with regard to cancer staging into those with low (stage I and II) and high (stage III and IV) degree of disease progression. Pearson's Chi² test was applied to independent variables. Analysis of qualitative variables influencing the occurrence of

Tab. I. Postoperative complications in patients with colorectal cancer

| COLORECTAL CANCER | NO. | % |
|---|------|------|
| Operated patients | 1581 | 100 |
| Patients with postoperative complications | 262 | 16,6 |
| SSI-S - surgical site infection - superficial | 102 | 6,45 |
| SSI-D – surgical site infection – deep incisional | 34 | 2,15 |
| SSI-O – surgical site infection – organ/space | 62 | 3,92 |

SSI was conducted using log-linear analysis. Odds ratio (OR) and 95% confidence intervals were calculated. Odds ratio (OR) was used to compare the risk of SSI. Statistical analysis was conducted using Statistica 10 software.

RESULTS

One thousand and eighty-one patients diagnosed with colorectal cancer were operated on in the period from February 1994 to February 2016. Postoperative complications were diagnosed in 262/16.6% of cases. SSI was diagnosed in 198/12.52% of cases. In 106/6.70% it was the only complication, while the remaining patients suffered from other kinds of postoperative infections (urinary tract infection in 122/7.72%, respiratory tract infection – 101/6.39%). In about a half of patients diagnosed with SSI (102/6.45%) the infection was superficial, in 34/2.15% - deep, and in 62/3.92% infection involved an organ/space (Table 1).

Univariate analysis revealed no differences with regard to incidence of SSI depending on patient sex or tumor location. Every fourth patient was over 75 years old (432/27.32%) and SSI was significantly more common in this group of patients (18.52% vs. 10.27%; $p=0.0001$). There were 637/40.29% of patients with cardiovascular disease and 294/18.60% with diabetes in the analyzed group, while both conditions coexisted in 74 patients. SSI occurred significantly more frequently in patients with cardiovascular disease and diabetes (14.60% vs. 11.12%, $p=0.04$ and 16.33% vs. 11.66%, $p=0.029$, respectively). The difference was even greater in patients with both comorbidities. SSI was twice as frequent in this group (24.32% vs. 11.94%, $p=0.002$) (Table 2).

Every fifth patient (306/19.35%) underwent to urgent surgery due to cancer complications. Patients with stage III and stage IV disease comprised almost half of the group (750/47.44%). SSI occurred significantly more often after urgent procedures, among patients with highly advanced disease, and after non-resection surgery (respectively: 24.84% vs. 9.57%, $p<0.0001$; 15.73%

Tab. II. Comparative analysis of the incidence of SSI

| COLORECTAL CANCER | | SSI+ | SSI- | P |
|-----------------------|--------------------------|--------------|---------------|---------|
| Sex | Women | 99 (12,53%) | 691 (87,47%) | NS |
| | Men | 99 (12,52%) | 692 (87,48%) | |
| Age (years) | below 75 years old | 118 (10,27%) | 1031 (89,73%) | <0,0001 |
| | over 75 years old | 80 (18,52%) | 352 (81,48%) | |
| Comorbidities | | | | |
| | cardiovascular disease + | 93 (14,60%) | 544 (85,40%) | 0,04 |
| | cardiovascular disease - | 105 (11,12%) | 839 (88,88%) | |
| | diabetes- | 150 (11,66%) | 1137 (88,34%) | 0,029 |
| | diabetes + | 48 (16,33%) | 246 (83,67%) | |
| | respiratory disease - | 289 (12,44%) | 1330 (87,56%) | NS |
| | respiratory disease + | 9/14,52% | 53 (85,48%) | |
| | kidney disease - | 191 (12,53%) | 1333 (87,47%) | NS |
| | kidney disease + | 7 (12,28%) | 50 (87,72%) | |
| | two conditions - | 180 (11,84%) | 1327 (88,96%) | 0,002 |
| | two conditions + | 18 (24,32%) | 56 (75,68%) | |
| Tumor location | | | | |
| | Colon | 124 (12,85%) | 841 (87,15%) | NS |
| | Rectum | 74 (12,01%) | 542 (87,99%) | |

