Clinical Investigation / Araştırma

DOI: 10.4274/tjod.galenos.2026.12428

Turk J Obstet Gynecol

Vulvar re-antisepsis and urinary tract infection after CO_2 cystoscopy in laparoscopic hysterectomy

Laparoskopik histerektomide CO_2 sistoskopi öncesi vulvar re-antisepsi ve idrar yolu enfeksiyonu

Alaattin Karabulut[1], Sevim Selen Karabulut[2], Sercan Kantarcı[1], Uğurcan Dağlı[1], Nilsu Özaslan Kutucu[1], Ahmet Güdüklü[3], Volkan Karataşlı[4], Adnan Budak[1], Abdurrahman Hamdi İnan[1]

[1]*University of Health Sciences Türkiye, Tepecik Training and Research Hospital, Department of Obstetrics and Gynecology, İzmir, Türkiye*

[2]*İzmir City Hospital, Department of Infectious Diseases and Clinical Microbiology, İzmir, Türkiye*

[3]*Foça State Hospital, Clinic of Obstetrics and Gynecology, İzmir, Türkiye*

[4]*University of Health Sciences Türkiye, Balıkesir Atatürk City Hospital, Department of Gynecologic Oncology, Balıkesir, Türkiye*

Abstract

Objective: To evaluate whether vulvar re-antisepsis before carbon dioxide (CO_2) cystoscopy after laparoscopic hysterectomy is associated with a lower incidence of postoperative urinary tract infection (UTI).

Materials and Methods: This prospective observational study included 98 women who underwent laparoscopic hysterectomy between November 25, 2025, and March 1, 2026. All patients received routine preoperative abdominal and vulvovaginal preparation with 10% povidone-iodine. According to routine intraoperative practice and surgeon preference, 53 patients underwent standard antisepsis alone, and 45 received additional vulvar and periurethral re-antisepsis immediately before CO_2 cystoscopy. The primary outcome was a postoperative UTI, defined according to Centers for Disease Control and Prevention/National Healthcare Safety Network criteria. Logistic regression was used to explore factors associated with postoperative UTI. The study was registered at clinicaltrials.gov (NCT07232446).

Results: Postoperative UTI occurred in 8 patients (15.1%) in the standard antisepsis group and in 4 patients (8.9%) in the re-antisepsis group (p=0.538). Vulvar re-antisepsis was not associated with postoperative UTI in the exploratory multivariable model [adjusted odds ratio (OR)=0.89, 95% confidence interval (CI): 0.19-4.23; p=0.881]. Delayed catheter removal (>6 hours) was associated with postoperative UTI (adjusted OR=12.87, 95% CI: 2.13-77.62; p=0.005).

Conclusion: Vulvar re-antisepsis before CO_2 cystoscopy did not result in a statistically significant reduction in postoperative UTIs. Given the limited number of events and the non-randomized design, these findings should be interpreted as exploratory.

Keywords: Antisepsis, carbon dioxide, cystoscopy, laparoscopic hysterectomy, urinary tract infection

Öz

Amaç: Laparoskopik histerektomi sonrasında uygulanan karbon dioksit (CO_2) sistoskopi öncesinde vulvar re-antisepsi yapılmasının postoperatif idrar yolu enfeksiyonu (İYE) insidansında azalma ile ilişkili olup olmadığını değerlendirmektir.

Gereç ve Yöntemler: Bu prospektif gözlemsel çalışmaya 25 Kasım 2025 ile 1 Mart 2026 tarihleri arasında laparoskopik histerektomi uygulanan 98 kadın dahil edildi. Tüm hastalara ameliyat öncesinde %10 povidon-iyot ile rutin abdominal ve vulvovajinal antiseptik hazırlık uygulandı. Rutin intraoperatif uygulama ve cerrah tercihine göre 53 hastaya yalnızca standart antisepsi uygulanırken, 45 hastaya CO_2 sistoskopiden hemen önce ek

PRECIS: In this prospective observational study, vulvar re-antisepsis before carbon dioxide cystoscopy was not associated with a significant reduction in postoperative urinary tract infection after laparoscopic hysterectomy.

