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Title:

Surgical Site Infection after Breast Surgery: Retrospective Analysis of 5-year Postoperative Data from a Single Center in Poland

Authors:

Anna Pałubicka[1,2], Radoslaw Jaworski[3], Marcin Wekwejt[4], Beata Swieczko-Zurek[4], Michal Pikula[5], Janusz Jaskiewicz[2], Jacek Zielinski[2]

Affiliations:

1) Department of Laboratory Diagnostics and Microbiology with Blood Bank, Specialist Hospital in Koscierzyna, Poland
2) Department of Surgical Oncology, Medical University of Gdansk, Poland
3) Department of Cardiac Surgery, Children's Health Memorial Institute, Warsaw, Poland
4) Faculty of Mechanical Engineering, Department of Materials Engineering and Bonding, Biomaterials Group, Gdansk University of Technology, Poland
5) Department of Clinical Immunology and Transplantology, Medical University of Gdansk, Poland

Corresponding author:

Radoslaw Jaworski MD, PhD

Department of Cardiac Surgery, Children's Health Memorial Institute, Warsaw, Poland

Aleja Dzieci Polskich 20,04-730 Warsaw, Poland

Tel. +48 22 815 73 46; Fax: +48 22 815 73 40

E-mail: radicis@go2.pl

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Abstract

Purpose:

Surgical site infection (SSI) is a significant complication of non-reconstructive and reconstructive breast. This study aimed to assess SSI after breast surgery over 5 years in a single center in Poland. The microorganisms responsible for SSI and their antibiotic susceptibility were determined.

Materials/methods:

Data of 2129 patients acquired over 5 years postoperatively by the [center] were analyzed.

Results:

SSI was diagnosed in 132 patients (6.2%) and was an early infection in most cases (65.2%). The incidence of SSI was highest in patients who underwent subcutaneous amputation with simultaneous reconstruction using an artificial prosthesis (14.6%) and breast reconstruction via the TRAM flap method (14.3%). Gram-positive bacteria were responsible for SSI in most cases (72.1%), and these were mainly *Staphylococcus* strains (53.6%). These strains were 100% susceptible to all beta-lactam antibiotics (except penicillin), but were less susceptible to macrolides and lincosamides.

Conclusions:

SSI is a serious problem, and attention should be focused on its prevention. Reconstruction using an artificial prosthesis or via the TRAM flap method is connected to increased SSI incidence. Further studies are required to prevent SSI following breast surgery.

Conflict of interest:

All authors declare no conflict of interest.

Financial disclosure:

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1. Introduction

Surgical site infection (SSI) is one of the most common and serious complications following surgery. The occurrence of SSI varies according to the type of operation, wound cleanliness, and operative field. This complication can lead to prolonged hospitalization, which increases the cost of treatment [1-3].SSI occurs frequently following breast surgery [4] because such surgery is mainly performed to treat breast cancer and consequently the tissue is subjected to chemotherapy and/or radiotherapy. The risk of complications, including SSI, is affected by the type of breast surgery and whether breast reconstruction is performed. Current surgical options include breast-saving techniques, mastectomy, autograft techniques, use of an acellular dermal matrix, implantation of breast implants, and a combination of these methods [4,5-7]. SSI occurs in an average of 2–7% of patients who undergo breast surgery.

This study aimed to assess SSI after breast surgery over 5 years in a single center in Poland. The microorganisms responsible for SSI and their antibiotic susceptibility were determined.

2. Methods

This retrospective study used the medical records of patients who underwent breast surgery due to neoplasms at the [center] between 2012 and 2016. The study population comprised 2129 patients and was divided into those who underwent classic breast surgery (without breast-saving techniques), breast-conserving surgery, breast reconstruction via the transverse rectus abdominis muscle (TRAM) flap method, and subcutaneous amputation with simultaneous reconstruction using an artificial prosthesis.

SSI was defined as any episode of infection clinical symptoms following surgery or when SSI was diagnosed by the surgeon. Antibiotic use and surgical removal of an implant were at the surgeon's discretion. Early and late SSI were defined when the onset of symptoms occurred within 30 days and more than 30 days after surgery, respectively.

