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Brief Original Article

Risk factors for surgical site infection after hysterectomy

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Abstract

Introduction: The aim of the study was to define the clinical and laboratory characteristics of patients who had surgical site infection (SSI) after hysterectomy.

Methodology: This study was a retrospective cohort study. The patient data of 840 subjects who had undergone any type of hysterectomy and reported SSI after surgery were obtained from the archives of a tertiary referral center. The different types of hysterectomy procedures performed on these patients included total abdominal hysterectomy (TAH), laparoscopic hysterectomy (LH), and vaginal hysterectomy (VH). In addition, age, body mass index (BMI), preoperative and postoperative blood parameters, gravidity, and parity were also documented.

Results: TAH, LH, and VH were performed on 63.2% (n = 531), 21.6% (n = 181), and 15.2% (n = 128) of patients, respectively. Overall, SSIs were observed in 3.7% (n = 31) of all hysterectomy patients. Among them, 4.5% of TAH patients, 1.7% of LH patients, and 3.1% of VH patients had SSIs after the hysterectomy operation. Analysis of the data revealed that the patients with SSIs had significantly higher BMIs, lower preoperative hemoglobin, lower postoperative hemoglobin and hematocrit, and higher postoperative platelet counts compared to patients who did not have any SSIs.

Conclusions: High BMI, blood loss during surgery, low hematocrit levels, and resulting anemia increased the incidence of SSI after hysterectomy. Among the different types of hysterectomy, LH was found to be relatively better than TAH and VH in preventing the occurrence of SSI.

Key words: infection; hysterectomy; surgical site infection.

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Introduction

Hysterectomy is the most common operation performed by gynecologists. It is generally performed to treat several different indications and therefore utilizes a variety of techniques and approaches. Among them, abdominal hysterectomy (TAH) continues to be the most common approach, but vaginal hysterectomy (VH) has been associated with fewer complications, shorter hospital stay, more rapid recovery, and lower overall costs [1-3]. However, there are some limitations for VH, which include concurrent pelvic disease, large uterus, and the absence of uterine prolapse [4]. Recently, both laparoscopic and robotic hysterectomies have become more feasible and are performed frequently. Laparoscopic hysterectomy (LH) has many advantages, such as less postoperative pain, shorter hospitalization, faster return to work, less blood loss, fewer postoperative complications, better cosmesis, and reduced hospitalization costs [5,6].

Surgical site infections (SSIs) affect body tissues, cavities, and organs manipulated during surgery, generally within 30 days of a surgical procedure. SSIs have the third highest incidence of the infections that necessitate hospitalization, comprising 14%–16% of total infections [7].

In this study, we aimed to define the clinical characteristics of patients who required re-hospitalization following the diagnosis of an SSI post-hysterectomy.

Methodology

Patient selection and data collection

This study was conducted in the Department of Obstetrics and Gynecology at Kanuni Sultan Suleyman Training and Research Hospital (Istanbul, Turkey) from April 2014 to April 2015. A total of 840 patients who had been hospitalized for an SSI after undergoing any type of hysterectomy were included in the study. The patients who had any other complication during the hysterectomy operation and those who had been treated in the outpatient clinics were excluded from the study.

SSIs were reported based on diagnosis, and were categorized per the Centers for Disease Control and Prevention National Healthcare Safety Network (CDC-

Table 1. Mean values with minimum and maximum values of all patients who underwent hysterectomy.

Characteristics	Mean values ± SD	Min–Max values
Age	50.8 ± 9.2	18–81
Body mass index (kg/m^2)	26.8 ± 3.4	17.1-42.5
Gravida	4.4 ± 2.6	0–16
Parity	3.3 ± 2.2	0–15
Preoperative hemoglobin (g/dL)	11.3 ± 2.0	6.0–15.2
Preoperative hematocrit (%)	36.4 ± 5.5	19.0–49.0
Preoperative white blood cell (10^3 cells/μL)	7.9 ± 2.9	2–39
Preoperative platelet count (10^3 cells/μL)	296.8 ± 88.8	32–811
Postoperative hemoglobin (g/dL)	10.3 ± 1.7	4.4–15
Postoperative hematocrit (%)	32.8 ± 4.6	16.0–51.0
Postoperative white blood cell (10^3 cells/μL)	11.4 ± 4.3	2–34
Postoperative platelet count (10^3 cells/μL)	265.7 ± 81.1	60–650
Thyroid stimulating hormone (μIU/mL)	2.03 ± 1.89	0.01–33.4

SD: standard deviation

NHSN) guidelines [8]. Furthermore, parameters including age; body mass index (BMI); gravidity and parity; type of operation; indications for surgery; use of transfusion; pre- and postoperative blood parameters, such as hemoglobin, hematocrit, white blood cell count, and platelet count; and treatment method were recorded. BMI was calculated as weight (kilograms) over height (meters square) and categorized per World Health Organization (WHO) classification as underweight (< 18.5), normal weight (18.5–24.9), overweight (25–29.9), obese (> 30), and morbidly obese (> 40).