Corresponding Author/Sorumlu Yazar: Alaattin Karabulut MD,
University of Health Sciences Türkiye, Tepecik Training and Research Hospital, Department of Obstetrics and Gynecology, İzmir, Türkiye
E-mail: alaattin_karabulut@hotmail.com **ORCID ID:** orcid.org/0000-0002-0244-4401

Received/Geliş Tarihi: 25.07.2026 **Accepted/Kabul Tarihi:** 26.08.2026 **Epub:** 01.09.2026

Cite this article as: Karabulut A, Karabulut SS, Kantarcı S, Dağlı U, Özaslan Kutucu N, Güdüklü A, et al. Vulvar re-antisepsis and urinary tract infection after CO_2 cystoscopy in laparoscopic hysterectomy. Turk J Obstet Gynecol. [Epub Ahead of Print]

vulvar ve periüretral yeniden antisepsi uygulandı. Birincil sonlanım noktası, *Centers for Disease Control and Prevention/National Healthcare Safety Network* kriterlerine göre tanımlanan postoperatif İYE idi. Postoperatif İYE ile ilişkili faktörleri araştırmak amacıyla lojistik regresyon analizi kullanıldı. Çalışma clinicaltrials.gov'a kaydedilmiştir (NCT07232446).

Bulgular: Postoperatif İYE, standart antisepsi grubunda 8 hastada (%15,1), re-antisepsi grubunda ise 4 hastada (%8,9) görüldü (p=0,538). Keşifsel çok değişkenli modelde vulvar re-antisepsi postoperatif İYE ile ilişkili değildi [düzeltilmiş olasılık oranı (OR)=0,89; %95 güven aralığı (GA): 0,19-4,23; p=0,881]. Gecikmiş kateter çıkarılması (>6 saat) postoperatif İYE ile ilişkili bulundu (düzeltilmiş OR=12,87; %95 GA: 2,13-77,62; p=0,005).

Sonuç: CO_2 sistoskopi öncesinde uygulanan vulvar re-antisepsi, postoperatif İYE sıklığında istatistiksel olarak anlamlı bir azalma göstermedi. Olay sayısının sınırlı olması ve randomize olmayan tasarım göz önüne alındığında, bu bulgular keşifsel olarak yorumlanmalıdır.

Anahtar Kelimeler: Antisepsi, karbondioksit, sistoskopi, laparoskopik histerektomi, idrar yolu enfeksiyonu

Introduction

Urinary tract injury is a significant complication of laparoscopic hysterectomy, particularly when pelvic anatomy is distorted by fibroids, adhesions, prior surgery, endometriosis. Intraoperative cystoscopy is therefore commonly used to assess urinary tract integrity and to facilitate early recognition of bladder or ureteral injury[1-4].

Routine or liberal use of cystoscopy after laparoscopic hysterectomy has therefore been advocated by many surgeons as a practical means of identifying unsuspected bladder or ureteral injury before the patient leaves the operating room. Early recognition allows immediate correction and may reduce delayed morbidity, although the broader effect of universal cystoscopy on postoperative injury rates remains debated. Systematic reviews and large cohort studies have shown that cystoscopy clearly improves intraoperative recognition of urinary tract injury, yet its association with delayed postoperative genitourinary complications has been less consistent across studies[2-5].

Another practical issue concerns how cystoscopy is performed. Historically, saline distension with intravenous indigo carmine was widely used to confirm ureteral patency, but dye shortages and concerns regarding availability, cost, workflow, and adverse effects have stimulated interest in alternative techniques. Studies evaluating sodium fluorescein, phenazopyridine, mannitol, dextrose-containing media, and other approaches have shown that visualization of ureteral jets can be achieved in different ways, but these techniques may differ in surgeon satisfaction, ease of interpretation, operative efficiency, and postoperative urinary outcomes[6-8].

In this context, carbon dioxide (CO_2) cystoscopy has emerged as an attractive alternative. CO_2 provides a clear visual field, avoids reliance on dyes or diuretics, and may shorten the time needed to visualize ureteral jets. Prior studies have suggested that CO_2 cystoscopy is feasible, safe, and efficient in gynecologic laparoscopy, with satisfactory visualization of bladder mucosa and ureteral efflux. More recent prospective data have further supported its diagnostic utility during laparoscopic gynecologic surgery, including total laparoscopic hysterectomy[9,10].

