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Original Article

An analysis of risk factors for postoperative pelvic cellulitis after laparoscopic-assisted vaginal hysterectomy

Wei-Chun Chang [a,b], Ching-Hung Hsieh [c], Cheng-Chieh Lin [b], Wu-Chou Lin [a,d], Yao-Ching Hung [a,b], Wei-Chien Wu [a,d,*]

[a] *Department of Obstetrics and Gynecology, China Medical University Hospital, Taichung 40447, Taiwan*

[b] *School of Medicine, China Medical University, Taichung 40402, Taiwan*

[c] *Department of Obstetrics and Gynecology, Clinic of Fu Jen Catholic University, Taipei, Taiwan*

[d] *China Medical University, Taichung 40402, Taiwan*

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Abstract

Objective: To assess risk factors for postoperative pelvic cellulitis in women undergoing laparoscopic-assisted vaginal hysterectomy (LAVH).
Materials and Methods: A total of 195 patients who underwent LAVH for benign gynecological diseases during the period 2007−2008 were enrolled. Among them, 11 patients developed pelvic cellulitis (group 1, cases) and 184 did not (group 2, controls).
Results: The proportion of patients in American Society of Anesthesiologists physical status scale (ASA) class II was significantly higher in group 1 ($p = 0.017$). The grade of pelvic adhesion was significantly more severe in group 1 ($p = 0.044$). The mean length of hospital stay in group 1 was significantly longer than in group 2. Logistic regression analysis revealed that patients in ASA class II were six times more likely to develop postoperative pelvic cellulitis than patients in ASA class I. In addition, the analysis showed that there was a twofold increase in risk for pelvic cellulitis with each single-grade increase in the degree of pelvic adhesion. Women with postoperative pelvic cellulitis also had a significantly increased length of hospital stay.
Conclusion: Understanding the risk factors for postoperative pelvic infection, such as systemic disease, pelvic adhesion, and prolonged hospital stay, comprehensive care of patients, and correction of modifiable risk factors will help reduce the rate of postoperative pelvic cellulitis in women undergoing LAVH.

Keywords: Pelvic cellulitis; Postoperative infection; Risk factors for postoperative infection

Introduction

Postoperative infectious complications are the main causes of postoperative morbidity. Overall, the incidence of postoperative infections approaches 38% [1].

Hysterectomy is one of the most common major surgical procedures for women with benign gynecological diseases and is classified as a clean-contaminated surgical procedure. Postoperative pelvic infections after hysterectomy are most commonly caused by the inoculation of species that constitute the normal flora of the lower genital tract into the vulnerable operative site. Prior to the widespread use of antimicrobial prophylaxis for hysterectomy, the incidence of postoperative pelvic infection ranged from 5% to 70%. With the advent of routine prophylaxis, the incidence rate has fallen to approximately 5% or less, and abscess formation has become rare [2, 3].

Although antibiotic prophylaxis is very effective in reducing the incidence of postoperative pelvic infection, pelvic infections still occur in some patients after certain surgical procedures. It is, therefore, important to evaluate and control as far as possible the factors that place patients at risk for postoperative infections.

* Corresponding author. Department of Obstetrics and Gynecology, China Medical University Hospital, 2 Yuh-Der Road, Taichung 40447, Taiwan.

E-mail address: w77613@gmail.com (W.-C. Wu).

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Laparoscopic-assisted vaginal hysterectomy (LAVH) has been shown to be an acceptable alternative to total abdominal hysterectomy and has gained widespread acceptance since it was first reported by Reich et al in 1989 [4]. To our knowledge, no studies have analyzed the incidence of and risk factors for postoperative pelvic cellulitis in patients who have undergone LAVH. Therefore, in this retrospective case-control study, we evaluated several possible risk factors for pelvic cellulitis after LAVH in women who had received preoperative prophylactic antibiotic therapy.