vs. 9.63%, $p < 0.001$; 17.37% vs. 9.57%, $p = 0.03$). Despite large number of patients with advanced disease and a large proportion of patients (19.35%) operated on due to complications of colorectal cancer, resection was performed in 1391/87.98% of patients and the incidence of SSI was significantly lower in this group (9.57% vs. 17.37%). Following the results of histopathological examination it was concluded that in 1258/79.57% of cases these procedures were radical. SSI occurred more often in patients after non-radical compared to radical procedures (15.48% vs. 11.76%), but the difference failed to reach statistical significance ($p = 0.07$).

Every third patient (528/33.40%) had a stoma formed during surgery. SSI was significantly more frequent in this group of patients (15.53% vs. 11.02%, $p = 0.01$). Colostomy was performed most often (404/25.55%) and it was associated with greater incidence of SSI compared to ileostomy (17.33% vs. 9.68%, $p = 0.04$) (Table 3).

Multivariate analysis showed that the greatest risk of SSI was

associated with high tumor staging (OR=1.75; 95% CI: 1.29-2.37, $p = 0.0003$), age over 75 years (OR=1.99; 95% CI: 1.46-2.70, $p < 0.0001$), and urgent surgery (OR=3.12; 95% CI: 2.27-4.30, $p < 0.0001$).

DISCUSSION

Surgical treatment of colorectal cancer is a procedure associated with high risk of perioperative complications. Great proportion of complications (20-40%) occurs within 30 days from surgery and are associated with high mortality (3-10%) [20]. SSI is one of the most commonly observed complications [21,22]. In a Catalonian (Spain) study including a group of 611 patients underwent elective surgery the diagnosis of SSI was made in 23.2% of patients (superficial – 12.8%, deep incisional – 2.1%, organ/space – 8.4%) [23]. On the other hand, a large cohort study completed by Segal et al. based on the data of 95 369 patients operated on over the period 2007-2009 in the United States estimated the incidence of SSI at 13% (su-

Tab. III. Comparative analysis of the incidence of SSI in surgical patients

| COLORECTAL CANCER | | ZMO+ | ZMO- | P |
|-------------------|---------------------|--------------|---------------|---------|
| Type of surgery | urgent | 76 (24,84%) | 230 (75,16%) | >0,0001 |
| | elective | 122 (9,57%) | 1153 (90,43%) | |
| | resection | 165 (9,57%) | 1226 (88,14%) | 0,03 |
| | non-resection | 33 (17,37%) | 157 (82,63%) | |
| | radical | 148 (11,76%) | 1110 (88,24%) | 0,07 |
| | non-radical | 50 (15,48%) | 273 (84,52%) | |
| Stoma | stoma - | 82 (15,53%) | 446 (84,47%) | 0,01 |
| | Stomia jelitowa - | 116 (11,02%) | 937 (88,98%) | |
| | ileostomy | 12 (9,68%) | 112 (90,32%) | 0,04 |
| | colostomy | 70 (17,33%) | 334 (82,67%) | |
| Clinical staging | high (stage III,IV) | 118 (15,73)% | 632 (84,27%) | <0,001 |
| | low (stage I,II) | 80 (9,63%) | 751 (90,37%) | |

perforial – 8.0%, deep incisional – 1.4%, organ/space – 3.8%) (24). In our study the total percentage of SSI was similar and amounted to 12.52%, with somewhat lower proportion of superficial infections (6.45%) and higher proportion of deep incisional infections (2.15%).

Based on multivariate analysis, we concluded that the incidence of SSI was affected to greatest extent by tumor staging, patient age and the mode of the procedure. In a study by Bot et al. high cancer staging, disseminated neoplastic disease in particular, was considered an independent risk factor for the occurrence of surgical complications [25]. In the analysis of 365 patients conducted by Shaffer et al. both univariate as well as multivariate analysis indicated high risk of SSI in patients with highly advanced colorectal cancer – odds ratio (OR) = 4.31 [5]. Similar results were obtained in a prospective analysis of 224 patients treated by a single surgeon for 12 months at a single center in Japan over the years 2008-2010 (OR = 2.4) [26]. Our study also showed that in surgical patients with highly advanced tumors (750/47.44%) SSI was significantly more frequent (15.73% vs. 9.63%); it also significantly more often affected patients who had undergone non-resection procedures (17.37% vs. 9.57%).