Despite the growing acceptance of intraoperative cystoscopy, attention has increasingly shifted from injury detection alone to the broader perioperative consequences of the procedure itself. Postoperative urinary symptoms, transient retention, delayed catheter removal, retained bladder fluid, and urinary tract infection (UTI) have been examined as clinically relevant outcomes after cystoscopy performed during laparoscopic hysterectomy. Although some trials found no clear effect of retained cystoscopy fluid on postoperative voiding outcomes, other studies have suggested that specific cystoscopy media—particularly dextrose-based solutions—may influence postoperative urinary symptoms or UTI risk[7,8,11].

From an infection-control perspective, contamination of the operative field by vaginal flora remains a longstanding concern during hysterectomy. Vaginal and vulvovaginal preparation are, therefore, routine components of gynecologic surgery, but the optimal agent and the ideal timing of antiseptic application remain unknown. Earlier research emphasized that hysterectomy-related infectious morbidity is closely linked to bacterial contamination from the vagina and suggested that additional or better-timed antiseptic measures might be beneficial, although the available evidence was limited and methodologically heterogeneous[12,13]. More recent randomized and observational studies comparing povidone-iodine and chlorhexidine before hysterectomy have shown lower intraoperative bacterial counts with the latter in some settings, yet the effect on postoperative infectious outcomes—including UTI—has been inconsistent[14-17].

Most published studies on gynecologic antisepsis have focused on preoperative vaginal preparation. By contrast, very little attention has been paid to whether a second antiseptic application immediately before intraoperative cystoscopy might reduce contamination during urethral and vulvar instrumentation. This question is clinically relevant because cystoscopy is typically performed after completion of a hysterectomy, at a time when the operation is already underway, tissue handling has occurred, and the initial surgical preparation may no longer fully reflect the microbial conditions in the vulvovaginal field. At the same time, current surveillance definitions make clear that UTI is strongly influenced by urinary tract instrumentation and catheter exposure, underscoring the importance of perioperative measures that may reduce avoidable contamination[18].

To our knowledge, no study has specifically evaluated whether vulvar re-antisepsis immediately before CO_2 cystoscopy after laparoscopic hysterectomy is associated with postoperative UTI rates. The present study was designed to compare

postoperative urinary symptoms and UTI outcomes between patients who underwent standard antiseptic preparation alone and those who received additional vulvar re-antisepsis before intraoperative CO_2 cystoscopy.

Materials and Methods

Study Design

This prospective observational study evaluated the effect of vulvar re-antisepsis, administered before CO_2 cystoscopy performed after laparoscopic hysterectomy, on postoperative UTIs at a high-volume tertiary referral center. Patients who underwent laparoscopic hysterectomy between November 25, 2025, and March 1, 2026, were included in the study. The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the University of Health Sciences Türkiye, İzmir Tepecik Training and Research Hospital Non-Interventional Research Ethics Committee (approval number: 2025/08-24, date: 11.09.2025). The study was prospectively registered at clinicaltrials.gov (NCT07232446), and written informed consent was obtained from all participants before enrollment. Given the observational design and the procedural nature of the intervention, surgeons, patients, and outcome assessors were not blinded to group allocation.

Study Population

Women undergoing laparoscopic hysterectomy for benign gynecologic indications were eligible for inclusion. Patients were enrolled consecutively during the study period. Patients with preoperative urinary symptoms were excluded. Additional exclusion criteria were uncontrolled diabetes mellitus, immunosuppression, a positive preoperative urine culture, a known urinary tract anomaly, conversion to laparotomy, continuation of surgery via the vaginal route, and a postoperative pathological diagnosis of malignancy. A total of 98 patients were included in the final analysis. Of these, 53 patients were managed with standard antisepsis alone, and 45 underwent additional vulvar re-antisepsis before cystoscopy.

Perioperative Management

All procedures were performed laparoscopically. In patients without contraindications, perioperative antibiotic prophylaxis was administered as 2 g of intravenous cefazolin. Surgical field preparation with 10% povidone-iodine included both the abdominal and vulvovaginal operative fields. After sterile draping, laparoscopic hysterectomy was carried out using a standard intraperitoneal approach.