The age, body mass index, hospitalization duration, smoker status, and comorbidities (diabetes and hypertension) of patients diagnosed with SSI were assessed. Samples were acquired from these patients for microbiological evaluation. The microorganisms responsible for SSI were determined and their antibiotic susceptibility was assessed after excluding samples that were contaminated and affected by pre-laboratory and human errors.

Continuous data are presented as means or medians, standard deviations (SDs) and ranges. Categorical data are presented as percentages. The Kolmogorov-Smirnov test was used to test whether the data were normally distributed. Continuous data were compared using a univariate analysis of variance follow by the least significant difference test or the Kruskal-Wallis test, depending on their distribution. Categorical data were compared using the chi-square test and Fisher's exact test. *P* values less than 0.05 were considered statistically significant. All statistical analyses were performed using SPSS software v.21 (IBM, Chicago, IL, USA).

This study was approved by the Ethics Examining Committee of Human Research at [center](approval no. 424/2017).

3. Results

A total of 2129 breast surgical interventions were conducted at our center in 2012–2016, with a median of 408 procedures per year (SD=55.7; range, 502–358).Classic breast surgery, breast-conserving surgery, breast reconstruction via the TRAM flap method, and subcutaneous amputation with simultaneous reconstruction using an artificial prosthesis were performed in 40%, 47%, 3%, and 10% of patients, respectively.

Over 5 years postoperatively,132 patients (6.2%)were diagnosed with SSI. These were early infections in most cases (65.2%). The number of patients who developed SSI was similar each year; a mean of 26patients (6.4%)were diagnosed with SSI annually (SD=10.2; range, 15–41). Table 1 shows the number of patients in each treatment group who were diagnosed with SSI. The incidence of SSI was significantly higher in patients who underwent subcutaneous amputation with simultaneous reconstruction using an artificial prosthesis (14.6%) and breast reconstruction via the TRAM flap method(14.3%) than in the other two groups. Patients with SSI had a median age of 55years(SD=13.1 years; range, 34.1–74.6 years), a median body mass index of 26.1 (SD=5.3; range,20.5–34.8), and a median hospitalization duration of 5 days (SD=4.8 days; range,21–33 days). In total, 24 (18.2%) and 85 (64.4%) of patients with SSI were smokers and had comorbidities, respectively.

Microbiological evaluation of samples from patients diagnosed with SSI yielded106positive results (80.3%) and 26negative results (19.7%). Among the negative results, three samples (2.3%) were contaminated by skin due to pre-laboratory errors. A total of 140 strains were detected in the 101 patients with microbiologically confirmed SSI. One type of bacteria was isolated in the majority (76) of patients, whereas two or more types of bacteria were isolated in30 patients (28.3%). Specifically, two and three types of bacteria were isolated in 26 and 4 patients, respectively. Gram-positive bacteria were responsible for the majority of infections(101, 72.1%), and most of the isolates (75, 53.6%) were *Staphylococcus* strains.The microorganisms responsible for SSI are presented in Figure 1 and Table 2.

Table 3 shows the susceptibility of the isolated bacteria to antibiotics. *Staphylococcus aureus* strains, the most common etiological factor, were susceptible to all beta-lactam antibiotics (except penicillin) and exhibited 100% sensitivity to aminoglycosides, trimethoprim/sulfamethoxazole, linezolid, and vancomycin. Conversely, only 89% of these strains were susceptible to macrolides and lincosamides.

4. Discussion

This study investigated the occurrence of SSI in patients who underwent breast surgery in a single surgical oncology center in northern Poland. The incidence of SSI after breast surgery was 6.2%.Although SSI was mostly classified superficially, it resulted in increased morbidity and increased duration of hospitalization. Recent reviews of the database of the National Surgical Quality Improvement Program demonstrated that 1.4–3.2% of patients develop SSI after breast surgery [8-10]. However, other studies reported that the rate of SSI is up to 36% following specific procedures such as modified radical mastectomy [11,12]. In the current study, the incidence of SSI was higher in patients who underwent subcutaneous amputation with simultaneous reconstruction using an artificial prosthesis and breast reconstruction via the TRAM flap method than in patients who underwent classic breast surgery and breast-conserving surgery. This is consistent with previous reports that the rate of complications is highest in patients who undergo breast reconstruction, especially with their own tissues[13-14].