Materials and methods

This study involved a sample of 195 patients who underwent LAVH for benign gynecological diseases in a medical center in central Taiwan during the period 2007−2008. All of the surgeons had at least 10 years of experience in performing LAVH. All women received 1 g cefazolin for prophylaxis within 30 minutes prior to the initial skin incision. All the preoperative physical status assessments were carried out according to the American Society of Anesthesiologists physical status scale (ASA), 112 patients being assigned to ASA class I (normal healthy) and 83 to ASA class II (with mild systemic disease). Kapur et al's staging system for intra-abdominal adhesions was used to classify the 195 patients in whom adhesiolysis was performed [5]. These 195 patients were divided into two groups based on the absence (184 patients) or presence (11 patients) of postoperative pelvic cellulitis occurring during hospitalization ($n = 2$) or after discharge ($n = 9$).

The 11 patients (case group) with postoperative pelvic cellulitis were diagnosed by their clinical symptoms and signs, including fever, lower abdominal pain, increased vaginal discharge exuding from the vaginal cuff, pelvic tenderness, or increased temperature of vaginal apex on bimanual pelvic examination. The other 184 patients (control group) did not present the symptoms and signs of pelvic cellulitis after LAVH.

Patients' characteristics (age, parity, grade of pelvic adhesion, and ASA class) and medical care process data (length of hospital stay, operation time, flatulence-relief time, dosage of postoperative antibiotics, surgical blood loss, shift in serum hemoglobin, shift in serum hematocrit, proportion of postoperative intravenous fluid injection over 2 days after surgery, and blood transfusion) were collected from the patients' charts and the hospital's database. Flatulence-relief time was calculated as the number of hours after surgery required to expel the build-up of colon gas, as reported by the patient; patients were encouraged to commence an oral dietary intake as soon as flatulence was relieved. A complete blood count and differential count were obtained at admission and 24 hours postoperatively. The operative time was calculated as the time from application of the vaginal douche for uterine manipulator insertion to the final closure of the trocar incision wound. Surgical blood loss was estimated by the surgeon and the circulating nurses at the end of the surgery by examining the amount of blood contained in the suction container and on the surgical sponges.

All laparoscopic procedures were performed under general endotracheal anesthesia. In all patients, one 10 mm main trocar was inserted supraumbilically, and three 5 mm trocars were inserted into the lower abdomen (one in the suprapubic area, and two in an upper lateral position). Only bipolar forceps and monopolar scissors were used. The vaginal vault was closed with interrupted or continuous locking 1/0 polyglactin sutures. None of the patients underwent reperitonealization.

Differences in the means of continuous variables were tested using the Student's *t*-test. The chi-squared test was used to measure differences in nominal variables between the two groups. A p value < 0.05 was considered statistically significant. Significant variables in the univariate analyses were included in a logistic regression model to identify the risk factors for postoperative pelvic cellulitis. All statistical analyses were performed on a personal computer with the statistical package SPSS for Windows (Version 17.0; SPSS Inc., Chicago, IL, USA). A prospective randomized controlled trial or cohort study is the highest level priprity of study design to have the least bias.

Results

Group 1 (patients with postoperative pelvic cellulitis) consisted of 11 patients with a mean age of 45.82 ± 1.40 years. Group 2 (patients without postoperative pelvic cellulitis) consisted of 184 patients with a mean age of 46.94 ± 8.40 years. There were no statistical differences in mean age ($p = 0.67$) or mean parity (2.645 vs 2.46; $p = 0.82$) between the two groups. There were more patients in ASA class 2 in group 1 than in group 2 (81.8% vs 40.2%; $p = 0.017$). In addition, the grade of pelvic adhesion was significantly more severe in group 1 than in group 2 ($p = 0.044$) (Table 1).

The mean length of hospital stay was significantly longer for group 1 than group 2 patients (6.45 days vs 4.54 days; $p = 0.01$). There were no significant differences in mean operation time, mean flatulence-relief time, dosage of postoperative antibiotics, surgical blood loss, mean shift in serum hemoglobin, mean shift in serum hematocrit, proportion of postoperative intravenous fluid injection over 2 days after surgery, or blood transfusion between the two groups (Table 2).

Table 3 shows the association between patients' characteristics and the occurrence of postoperative pelvic cellulitis. Among the 195 patients, 83 of them were classified as being in ASA class II, and the remaining 112 patients were classified as being in ASA class I. Logistic regression analysis revealed that patients in ASA class II were almost six times more likely to develop postoperative pelvic cellulitis than patients in ASA class I [$\mathrm{Exp}(\beta) = 5.822$, 95% confidence interval (CI) 1.03−33.64]. This indicates that ASA can serve as a good predictor of pelvic cellulitis.

