

Risk factors for surgical site infections in rectal cancer patients

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Introduction. Rectal cancer surgery is associated with high rates of post-operative complications in which the most common are Surgical Site Infections (SSI).

Materials and methods. Factors responsible for SSI incidence were retrospectively analysed in rectal cancer patients who had undergone surgery at a single centre for oncology between July 2012 and July 2016. The study end-point was patients' contracting SSI. Statistical analyses were performed by the 'Statistica 12' package consisting of the Pearson's Chi-squared test (χ^2), the Kruskal-Wallis test and the Mann-Whitney U-test (with continuity correction). Qualitative variables were analysed using log-linear analysis. The likelihoods of SSI incidence were compared by using odds ratios within 95% confidence limits.

Results. Amongst the 187 patient subjects under observation during their 30 day follow-up, 44 (23.5%) suffered from post-operative complications of which SSI were the most common at 27 (14.4%). In those patients with advanced stage IV cancer, SSI occurred 3-fold more compared to patients with lower stage cancers; respectively 27.3% vs 11.7%, $p = 0.021$. Multivariate analysis demonstrated that the highest SSI risk was in patients having a low-lying tumour (≤ 5 cm from the anal rim; OR 2.31 (95% CI of 1.15 to 4.62), $p = 0.019$ and those patients who had undergone Hartmann's procedure; OR 1.85 (95% CI of 1.04 to 3.31), $p = 0.038$.

Conclusions. Surgical site infections in rectal cancer patients undergoing surgery occur significantly more in those at advanced stage IV rectal cancer where the tumour is low-lying (0–5 cm from the anal rim) and after having undergone the Hartmann's procedure.

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Introduction

Modern-day surgery entails performing ever more complicated procedures in ever more elderly patients who frequently also suffer from comorbidities, accompanied by lowered immunity (ASA III, IV). For these reasons, greater numbers of post-operative complications can be expected in such cases. Surgical site infection (SSI) is the most often occurring complication, particularly in patients undergoing intensive therapy, general surgery and cardiac surgery and whose average incidence is 19.6% in patients of the EU (European Union). Based on data collected from 35 hospitals, SSI has been diagnosed in 20.1% patients in Poland [1]. SSI

can be of a 'superficial surgical site infection' kind (SSI-S), a 'deep surgical site infection' kind (SSI-D) or an 'organ/space surgical site infection' type (SSI-O). Its rates depend on the hygienic state of the site of operation, i.e. whether clean, clean-infected or dirty-infected; respectively $< 2\%$, $< 10\%$ and from 20–40%, [2]. Post-operative colorectal cancer patients, particularly for rectal cancer, are often vulnerable to complications; a very common type being SSI in patients where the surgery had been conducted within an infected-dirty site. Depending on the hospital and type of surgical procedure, complication rates in such patients vary from 9.6% to 76% [3–7].

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Table I. Comparisons of SSI incidence in rectal cancer patients

Rectal cancer, n = 187		SSI(+)	SSI(-)	p
Gender	Women, n = 86	11 (12.8%)	75 (87.2%)	NS
	Men, n = 101	16 (15.8%)	85 (84.2%)	
ASA	1, 2, n = 67	8 (11.9%)	59 (88.1%)	NS
	3, 4, n = 120	19 (15.8%)	101 (84.2%)	

SSI(+) — diagnosed surgical site infection; SSI(-) — non-diagnosed surgical site infection; ASA — classification for assessing surgical risk

The most significant risk factors for contracting SSI are patient-dependent, (i.e. primary disease, accompanying disease, nutritional status and age), on the biologically causative factor and the state of the surgical site. Another vital determinant is how well the patient is prepared for surgery, (i.e. surgical site preparation and anti-bacterial therapy), together with hygiene of the operating theatre (filters and air circulation). Many indices for assessing SSI risk have been formulated. According to the SENIC index (i.e. Study of the Efficacy of Nosocomial Infection Control) in rectal cancer patients, one can expect SSI rates of 17.2% of those undergoing surgery for this condition [8].