Numerous patient- and procedure-related factors affect the risk of SSI. Therefore, a bundle approach that targets multiple risk factors is required to reduce the risk of bacterial contamination and improve patient defenses. Guidelines for the prevention of SSI issued by the Center for Disease Control and Prevention emphasize the importance of rigorous patient preparation, aseptic practice, and attention to detail during surgery. Perioperative antibiotic prophylaxis is important to limit infectious complications. Care should be taken to choose an appropriate antibiotic, deliver it at the optimal time interval prior to surgery, and limit its use after surgery. Suboptimal prophylactic antibiotic dosing is a potentially modifiable risk factor for SSI following breast surgery. Olsen et al. reported that the risk of SSI is increased in patients who undergo mastectomy and in patients who are fitted with an implant or a tissue expander during surgery [15]. These findings can be used to develop a specific risk stratification index that predicts the risk of SSI following breast surgery and to devise infection prevention strategies tailored for breast surgery patients [15].

In the current study, *Staphylococcus* species were most frequently isolated from patients with SSI. This is consistent with the previous finding that *Staphylococcus* species were isolated in 60% of cultures from patients who developed SSI after breast surgery [11,16]. Surprisingly, multi-drug-resistant variants were rarely identified in the current study and nomethicillin-resistant *S. aureus* strains were isolated. A previous study reported that methicillin-resistant *S. aureus* is responsible for up to 9.8% of SSI cases after breast surgery [16]. In the current study, 28% of isolated bacteria were Gram-negative strains. In a recent report of patients who developed SSI after breast reconstruction using implants,Gram-positive strains, including *Staphylococcus epidermidis* and *S.aureus*, were most frequently isolated, while 16% of isolates were Gram-negative bacteria, such as *Pseudomonas aeruginosa*[17].Similarly, Darragh et al. reported that *S. epidermidis*, *P. aeruginosa*, *Enterobacter cloacae*, *S. aureus*, and *Escherichia coli* are most frequently isolated from patients who develop SSI after breast surgery [18].

The limitations of this study include its retrospective case-control design and the small numbers of patients with important risk factors and SSI. Consequently, we were unable to analyze potential risk factors for the development of SSI in breast cancer patients. A larger cohort study of breast cancer patients is required to investigate such risk factors in detail, including neoadjuvant and adjuvant chemotherapy and radiotherapy.

5. Conclusions

The average incidence of SSI after breast surgery remains constant worldwide and is increased when reconstruction is performed during primary surgery. SSI is a serious problem, and attention should be focused on its prevention. New surgical techniques are being developed, and further studies are required to prevent SSI following breast surgery.

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Table 1.
Surgical site infection in breast cancer patients who underwent breast surgery at [center] in 2012–2016.

	Classic breast surgery (n=865)	**Breast-conserving surgery (n=1002)**	**Breast reconstruction via the TRAM flap method (n=56)**	**Subcutaneous amputation with simultaneous reconstruction(n=206)**	***p* value**
All SSI	46 (5.3%)	48 (4.8%)	8 (14.3%)	30 (14.6%)	**<0.001**
Early SSI	34 (3.9%)	31 (3.1%)	4 (7.1%)	17 (8.3%)	**0.004**
Late SSI	12 (1.4%)	17 (1.7%)	4 (7.1%)	13 (6.3%)	**<0.001**

SSI, surgical site infection; TRAM, transverse rectus abdominis muscle.

Table 2.
Microorganisms responsible for surgical site infection in breast cancer patients who underwent breast surgery at the [center] in 2012–2016.