We also found that the risk for postoperative pelvic cellulitis increased with the severity of pelvic adhesion [$\beta = 0.785$, $\mathrm{Exp}(\beta) = 2.191$, 95% CI 1.21−3.82]. The result revealed that there was a twofold increase in risk for pelvic cellulitis with

Table 1
Comparison of characteristics of women undergoing laparoscopic-assisted vaginal hysterectomy.

Variable	Group 1 With pelvic cellulitis		Group 2 Without pelvic cellulitis		p[a]
Age (y)	11	45.82 (± 1.40) [43.08 to 48.56]	184	46.94 (± 8.40) [30.48 to 63.40]	0.67
Parity	11	2.645 (± 0.67) [1.33 to 3.96]	184	2.46 (± 2.55) [−2.54 to 7.46]	0.82
Pelvic adhesion	11		184		0.044
0	5 (45.4%)		129 (70.1%)		
1	0 (0%)		19 (10.3%)		
2	3 (27.3%)		20 (10.9%)		
3	3 (27.3%)		16 (8.7%)		
ASA	11		184		0.017
1	2 (18.2%)		110 (59.8%)		
2	9 (81.8%)		74 (40.2%)		

Data are presented as number, mean (± standard deviation), and 95% confidence interval, or number of cases (percentage).
ASA = American Society of Anesthesiologists physical status scale.
[a] Student's t-test for continuous variables, chi-squared test for normal variables.

each single-grade increase in the degree of pelvic adhesion. In addition, logistic regression analysis revealed that the risk for postoperative pelvic cellulitis increased significantly with increasing length of hospital stay [$\beta = 1.003$; $\text{Exp}(\beta) = 2.727$, 95% CI 1.38−5.44].

The logistic regression equation was calibrated as shown at the bottom of Table 3. The predictive ability of the equation was 97.43% (190/195), indicating that the equation can serve as a good instrument for predicting the occurrence of pelvic cellulitis.

Discussion

Postoperative infection is a common complication after hysterectomy and is associated with significant morbidity and mortality. Postoperative pelvic infections affect up to 38% of all women who undergo gynecological surgery. Therefore, the prevention or reduction of postoperative infection continues to be a major goal for all surgeons. The third most common hospital infection is surgical site infection, recently defined by the Centers for Disease Control and Prevention (CDC) as infections that occur at or near the surgical incision [6]. Surgical site infections are divided into two categories according to the CDC guidelines: an organ or space surgical site infection, and a superficial or deep incisional infection [6, 7]. Infections defined as organ or space surgical site infections must occur within 30 days of an operative procedure and must occur in conjunction with one of the following: diagnosis by a physician; exploration, radiographic imaging, or histopathology suggestive of an infection or abscess; bacteria isolated from tissue or cultures taken from the site of infection; or purulent material detected when a drain is placed in the space or site of concern [7].

Hysterectomy carries a high rate of infection, presumably because the vaginal flora cannot be eliminated from the operative site. Post-hysterectomy pelvic soft tissue infections range in severity from pelvic cellulitis to infected pelvic hematoma/abscess, pelvic cellulitis being the most common

Table 2
Comparison of medical outcomes of women undergoing laparoscopic-assisted vaginal hysterectomy.