Our study aim was to retrospectively analyse risk factors for SSI incidence in rectal cancer patients who had undergone open surgery between 2012 and 2016.

Material and methods

The medical documentation was investigated from all successive rectal cancer patients that had been operated on from 01.06.2012 to 30.06.2016; of whom fourteen were excluded. Five patients died due to cardiac complications during 30 days of follow-up, but without any SSI symptoms (three were post-Hartmann procedure, whilst two after lower anterior rectal resection). Incomplete documentation was found in nine out-patient cases (three post-Hartmann's procedure, two after Miles surgery, three following anterior rectal resection and one after stoma construction). Following attempts to contact these patients by telephone or post no replies were received. Finally, 187 patients were reviewed of which 86 were female (46%). Information was gathered on indications/diagnoses and mode of operation

(elective or emergency/sudden). Type of rectal resection was classified according to tumour location as a lower (≤ 5 cm), middle ($> 5-10$ cm) and upper (> 10 cm) resection. The clinical advancement stage was graded by the TNM system according to the UICC (Union for International Cancer Control), [9].

The type and course of follow-up was assessed. All patients had been prepared for surgery according to accepted standards (i.e. colonic preparation, preventative anti-bacterial therapy and defining the stoma positioning). The adopted endpoint for our study was the occurrence of SSI (within 30 days of follow-up). Statistics were performed by the Chi-squared test (χ^2), Kruskal-Wallis test and the Mann-Witney test (with continuity correction). Qualitative variables were analysed by log-linear analysis. The likelihoods of SSI incidence were compared by using odds ratios within 95% confidence limits.

Results

Post-operative complications were diagnosed in 44 study subjects (23.5% patients) the most frequent being SSI at 27 (14.4%). The subjects median age was 69 years (37–94), however the Mann-Whitney U test (with continuity correction) revealed that there was no effect of age on SSI incidence; $p = 0.559$. In the study subjects, there were somewhat more males than females; 101 vs 86, respectively, and gender wasn't found to significantly affect SSI incidence (Tab. I). According to the ASA risk assessment (American Society of Anaesthesiologists), up to 120 (64.2%) of our subjects were graded at stage III and IV, in whom SSI appeared more frequently compared to the other subjects; 15.5% vs

Table II. Comparisons of SSI incidence according to mode of surgery, adopted neoadjuvant radiotherapy and clinical advancement cancer staging

Rectal cancer		SSI(+)	SSI(-)	p
Mode of surgery	Urgent/sudden, n = 51	9 (17.66%)	42 (82.4%)	NS
	Elective, n = 136	18 (13.2%)	118 (86.8%)	
Radiotherapy neoadjuvant	Yes, n = 24	5 (20.8%)	19 (79.2%)	NS
	No, n = 163	22 (13.5%)	141 (86.5%)	
Clinical advancement staging	I, II, III stage, n = 154	18 (11.7%)	136 (88.3%)	0,021
	IV stage, n = 33	9 (27.3%)	24 (72.7%)	

SSI(+) — diagnosed surgical site infection; SSI(-) — non-diagnosed surgical site infection; ASA — classification for assessing surgical risk

Table III. Comparisons of SSI incidence according to surgical procedure

Rectal cancer		SSI(+)	SSI(-)
Surgical procedure	ARR, n = 71	10 (14.1%)	61 (85.9%)
	ARR + protective ileostomy, n = 30	3 (10%)	27 (90%)
	Hartmann's procedure, n = 42	10 (23.8%)	32 (76.2%)
	Miles operation, n = 26	2 (7.7%)	24 (92.3%)
	Stoma, n = 18	2 (11.1%)	16 (88.9%)
	Total, n = 187	27	160

Kruskal-Wallis test: H (4, n = 187) = 4.565747, p = 0.335; SSI(+) — diagnosed surgical site infection; SSI(-) — non-diagnosed surgical site infection; ARR — anterior rectal resection

11.9% rates respectively. Nevertheless, such differences were statistically insignificant (Tab. I).