Study Groups

Patients were classified based on whether vulvar antisepsis was repeated immediately before intraoperative cystoscopy. Group allocation was not randomized and reflected surgeon-specific routine practice. Some surgeons routinely performed repeated vulvar and periurethral antisepsis immediately before cystoscopy, whereas others did not. Thus, the operating surgeon's usual practice, rather than predefined patient-level UTI risk criteria or case complexity, primarily determined the decision. In the standard antisepsis group, all patients underwent abdominal and vulvovaginal preparation with 10% povidone-iodine before surgery; however, no repeat vulvar antiseptic application was performed immediately before cystoscopy. In the vulvar re-antisepsis group, immediately before cystoscope insertion, the vulvar and periurethral areas, including the urethral meatus and vaginal introitus, were prepared again by the operating team using sterile gauze and 10% povidone-iodine. The antiseptic solution was allowed to remain in contact with the prepared area for approximately 1 minute before cystoscope insertion. This additional preparation was performed after completion of laparoscopic hysterectomy and immediately before CO_2 cystoscopy.

The same perioperative antibiotic prophylaxis protocol was applied in both groups. All patients included in the study received intravenous cefazolin before skin incision. No patient had a documented beta-lactam allergy; therefore, no alternative prophylactic regimen was required.

CO_2 Cystoscopy Technique

After completion of laparoscopic hysterectomy, intraoperative cystoscopy was performed using CO_2 as the bladder distension medium. Before cystoscopy, the bladder was emptied and the Foley catheter balloon was deflated. Bladder insufflation was achieved using a trocar and Foley catheter setup. A 30 degree, 5 mm optic was then used to evaluate the bladder mucosa and the bilateral ureteral jet efflux. After cystoscopic evaluation, the Foley catheter was reinserted into the bladder and the balloon was reinflated. CO_2 cystoscopy was performed using the technique reported by Inan et al.[10].

Postoperative Management and Follow-up

The routine postoperative practice was to remove the urinary catheter 6 hours after surgery. No predefined criteria were used for catheter retention beyond 6 hours. When catheter removal was delayed, timing was individualized based on the patient's postoperative clinical condition and intraoperative or surgical circumstances. All patients were followed for 6 weeks postoperatively. Patients were routinely scheduled for outpatient follow-up visits on postoperative days 10 and 30 and were assessed for urinary symptoms during these visits. Postoperative urinary symptoms included dysuria, urinary urgency, urinary frequency, suprapubic pain or tenderness, and costovertebral angle tenderness or flank pain/tenderness, consistent with the symptom components of the Centers for Disease Control and Prevention/National Healthcare Safety Network (CDC/NHSN) criteria for symptomatic UTI, and were assessed based on patient-reported complaints during postoperative follow-up. The operating surgical team assessed postoperative urinary symptoms during routine follow-up

visits. When clinically indicated, urinalysis and urine culture were obtained, and treatment was initiated as appropriate. The same follow-up approach and clinical threshold for obtaining urinalysis and urine culture were applied in both groups.

Data Collection

Clinical data were recorded prospectively using a structured case report form. Baseline variables included age, body mass index, gravidity, parity, menopausal status, smoking status, diabetes mellitus, previous abdominal surgery, and hormone replacement therapy use. Operative variables included surgical indication, operation time, and cystoscopy time; postoperative variables included delayed catheter removal, urinary symptoms, and UTI. Operation time was recorded separately from cystoscopy time and did not include the cystoscopy duration. Delayed catheter removal was defined as removal of the catheter later than 6 hours after surgery. Postoperative UTI was defined according to the CDC/NHSN criteria. Diagnosis required compatible urinary symptoms together with a positive urine culture, in accordance with CDC/NHSN criteria[18].