	Classic breast surgery (n=865)	**Breast-conserving surgery (n=1002)**	**Breast reconstruction via the TRAM flap method (n=56)**	**Subcutaneous amputation with simultaneous reconstruction (n=206)**	***p* value**
MSSA	22 (47.83%)	16 (33.33%)	3 (37.50%)	11 (36.67%)	0.529
CNS	7 (15.22%)	10 (20.83%)	0 (0.00%)	6 (20.00%)	0.499
Streptococcus spp.	3 (6.52%)	4 (8.33%)	1 (12.50%)	1 (3.33%)	0.763
Enterococcus faecalis	5 (10.87%)	4 (8.33%)	4 (50.00%)	4 (13.33%)	**0.012**
Enterobacteriaceae	13 (28.26%)	7 (14.58%)	0 (0.00%)	1 (3.33%)	**0.016**
Pseudomonas/Acinetobacter	6 (13.04%)	3 (6.25%)	1 (12.50%)	1 (3.33%)	0.428
Anaerobes	3 (6.52%)	4 (8.33%)	0 (0.00%)	0 (0.00%)	0.370

MSSA, methicillin-susceptible *Staphylococcus aureus*; CNS, coagulase-negative *Staphylococcus*; TRAM, transverse rectus abdominis muscle.

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Table 3.
Antibiotic susceptibility of *Staphylococcus*, *Streptococcus* spp., and Gram-negative bacilli strains isolated from breast cancer patients with surgical site infection at [center] in 2012–2016.

		Strains						
		Staphylococcus aureus	*Coagulase-negative Staphylococcus*	*Enterococcus faecalis*	*Streptococcus* spp.	*Enterobacteriaceae*	*Pseudomonas/Acinetobacter*	*Anaerobes*
Number of strains		52	23	17	9	21	11	7
Antibiotics	**PE**	**0%**	**0%**	100%	100%	---	---	100%
	MET	100%	**78%**	---	---	---	---	---
	GE	100%	100%	---	---	---	---	---
	Ge High	---	---	100%	---	---	---	---
	S High	---	---	100%	---	---	---	---
	TYG	---	---	100%	100%	---	---	---
	TEI	---	---	100%	100%	---	---	---
	AN	100%	100%	---	---	100%	100%	---
	E	**89%**	**78%**	nr	**89%**	---	---	---
	CC	**89%**	**78%**	nr	---	---	---	43%
	SXT	100%	**91%**	nr	---	**91%**	100%	---
	CIP	**98%**	**91%**	**87%**	100%	**96%**	100%	---
	VA	100%	100%	100%	100%	---	---	---
	LZD	100%	100%	100%	100%	---	---	---
	AM	100%	**78%**	100%	100%	**26%**	---	100%
	AMC	100%	**78%**	100%	100%	**26%**	---	100%
	CXM	100%	**78%**	**nr**	100%	**96%**	---	---
	CTX	100%	**78%**	**nr**	100%	**96%**	**88%**	---
	CAZ	100%	**78%**	**nr**	100%	**96%**	**88%**	---
	IPM	100%	**78%**	100%	100%	100%	100%	---
	MEM	100%	**78%**	100%	100%	100%	100%	---
	MTZ	---	---	---	---	---	---	100%

---, not applicable/not tested; nr, natural resistance; PE, penicillin; MET, methicillin; GE, gentamicin; AN, amikacin; E, erythromycin; CC, clindamycin; SXT, trimethoprim/sulfamethoxazole; CIP, ciprofloxacin; VA, vancomycin; LZD, linezolid; GE High, high concentration of gentamicin; S High, high concentration of streptomycin; TYG, tigecycline; TEI, teicoplanin; AM, ampicillin; AMC, amoxicillin/clavulanic acid; CXM, cefuroxime; CTX, cefotaxime; CAZ, ceftazidime; IPM, imipenem; MEM, meropenem; MTZ, metronidazole.

Figure 1.

Microorganisms responsible for SSI in patients who underwent breast surgery (number; percentages).MSSA, methicillin-susceptible *Staphylococcusaureus*; CNS, coagulase-negative *Staphylococcus*.