Emergency/sudden operations were performed in every fourth subject (51 cases; 27.3%), where despite the obvious limitation for surgical preparation, the incidence of SSI was insignificantly higher compared to the other instances; 17.7% vs 13.2% respectively. Out of all subjects, there were 33 (17.7%) where clinical stage IV advanced cancer had been graded in whom SSI occurred significantly more often than the rest; 27.3% vs 11.7%, p = 0.021. Neoadjuvant radiotherapy was given to 24 subjects (12.8%) in whom SSI occurred more frequently compared to those not receiving this type of therapy at 20.8% vs 13.5% (Tab. II), although this difference was statistically insignificant.

The procedure most often followed by SSI incidence (23.8%) in our study was the Hartmann's resection. Nonetheless, such differences proved insignificant by the Kruskal-Wallis test; H (4, n = 187) = 4.565747, p = 0.335 (Tab. III). However, upon comparing only the Hartmann's procedure patients to all the other surgery patients, using the Pearson χ^2 test, then significantly higher SSI incidences were observed in the former; 23.8% vs 7.7%, p = 0.049 (Tab. IV).

Procedures resulting in stoma creation were the case in 116 subjects (62%) of which 42 underwent Hartman's resection, 26 had been after Miles operation and 18 received stoma as a sole palliative measure, whilst remaining 30 patients had temporary ileostomy completing the lower anterior resection of rectum. In patients where a stoma had been constructed, there were higher rates of SSI compared

to all the others (15.5% vs 12.7%), but the difference was insignificant (Tab. IV).

Upon comparing SSI incidence, according to tumour localisation, the highest rates were those at a lower tumour location (26.3%), at 0–5 cm from the anal rim; such differences being significant at p = 0.024 (Tab. V). A multifactorial analysis demonstrated that the greatest risk of SSI was in rectal cancer patients after the Hartmann's procedure with a lower tumour localisation (i.e. 0–5 cm from the anal rim) (Tab. VI).

Discussion

The incidence of SSI following rectal cancer surgery widely varies, ranging from 7.6% to 26.7% [10–16]. Such cancer surgery is technically more demanding than colonic surgery, as patients are frequently after neoadjuvant radiotherapy and that operation times are usually longer. Surgery is associated with greater bacterial contamination (anastomosis close to the anus) and constructing a stoma is often required. As such, it therefore seems appropriate to analyse treatment outcomes separately. Many studies have found that SSI occurs more frequently in rectal cancer patients undergoing surgery than in those being operated for colonic cancer [11–14, 17]. A study by Konishi et al. on 556 patients after large bowel resection found that in those post-rectal resection, SSI occurred twice more frequently compared to patients who had undergone colonic resection, (i.e. 18.0% vs 9.4%), this difference being significant at p = 0.0033, [10].

Table IV. Comparisons of SSI incidence according to tumour location and surgical procedure

Rectal cancer		SSI(+)	SSI(-)	p
Tumour distance from anal rim	≤ 5 cm, n = 38	10 (26.3%)	28 (73.7%)	0.019
	> 5 cm, n = 149	17 (11.4%)	132 (88.6%)	
Surgical procedure	Hartmann's procedure, n = 42	10 (23.8%)	32 (76.2%)	0.049
	Other operation types, n = 145	2 (7.7%)	24 (92.3%)	
Stoma	With constructed stoma, n = 116	18 (15.5%)	98 (84.5%)	NS
	Without constructed stoma, n = 71	9 (12.7%)	62 (87.3%)	

SSI(+) — diagnosed surgical site infection; SSI(-) — non-diagnosed surgical site infection

Table V. Comparisons of SSI incidence according to tumour location

Rectal tumour location	SSI(+)	SSI(-)
Lower (≤ 5 cm)	10 (26.3%)	28 (73.7%)
Middle (> 5 –10 cm)	11 (13.4%)	71 (86.6%)
Upper (> 10 cm)	6 (9.0%)	61 (91.0%)
Total	27	160