Statistical Analysis

Continuous variables were assessed for distributional characteristics and are presented as mean ± standard deviation or median (interquartile range), as appropriate. Categorical variables are presented as numbers (%). Between-group comparisons of continuous variables were performed using the independent-samples t-test or Mann-Whitney U test, as appropriate. Categorical variables were compared using the χ^2 test or Fisher's exact test. No formal a priori sample size calculation was performed because this was an exploratory, prospective, observational study that included consecutive eligible patients enrolled during the predefined study period. Logistic regression analysis was used to explore factors associated with postoperative UTI. The regression model included the following variables: vulvar re-antisepsis, age, body mass index, diabetes mellitus, operation time, delayed catheter removal (>6 hours), and cystoscopy time. Because of the limited number of postoperative UTI events, multivariable logistic regression was considered exploratory. Covariates were selected based on clinical relevance, and no automated stepwise variable-selection procedure was used. Adjusted estimates were interpreted cautiously because of the risk of model overfitting and imprecision. Crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. All statistical analyses were performed using SPSS Statistics for Windows, version 24.0 (IBM Corp., Armonk, NY, USA). All tests were two-sided; a p-value of <0.05 was considered statistically significant. Given the exploratory nature of the analyses, no formal adjustment for multiple comparisons was applied.

Results

A total of 107 patients were assessed for eligibility. Nine patients were excluded because of a positive preoperative urine culture (n=5), uncontrolled diabetes mellitus (n=3), or a known urinary tract anomaly (n=1). No patients met the remaining predefined exclusion criteria during the study period. The final study population consisted of 98 patients, of whom 53 were included in the standard antisepsis group and 45 were included in the vulvar re-antisepsis group (Figure 1). All patients included in the study completed the 6 weeks follow-up and were analyzed.

Baseline demographic and preoperative characteristics were comparable between the groups. The median age was 51 (47-56.5) years in the standard antisepsis group and 48 (46-55.5) years in the vulvar re-antisepsis group (p=0.226). Gravidity, parity, postmenopausal status, body mass index, smoking status, diabetes mellitus, previous abdominal surgery, and hormone replacement therapy use did not differ significantly between the groups (Table 1).

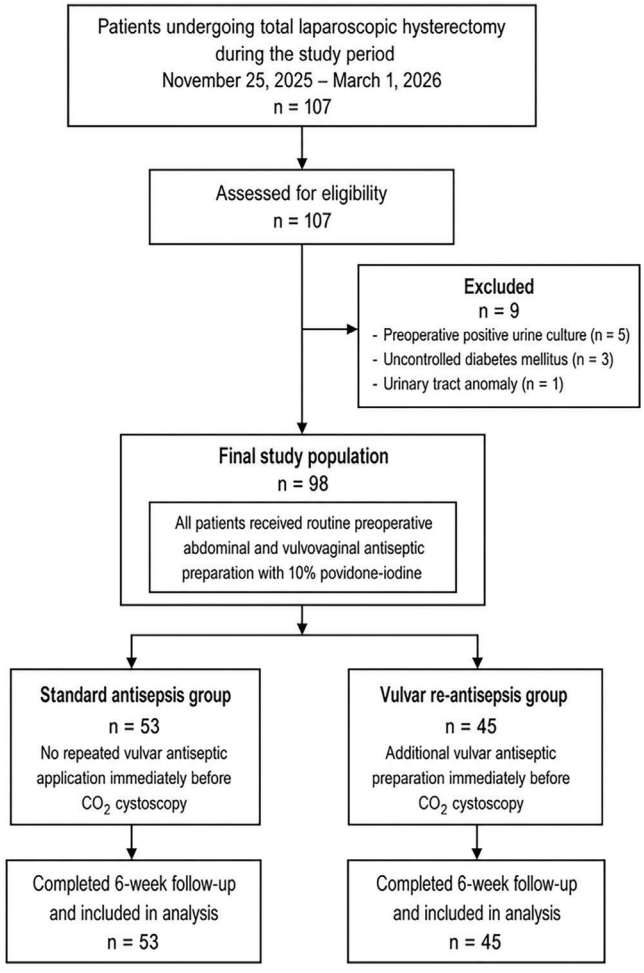

Figure 1. Participant flow diagram

The distribution of surgical indications did not differ significantly between the groups (p=0.140). Myoma was the most common indication in both groups, accounting for 43.4% of cases in the standard antisepsis group and for 40.0% in the vulvar re-antisepsis group. The median operation time was 140 (101-210) minutes in the standard antisepsis group and 124 (89.5-142) minutes in the vulvar re-antisepsis group; this difference was not statistically significant (p=0.070). The median cystoscopy time was 3 (2-5) minutes in the standard group and 3 (2-4) minutes in the vulvar re-antisepsis group (p=0.730). Delayed catheter removal (>6 hours) occurred in 10 patients (18.9%) in the standard antisepsis group and in 4 patients (8.9%) in the vulvar re-antisepsis group (p=0.247) (Table 2).