Variable	Group 1 With pelvic cellulitis		Group 2 Without pelvic cellulitis		p[a]
Operation time (min)	11	142.73 (± 61.74) [21.72 to 263.74]	184	152.55 (± 60.58) [33.81 to 271.29]	0.60
Length of hospital stay (d)	11	6.45 (± 3.36) [−0.14 to 13.04]	184	4.54 (± 0.41) [3.74 to 5.34]	0.01
Shift in serum hemoglobin (g/L)	11	−8.7 (± 9) [−26.3 to 8.9]	184	−6.9 (± 10.1) [−26.7 to 12.9]	0.67
Shift in serum hematocrit (%)	11	−2.07 (± 2.54) [−7.05 to 2.91]	184	−2.16 (± 2.41) [−6.89 to 2.56]	0.91
Flatulence-relief time (min)	11	674.55 (± 679.28) [−683.84 to 1978.94]	184	988.77 (± 753.76) [−488.60 to 2466.14]	0.18
Surgical blood loss (mL)	11	72.73 (± 46.71) [−18.82 to 164.28]	184	94.52 (± 72.77) [−48.11 to 237.15]	0.33
Dosage of postoperative antibiotics (vials)	11	2.27 (± 1.49) [−0.65 to 5.19]	184	2.39 (± 1.45) [−0.45 to 5.23]	0.79
Postoperative intravenous fluid injection over 2 d after surgery	11		184		0.964
No	10 (90.9%)		168 (91.3%)		
Yes	1 (9.09%)		16 (8.7%)		
Blood transfusion	11		184		0.499
No	9 (81.8%)		163 (88.6%)		
Yes	2 (18.2%)		21 (11.4%)		

Data are presented as number, mean (± standard deviation), and 95% confidence interval, or number of cases (percentage).
[a] Student's t-test for continuous variables, chi-squared test for nominal variables.

Table 3
Factors influencing the occurrence of pelvic cellulitis in women undergoing laparoscopic-assisted vaginal hysterectomy.

Variable	Logistic regression analysis				
	Regression parameter			Degree of risk increase	
	β	StDev	p	Exp(β)	95% CI
Constant	−9.380	2.128	0.000	0.000	NA
Pelvic adhesion[a]	0.785	0.291	0.007	2.191	1.21−3.82
ASA[b]	1.762	0.877	0.046	5.822	1.03−33.64
Length of hospital stay[a] (d)	1.003	0.332	0.003	2.727	1.38−5.44

Logistic regression equation: $\ln P/(1-P) = f(x) = -9.380 + 0.785 \times Pelvic\_adhesion + 1.762 \times ASA + 1.003 \times Hospital\_stay$.
ASA = American Society of Anesthesiologists physical status scale; CI = confidence interval; NA = not available.
[a] Significant at $\alpha = 0.01$ level.
[b] Significant at $\alpha = 0.05$ level.

infection after hysterectomy. The infections are usually polymicrobial. In our two patients who developed cellulitis in hospitalization, vaginal cuff culture revealed *Escherichia coli* and *Enterococcus faecalis*. With the appropriate administration of prophylactic antibiotics, the incidence of postoperative febrile morbidity is only 5% [3, 4]. Although numerous studies have demonstrated that administering prophylactic antibiotics preoperatively reduces the incidence of postoperative infection, serious postoperative infections still occur [8].

The likelihood of post-hysterectomy infection depends on many factors. Postoperative infection has been attributed to multiple clinical variables, such as age, body mass index (BMI), ASA class, grade of pelvic adhesion, excessive blood loss, and prolonged surgical time.

Several patient characteristics and surgical factors have been shown to increase the risk for postoperative infections in obstetric and gynecological patients. Several risk factors can be controlled preoperatively and postoperatively by surgeons, such as the patient's being underweight, their nutrition, and blood glucose level; however, some factors, such as age, cannot be controlled. Obesity is a known risk factor for postoperative infection and may reflect poor hygiene and inadequate nutrition. In addition, obese patients often have poor glucose control and may require prolonged operative time [9, 10]. It has also been shown that antibiotic agents should be adjusted to the patient's body weight. Forse et al [11] showed doubling the dose of antibiotic reduced the rate of wound infection from 16.5% to 5.6%.

In addition, poor glucose control (blood glucose levels >11.1 mmol/L) within the first 48 hours postoperatively, older age, malnutrition, acute hypovolemia, and chronic underlying diseases (i.e., cirrhosis or immunocompromised status) that can further suppress the immune system in patients with pre-existing immune dysfunction have also been shown to be risk factors for postoperative infection [6,12–14]. Patients with those risk factors, alone or in combination (for ASA class II or higher), have an increased likelihood of poor healing at the operative site and subsequent infection. In addition, poor nutrition and hygiene, factors associated with lower socioeconomic status, have also been shown to increase the risk for postoperative complications [15].