Management strategy

During hospitalization, the patients were either treated only with antibiotics and dressing (64.5%) or required surgical intervention (35.5%) in addition to the antibiotic treatment. If surgery was performed, the infected tissues were debrided and sutured using permanent sutures following antibiotics/dressing.

Following the collection of culture material from the infection site, an empirical antibiotic treatment consisting of gentamicin, clindamycin and/or ampicillin, cephalosporin, and metronidazole was prescribed. If patients did not improve on these antibiotics, more appropriate antibiotic regimens were prescribed based on consultation with infectious diseases specialists.

Statistical analysis

This study was designed to be a retrospective cohort study. The patient data, excluding personal information, were obtained from archived records that were documented. Informed consent was obtained from every patient prior to hospital admission.

All statistical analyses were performed using SPSS version 20 (SPSS, Armonk, USA) for Windows. The differences in mean values between the groups were analyzed using the t-test and Chi-squared test. $P < 0.05$ was considered statistically significant.

Results

The mean age of patients in the study was 50.8 ± 9.2 years, and mean BMI was 26.85 ± 3.41. The clinical and laboratory characteristics of the patients are summarized in Table 1. Most of the subjects in the study (814 patients, 96.9%) were multiparous, and the patient records indicated that all of them had stable vital signs on re-admission.

The patient records also indicated that abdominal (TAH), laparoscopic (LH), and vaginal hysterectomies (VH) were performed on 63.2% (n = 531), 21.6% (n = 181), and 15.2% (n = 128) of patients, respectively. The reported LH procedure was total laparoscopic hysterectomy. Further, myoma uteri were most frequently reported after hysterectomy, either with or without an SSI (Table 2). In addition, blood transfusions were performed during hysterectomy surgery in 11% of cases.

SSIs were observed in 3.7% (n = 31) of all hysterectomy patients. More specifically, 24 of 531 patients who underwent TAH (4.5%), 3 of 181 patients

Table 2. Distribution of the indications for hysterectomy.

Indications	N (%)
Myoma uteri	485 (57.7)
Menometrorrhagia	68 (8.1)
Endometrial hyperplasia	42 (5.0)
Urogynecologic	139 (16.5)
Adnexal mass	40 (4.8)
Oncologic	48 (5.7)
Obstetric	17 (2.0)
Uterine rupture	1 (0.1)

who underwent LH (1.7%), and 4 of 128 patients who underwent VH (3.1%) had an SSI following the hysterectomy operation (Figure 1). Among them, the treatment with antibiotics was sufficient in 64.5% cases, predominantly because these were superficial infections, per CDC guidelines.

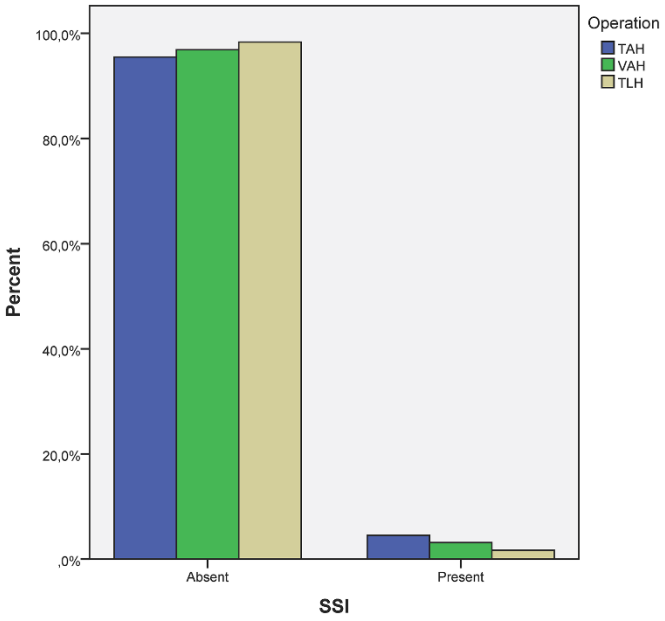
Table 3 reveals differences in clinical and laboratory parameters between the patients with or without SSIs. Notably, the patients with an SSI had significantly higher BMI, relatively lower preoperative hemoglobin, lower postoperative hemoglobin and hematocrit, and a higher postoperative platelet count compared to the patients who did not have an SSI. In particular, TAH patients with an SSI had significantly higher BMI, relatively lower preoperative hematocrit, lower postoperative hemoglobin and hematocrit, and higher platelet counts compared to TAH patients who did not have an SSI (Table 4). The other parameters, including age, gravidity and parity, preoperative hemoglobin level, preoperative white blood cell and platelet counts, postoperative white blood cell counts, and TSH level were not significantly different between patients with or without an SSI.