Kruskal-Wallis test: $H(1, n = 187) = 5.085923, p = 0.024$; SSI(+) — diagnosed surgical site infection; SSI(-) — non-diagnosed surgical site infection

Likewise in a controlled, multicentre and randomised study on 376 laparoscopies of the colon and 206 of the rectum, there were significantly more complications in the latter than the former; 14% vs 8.2% respectively, $p = 0.041$, [18]. A study by Degratego et al. on 277 patients separately investigated the post-operative follow-up after rectal resection and resection of the left and right sides of the colon. They found that SSI rates were twice higher in those after rectal resection compared to those after resection of the right side of the colon; 17.6% vs 8%, however SSI rates were similar when comparing left side colonic resection with rectal resection; 18.4% vs 17.6% [19]. Our SSI study was based on assessing SSI according to the European Commission definition which was adopted by general surgery specialists for patients treated in hospital or those observed within a specialist clinic. We found that out of 187 patient subjects with rectal cancer, SSI occurred post-operatively in 14.4% instances.

The literature describes significantly higher incidences of SSI in patients with increased surgical risks according to ASA [3, 20–22]. Most of our subjects were ASA stage 3–4 risk at 120 (64.2%), where SSI occurred more frequently but differences were insignificant; 15.8% vs 11.9%.

A multicentre observational study ($n = 29$) conducted by Spanish surgeons on 2131 patients operated on due to rectal cancer from May 2006 to May 2009, found 16.9% SSI rates of diagnosis with superficial infection (SSI-S) at 8.9% and organ/space infection (SSI-O) at 8%. A multifactorial analysis revealed risk factors for SSI-S to be cancer advancement staging and when the tumour is localised 11 cm from the anus. After the Hartmann's procedure or the anterior lower resection of the rectum, then the SSI-O rates were significantly higher [23]. Our study showed 33 (17.7%) subjects with clinical stage IV cancer advancement, where SSI rates were significantly higher compared to those

at lower stages of cancer advancement; 27.3% vs 11.7%, $p = 0.021$. We also found that the distance to the anal rim significantly impacted on the incidence of SSI. Most commonly (26.32%), SSI occurred in subjects with lower localised tumours (≤ 5 cm from the anal rim); $p = 0.024$. There were no statistically significant differences in SSI rates between all the types of surgery performed. The Hartmann's procedure was frequent (22.5%) and had significantly higher SSI rates compared to all the others, taken in total; 23.8% vs 11.7%, $p = 0.049$. Such patients received emergency/sudden operations. In those patients where preparation time for surgery was limited or in those with frequently constructed intestinal stomas, then there are significantly greater opportunities for wound infection. The aforementioned Konishi et al. study demonstrated that up to 35.2% patients where a stoma had been made, then SSI occurred significantly more than in those remaining; $p < 0.0001$, [10]. In spite of observing SSIs more frequently in our study for patients with constructed stomas, the differences found were however insignificant; 20.8% vs 13.5%, $p = 0.34$.

Our study has certain limitations. It is a single centred one and is non-randomised. Nevertheless, the conditions for preparing for intestinal surgery and in taking preventative measures using antibiotics were based on standards that are mandatory at our centre. Furthermore, our patient follow-up was conducted by surgical specialists at the clinic, thereby ensuring appropriate and timely assessment of any complications that may have arisen.

Conclusions

Infections at the sites of surgery in patients suffering from rectal cancer arise significantly more often at stage IV cancer advancement, with the tumour localised at lower positions (0–5 cm from the anal rim) and after the Hartmann's procedure.

Table VI. Rectal cancer patients SSI incidence in multivariate analysis

Variable	OR	95% CI	p
Lower tumour location (0–5 cm) vs 6–15 cm	2.31	1.15–4.62	0.019
Hartmann's procedure vs other operations	1.85	1.04–3.31	0.038

OR — odds ratio; CI — confidence interval

Conflict of interest: none declared

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