Furthermore, many studies have demonstrated a direct relationship between bacterial vaginosis and postoperative pelvic infection [16, 17]. Bacterial vaginosis is characterized by the imbalance of naturally occurring bacterial flora. Perhaps, before operative procedures, physicians should test for various bacterial species (Gram-positive, Gram-negative, aerobic, and anaerobic bacteria) known to be associated with postoperative infection when present in large numbers [17]. All our patients received a preoperative vaginal douche after anesthesia to help promote a healthy vaginal microflora.

Surgical risk factors also play a role in postoperative infection. The status of a surgical wound (i.e., clean, clean-contaminated, or contaminated) influences the level of risk. During hysterectomy, the vagina is opened, and contamination of normally sterile tissue with potential pathogens of the vaginal microflora is possible. Therefore, re-establishment of healthy vaginal microflora and the administration of prophylactic antibiotics may reduce the rate of postoperative infection. An antibiotic with an adequate half-life in relation to the length of the operation performed should be administered within 30 minutes of starting the operation, as with all the women in this study [3]. Surgical time, however, can alter the effectiveness of preoperative prophylactic antibiotics. If the operation lasts considerably longer than the half-life of the antibiotic used, a second dose should be administered. Excessive blood loss also decreases the serum antibiotic level [3]. Therefore, multiple factors are involved in the prevention of postoperative infectious morbidity and mortality [3].

ASA scale and length of hospital stay are well-known risk factors for postoperative pelvic cellulitis [18, 19]. Longer length of hospital stay and higher ASA class have also been shown to be associated with pre-existing immune dysfunction [20–22]. We found that patients in ASA class II had an almost six times greater risk for developing postoperative pelvic cellulitis than patients in ASA class I (Table 3). In our study, the mean length of hospital stay in group 1 was significantly longer than in group 2; the longer hospital stays increased the rate of postoperative pelvic cellulitis. Therefore, it is possible that earlier feeding when patients are hungry might significantly reduce hospital admission time and postoperative pelvic cellulitis.

Grade of pelvic adhesion is also a risk factor for postoperative pelvic cellulitis. We found that there was a twofold increase in risk for postoperative pelvic cellulitis with each single-grade increase in the level of pelvic adhesion (Table 3). Many pelvic laparoscopic procedures leave behind blood and necrotic tissue. The high incidence of postoperative pelvic cellulitis in patients with severe pelvic adhesion can be explained at least in part by the fact that these patients experienced longer operation times and had more electrocoagulation-induced tissue damage. Robotic surgery is not widely available, but this is potentially one method of decreasing operative time in case where extensive pelvic adhesions are present.

Although inflammation is normal at the operative site as wound healing proceeds, clinicians must remain alert to the possible development of pelvic cellulitis or abscess formation. Pelvic cellulitis may involve an infected fluid collection or hematoma that encompasses the retroperitoneal space at the vaginal apex without abscess formation. Patients typically present 5–10 days after surgery with fever, an increase in lower abdominal pain, increased vaginal discharge exuding from the vaginal cuff, or a sensation of pelvic fullness [15]. Bimanual pelvic examination shows pelvic tenderness and motion tenderness. All our patients with postoperative pelvic cellulitis complained of pelvic tenderness and cuff motion tenderness during pelvic examination. Abscesses develop when infected hematomas or pelvic cellulitis spreads into the parametrial pelvic soft tissue [23]. The symptoms mirror those of pelvic cellulitis or hematomas with the addition of a mass corresponding to the collection of infected fluid at the operative site.

In conclusion, understanding the risk factors for postoperative pelvic infection such as systemic disease (ASA class II or higher), pelvic adhesion, and prolonged hospital stay, in addition to comprehensive patient care, will help reduce the rate of postoperative pelvic cellulitis in women undergoing LAVH. Moreover, the incidence of postoperative pelvic cellulitis could be lowered by the correction of modifiable risk factors, for example decreasing the length of hospital stay by earlier feeding, modifying comorbidities (improved glucose control and being of optimal body weight), and potentially decreasing operative times with robotic surgery. We emphasize the importance of a complete preoperative assessment, treatment plan, and care for women who undergo LAVH.

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