Literature estimated that SSI is much more common among patients undergoing urgent procedures (1.9-2.65 times more frequent) [21,27]. A retrospective analysis by Bayar et al. of patients operated on due to colorectal cancer over the period 2009-2013 at a single center showed that SSI was the most common complication and was significantly more frequent among

patients who underwent urgent surgery (26.7% vs. 10.9%). No differences were noted in this group with regard to sex, age, or disease staging [28].

In our analysis as many as 306/19.35% patients were subject to urgent procedure due to disease complications and the incidence of SSI in this group was 2.59 times higher (24.84% vs. 9.57%, $p < 0.0001$).

Presence of comorbidities among operated patients grows with age. Over 90% of patients treated for colorectal cancer are over 50 years old, who are more often diagnosed with cardiovascular disorders and diabetes [29]. Segal et al. revealed significant impact of respiratory disease and diabetes on the the incidence of SSI [24]. Every fourth patient in our study group was over 75 years old (432/27.32%) and SSI was more frequent in those patients (18.52% vs. 10.27%, $p = 0.00001$). Over 40% (637) of patients had been diagnosed with cardiovascular diseases and over 18% (294) suffered from diabetes – SSI was more frequent among patients with those comorbidities (14.60% vs. 11.12%, $p = 0.04$ and 16.33% vs. 11.66%, $p = 0.029$, respectively).

Immune disorders typical for malignancy and the type of surgical incision are the factors most frequently mentioned in the literature as influencing the incidence of SSI. In the study by Sohn the proportion of SSI for clean wounds amounts to 1.5-3.9%, for clean-contaminated 3-4%, for contaminated 8.5-15.2%, and for dirty wounds reaches up to 41% [27]. All surgical wounds in patients undergoing surgery for colorectal cancer are clean-contaminated, contaminated or dirty, and are at the high risk of con-

tact with fecal contents of the intestine. It particularly concerns patients operated due to intestinal perforation and those with a stoma [4,5,6,23]. Every one in three patients from our study group had a stoma formed (528/33.40%) and SSI was observed significantly more frequently in those patients (15.53% vs. 11.02%). A stoma was most often formed at the colon (404/25.55%) and these patients were at significantly higher risk of SSI compared to those with ileostomy (17.33% vs. 9.68%). Aside from smaller incidence of complications and easier reoperation, it is undoubtedly another argument for preferential formation of ileostomy over colostomy whenever possible.

Retrospective character of our work based on medical records from a single center and lack of randomization are the limitations of our study. Another limitation is related to incomplete information in patients' medical records regarding prophylaxis and bowel preparation prior to the procedure. Currently, preparation of large intestine before surgery as well as antibiotic prophylaxis are based on standards established at our in-

stitution. We employ mechanical washout of the bowel: colon prep schemes are based on phosphate or polyethylene glycol solution. Antibiotic prophylaxis consists of 1st generation cephalosporin and 100ml of 0.5% metronidazole administered 1 to 30 minutes before the first skin incision. Patients weighing over 80kg receive a double dose and 1st generation cephalosporin + 100ml of 0.5% metronidazole are administered again after four hours of surgery.

CONCLUSIONS

Surgical site infection after colon cancer surgery is significantly more common among patients over 75 years old, with diabetes and cardiovascular disease, with highly advanced cancer, undergoing urgent surgery due to complications.

SSI occurs significantly more frequently in patients after colostomy.

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Word count: 2300

Page count: 6

Tables: 3

Figures: –

References: 29

DOI: 10.5604/01.3001.0009.5858

Table of content: <http://ppch.pl/resources/html/articlesList?issueld=9609>

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Competing interests: The authors declare that they have no competing interests.



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