Postoperative urinary symptoms occurred in 17 patients (32.1%) in the standard antisepsis group and in 8 patients (17.8%) in the vulvar re-antisepsis group, respectively, corresponding to an absolute risk difference of -14.3 percentage points (95% CI: -31.1 to 2.5). Although the frequency was lower in the vulvar re-antisepsis group, the difference was not statistically significant (p=0.162). Similarly, postoperative UTI diagnosed according to CDC/NHSN criteria was observed in 8 patients (15.1%) in the standard antisepsis group and in 4 patients (8.9%) in the vulvar re-antisepsis group, corresponding to an absolute risk difference of -6.2 percentage points (95% CI: -18.9 to 6.5), although this difference was not statistically significant (p=0.538) (Table 2). No adverse events or unintended effects related to vulvar re-antisepsis or CO_2 cystoscopy were observed in either group.

Univariable logistic regression analysis showed no significant association between vulvar re-antisepsis and postoperative UTI (crude OR: 0.55, 95% CI: 0.15-1.96, p=0.355). Age, body mass index, diabetes mellitus, and cystoscopy time were

Table 1. Baseline demographic and preoperative characteristics

	Standard antisepsis (n=53)	Vulvar re-antisepsis (n=45)	p-value
Age, years	51 (47-56.5)	48 (46-55.5)	0.226
Gravidity	2 (2-3)	2 (2-3)	0.402
Parity	2 (2-3)	2 (1-2)	0.179
Postmenopausal, n (%)	30 (56.6%)	25 (55.6%)	0.917
BMI, kg/m^2	27.19±4.07	26.46±4.30	0.391
Smoking, n (%)	13 (24.5%)	13 (28.9%)	0.653
Diabetes mellitus, n (%)	10 (18.9%)	9 (20.0%)	0.888
Previous abdominal surgery, n (%)	33 (62.3%)	30 (66.7%)	0.678
HRT use, n (%)	2 (3.8%)	2 (4.4%)	1.000

Continuous variables are presented as median (IQR) or mean ± SD, as appropriate; categorical variables are presented as n (%)
BMI: Body mass index, HRT: Hormone replacement therapy, IQR: Interquartile range, SD: Standard deviation

Table 2. Operative characteristics and postoperative urinary outcomes

	Standard antisepsis (n=53)	Vulvar re-antisepsis (n=45)	p-value
Operation indication, n (%)			
Abnormal uterine bleeding	8 (15.1%)	11 (24.4%)	0.140
Myoma	23 (43.4%)	18 (40.0%)	
Pelvic organ prolapse	13 (24.5%)	4 (8.9%)	
Endometrial hyperplasia	6 (11.3%)	5 (11.1%)	
Other	3 (5.7%)	7 (15.6%)	
Operation time, min	140 (101-210)	124 (89.5-142)	0.070
Cystoscopy time, min	3 (2-5)	3 (2-4)	0.730
Delayed catheter removal (>6 hours), n (%)	10 (18.9%)	4 (8.9%)	0.247
Postoperative urinary symptoms, n (%)	17 (32.1%)	8 (17.8%)	0.162
Postoperative UTI, n (%)	8 (15.1%)	4 (8.9%)	0.538

Continuous variables are presented as median (IQR); categorical variables are presented as n (%)
UTI: Urinary tract infection, IQR: Interquartile range

not significantly associated with postoperative UTI in this analysis. Operation time was associated with postoperative UTI in the crude model (crude OR: 1.01, 95% CI: 1.00-1.02, p=0.013), and delayed catheter removal (>6 hours) was strongly associated (crude OR: 9.75, 95% CI: 2.54-37.43, p=0.001) (Table 3).