Furthermore, antibiotic susceptibility tests indicated that an empirical antibiotic treatment was appropriate in 22 of 31 patients with an SSI (70.9%). However, the antibiotic treatments needed some adjustments in the remaining 9 patients (29.1%). *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa* were prevalent in cultures collected from SSIs.

Discussion

SSIs are known to affect body tissues, cavities, and organs manipulated during operations, and they typically occur within 30 days of a surgical procedure.

Figure 1. Bar graph showing the distribution of surgical site infections based on different approaches of hysterectomy.



They are categorized by CDC-NHSN as superficial incisional, deep incisional, or organ/space infections [8,9]. The first type affects only the skin and/or subcutaneous tissue; the second type affects deep structures of the incision site (*e.g.*, fascia and/or muscle layer); and the last type affects any part of the anatomy that is manipulated during the operation, except for wall incisions. Purulent drainage, with or without laboratory confirmation, is associated with localized swelling, redness and/or heat in the first two types of SSI. As the SSI progresses, systemic symptoms and signs appear, such as fever (> 38°C) and hypotension. Moreover, wound dehiscence, which refers to the loss of integrity of the fascial closure, is implicated. The microorganisms commonly isolated from SSIs were

Table 3. Difference in mean values of the patients with and without surgical site infection.

Characteristics	Surgical site infections		p
	Absent (n = 809)	Present (n = 31)	
Age	50.9 ± 9.3	48.9 ± 8.0	.252
Body mass index (kg/m^2)	26.7 ± 3.3	30.0 ± 4.9	**.001**
Gravida	4.4 ± 2.6	5.2 ± 2.9	.093
Parity	3.4 ± 2.2	3.4 ± 2.1	1.00
Preoperative hemoglobin (g/dL)	11.3 ± 1.9	10.7 ± 1.9	.104
Preoperative hematocrit (%)	36.5 ± 5.5	34.2 ± 4.8	**.021**
Preoperative white blood cell (10^3 cells/µL)	7.9 ± 2.9	8.4 ± 3.1	.302
Preoperative platelet count (10^3 cells/µL)	296.7 ± 87.7	299.2 ± 114.7	.879
Postoperative hemoglobin (g/dL)	10.3 ± 1.7	9.5 ± 1.3	**.006**
Postoperative hematocrit (%)	32.8 ± 4.6	30.6 ± 4.3	**.006**
Postoperative white blood cell (10^3 cells/µL)	11.4 ± 4.3	10.8 ± 4.4	.467
Postoperative platelet count (10^3 cells/µL)	263.3 ± 79.3	327.4 ± 101.5	**< 0.001**
Thyroid stimulating hormone (µIU/mL)	2.02 ± 1.89	2.07 ± 1.95	.898

Table 4. Difference in mean values of patients who underwent total abdominal hysterectomy.

Characteristics	Total (n = 531)	Surgical site infections		p
		Absent (n = 507)	Present (n = 24)	
Age	48.8 ± 8.4	48.9 ± 8.5	46.7 ± 5.6	.195
Body mass index (kg/m^2)	26.6 ± 3.4	26.4 ± 3.2	31.1 ± 4.8	**< 0.001**
Gravida	4.2 ± 2.5	4.1 ± 2.5	4.9 ± 2.8	.130
Parity	3.1 ± 2.1	3.1 ± 2.0	3.3 ± 2.1	.598
Preoperative hemoglobin (g/dL)	11.0 ± 2.00	11.0 ± 2.0	10.5 ± 1.6	.195
Preoperative hematocrit (%)	35.7 ± 5.6	35.8 ± 5.7	33.6 ± 4.1	**.019**
Preoperative white blood cell (10^3 cells/μL)	7.9 ± 2.6	7.9 ± 2.6	8.7 ± 3.3	.279
Preoperative platelet count (10^3 cells/μL)	305.6 ± 92.9	305.5 ± 91.3	307.9 ± 124.3	.902
Postoperative hemoglobin (g/dL)	10.1 ± 1.7	10.1 ± 1.7	9.2 ± 1.3	**.012**
Postoperative hematocrit (%)	32.2 ± 4.5	32.3 ± 4.5	29.5 ± 3.4	**.003**
Postoperative white blood cell (10^3 cells/μL)	11.6 ± 4.2	11.7 ± 4.2	10.2 ± 3.9	.100
Postoperative platelet count (10^3 cells/μL)	275.4 ± 83.2	272.7 ± 80.9	331.6 ± 110.1	**.001**
Thyroid stimulating hormone (μIU/mL)	2.03 ± 1.52	2.01 ± 1.51	1.80 ± 1.79	.501

Ureaplasma, coagulase-negative *Staphylococci*, *Enterococcus faecalis*, *Mycoplasma*, anaerobes, Gram-negative rods, *Staphylococcus aureus*, and group B *Streptococcus* [10].