In the exploratory multivariable model, vulvar re-antisepsis was not associated with postoperative UTI (adjusted OR: 0.89, 95% CI: 0.19-4.23, p=0.881). Among the variables entered into the model, delayed catheter removal (>6 hours) was the only factor that remained statistically associated with postoperative UTI (adjusted OR: 12.87, 95% CI: 2.13-77.62, p=0.005). Operation time was no longer statistically significant after adjustment (adjusted OR: 1.01, 95% CI: 1.00-1.02, p=0.101) (Table 3).

Discussion

In this prospective observational study, we evaluated whether vulvar re-antisepsis, performed immediately before intraoperative CO_2 cystoscopy after laparoscopic hysterectomy, reduced postoperative UTIs. Although the rate of postoperative UTI was numerically lower in the vulvar re-antisepsis group than in the standard antisepsis group, this difference did not reach statistical significance. In contrast, delayed catheter removal was the only factor that remained statistically associated with postoperative UTI in the exploratory multivariable model.

Urinary tract injury and its early intraoperative detection remain central concerns in laparoscopic hysterectomy. Routine cystoscopy has been widely adopted to improve detection of ureteral and bladder injuries, and several studies have demonstrated that intraoperative cystoscopy increases the rate of immediate recognition of urinary tract injuries, thereby reducing delayed morbidity[2,4]. Although cystoscopy is beneficial for detecting injuries, its impact on postoperative urinary outcomes—particularly UTI—remains unclear.

Previous studies investigating cystoscopy-related factors have yielded heterogeneous results regarding postoperative urinary morbidity. For example, the type of distension medium has been suggested as a potential contributor to infection risk. Dextrose-containing media have been associated with increased rates of postoperative UTI, possibly due to transient glucosuria promoting bacterial growth[7]. In contrast, Misal et al.[8] compared postoperative urinary symptoms after benign laparoscopic hysterectomy between patients undergoing cystoscopy with 50% dextrose and those undergoing cystoscopy with saline and intravenous indigo carmine. They reported no significant difference in postoperative urinary symptoms or empiric treatment for UTI between the groups, suggesting that the relationship between the cystoscopy medium and postoperative urinary morbidity may depend on patient characteristics, perioperative context, and the specific distension protocol used. These findings suggest that while cystoscopy itself is an important diagnostic tool, modifiable perioperative factors may influence infection risk.

CO_2 cystoscopy represents an alternative approach that avoids the use of liquid distension media and dyes. Previous reports have demonstrated that CO_2 cystoscopy is feasible, safe, and efficient for assessing ureteral patency during laparoscopic gynecologic surgery[9,10]. In the present study, CO_2 cystoscopy provided a standardized intraoperative assessment for all patients, thereby minimizing variability attributable to the cystoscopic technique. This is important when interpreting the effects of additional interventions, such as vulvar re-antisepsis.

The rationale for vulvar re-antisepsis before cystoscopy is the potential for contamination during the procedure. Although preoperative vaginal and vulvovaginal antisepsis is a standard component of gynecologic surgery, bacterial recolonization of the operative field during the procedure is well recognized. Earlier studies have shown that vaginal antiseptic preparation reduces bacterial load and may decrease postoperative infectious complications[12,13]. More recent analyses comparing antiseptic agents have demonstrated differences in microbial colonization, although their impact on clinical infection outcomes, including UTI, has been inconsistent[14-17]. All patients in the present study received routine preoperative abdominal and vulvovaginal antisepsis. Therefore, the comparison was not between antisepsis and no antisepsis, but rather between routine preoperative antisepsis

Table 3. Exploratory logistic regression analysis of factors associated with postoperative UTI

	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Vulvar re-antisepsis	0.55 (0.15-1.96)	0.355	0.89 (0.19-4.23)	0.881
Age	1.02 (0.94-1.09)	0.697	0.99 (0.90-1.09)	0.819
BMI	1.00 (0.87-1.16)	0.968	1.01 (0.84-1.21)	0.928
Diabetes mellitus	0.81 (0.16-4.05)	0.799	0.84 (0.11-6.15)	0.863
Operation time	1.01 (1.00-1.02)	0.013	1.01 (1.00-1.02)	0.101
Delayed catheter removal (>6 hours)	9.75 (2.54-37.43)	0.001	12.87 (2.13-77.62)	0.005
Cystoscopy time	1.02 (0.75-1.39)	0.906	0.59 (0.32-1.09)	0.093

BMI: Body mass index, OR: Odds ratio, CI: Confidence interval

alone and routine antisepsis followed by repeated vulvar preparation performed immediately before cystoscopy.