The risk factors for SSIs include reproductive age (20–35 years), high BMI, malnutrition, low socioeconomic status, preoperative anemia, and comorbid diseases such as diabetes mellitus and hypertension [11–13]. Accordingly, our study found significantly higher BMI and lower hematocrit and hemoglobin levels in patients with an SSI. It is known that the modifiable risk factors for SSIs exist during the surgical procedure [14], and prophylactic antibiotic use is important. Antibiotic therapy is employed preoperatively and postoperatively in hysterectomy patients in accordance with the suggestions of the American College of Obstetricians and Gynecologists (ACOG). In addition, longer operation time and excessive blood loss during surgery are other modifiable risk factors of SSI. In line with this, we found significantly lower hematocrit and hemoglobin levels in SSI patients. However, since this was a retrospective study, we could only indirectly demonstrate that there was more blood loss in SSI patients. Pop-Vicas *et al.* identified the duration of surgery and surgical complexity in gynecologic malignancies as the significant SSI risk factors, supporting our results [15].

Moreover, our study indicated higher postoperative platelet counts in patients with an SSI. This may be due to reactive thrombocytosis that may occur in hemorrhagic conditions. Furthermore, the relatively low hematocrit and hemoglobin levels in SSI patients, which indicated more blood loss, may also have caused the higher platelet counts in these patients.

Although laparoscopy has been a preferred approach, the traditional TAH methodology continues to be used more frequently. Interestingly, we found a higher percentage of SSI in patients with TAH (4.5% in TAH, 1.7% in LH, 3.1% in VH). Lake *et al.* also found a higher risk for postoperative cellulitis after TAH compared with the vaginal approach [16]. Since our patient data were derived from a tertiary referral center, where more challenging operations are frequently referred to and performed, it is conceivable that greater than usual blood loss may have been reported in TAH patients. Conversely, LH is known to have many advantages, such as shorter operation time, reduced blood loss during surgery, and minimal incision size. Any or all of the above factors may have contributed to a selection bias in our study, and therefore prospective controlled studies that avoid such bias are warranted in the future.

It is important to note that the surgical approach for hysterectomy depends on many factors, including the surgeon's and/or patient's choice, surgeon's experience and skill, indications for operation, and patient's characteristics [17]. All the benefits and hazards of the selected approach should be discussed with the patient before a final decision is reached. It is noteworthy that laparoscopic and robotic hysterectomies continue to be valuable alternatives for abdominal hysterectomy, especially in obese women [18,19].

Since many predictors for SSIs are modifiable, these types of infections can be prevented. Many publications showed that antimicrobial prophylaxis, surgical methods, operating room environment, and preoperative skin preparation affect the risk of SSI [20]. Based on the CDC guidelines [8], the following best practices have been well defined: a) hair at the incision

site should be clipped only if necessary; b) antibiotics should be administered prophylactically less than 30 minutes before the surgical procedure begins, and repeated if blood loss reaches 1.5 liters, or if the duration of operation extends beyond 3 hours; c) skin should be prepared with chlorhexidine; d) the surgical team should wash their hands and forearms; e) comorbidities, such as diabetes, should be controlled appropriately; f) the wound should be sutured if subcutaneous tissue layer is greater than 2 cm in depth; and g) BMI is high [21]. Furthermore, a diet with appropriate caloric intake is important for optimal wound healing [22]. However, a single intervention has not been defined as the most responsible method for decreasing the rate of SSIs [23].

Conclusions

As hysterectomy is known to significantly affect the physical and psychological health of women, in addition to the economic burden associated with it, the modifiable risk factors should be seriously considered in patients undergoing this procedure in future. We found that BMI, preoperative anemia, and intraoperative blood loss increased the incidence of SSI. Although proper management with antibiotics is sufficient in a large percentage of patients, TAH may lead to a higher incidence of SSI, compared to LH or VH, irrespective of the blood loss associated with the procedure. Our findings will need further confirmation in prospective controlled studies conducted in the future.

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