Despite this theoretical rationale, our findings indicate that a single additional vulvar antiseptic application immediately before cystoscopy did not result in a statistically significant reduction in postoperative UTI rates. This may be explained by several factors. First, UTI after gynecologic surgery is multifactorial and is influenced by host characteristics, perioperative management, and urinary tract instrumentation. Second, the effect of transient contamination during cystoscopy may be limited compared with that of more dominant factors, such as catheterization duration. Finally, the relatively low number of events in our cohort may have limited the statistical power to detect a modest effect. Given the limited number of postoperative UTI events and the exploratory nature of this study, the absence of statistical significance should not be interpreted as definitive evidence of no effect. The findings indicate that vulvar re-antisepsis before CO_2 cystoscopy did not result in a statistically significant reduction in postoperative UTI in this cohort.

From a practical perspective, vulvar re-antisepsis requires only a brief additional preparation step and uses an antiseptic already routinely available in the operating room, but it nonetheless adds a procedural step and may modestly affect operative workflow. Formal cost and workflow analyses were not performed in this study. In the absence of a demonstrated reduction in postoperative UTI, the value of routinely adopting this practice should therefore be evaluated in adequately powered randomized studies.

Notably, delayed catheter removal (>6 hours) was the only factor that remained statistically associated with postoperative UTI in the exploratory multivariable model. This finding is consistent with the well-established relationship between urinary catheterization and infection risk. According to CDC/NHSN definitions and prior studies, catheter duration is a key determinant of catheter-associated UTI, with longer exposure increasing the likelihood of bacterial colonization and infection[18]. Delayed catheter removal occurred more frequently in the standard antisepsis group, although the difference was not statistically significant. This imbalance may have contributed to the numerically higher postoperative UTI rate in that group. Because the reasons for delayed catheter removal were not systematically recorded, and retention beyond 6 hours was individualized according to clinical and surgical circumstances, the observed association should not be interpreted as evidence that delayed catheter removal itself caused postoperative UTI. Delayed catheter removal may represent a potentially modifiable postoperative factor, but it may also serve as a marker of more complicated surgery or postoperative recovery. Therefore, catheter duration should be minimized whenever clinically feasible; the present association should be interpreted cautiously.

Operative time was numerically longer in the standard antisepsis group, and this difference approached statistical significance; this may reflect greater surgical complexity in some cases. Although operation time was recorded separately from cystoscopy time, the between-group difference in operation time may have influenced postoperative catheter management and urinary outcomes. In addition, the estimates for cystoscopy time should be interpreted with caution because the direction and magnitude of the association may be unstable in the context of the limited number of postoperative UTI events and possible model overfitting. Therefore, neither operation time nor cystoscopy time should be overinterpreted as a definitive, independent determinant of postoperative UTI in this cohort.

Although the overall distribution of surgical indications did not differ statistically between groups, numerical imbalances were observed for some, particularly pelvic organ prolapse and those categorized as "other." These differences may reflect variations in case mix or be related to surgical complexity or postoperative catheter management. Therefore, residual confounding related to surgical indication cannot be excluded.

The present study has several strengths. The prospective design and standardized surgical approach, including routine use of CO_2 cystoscopy, allowed for a relatively homogeneous cohort. In addition, detailed perioperative data collection enabled the evaluation of multiple potential risk factors for postoperative UTI.

Study Limitations

The observational and non-randomized design introduces the possibility of selection bias; therefore, causality cannot be inferred from these findings. Because group allocation reflected surgeon-specific routine practice, residual confounding related to surgeon-level practice patterns or differences in case mix cannot be excluded. Although re-antisepsis was not assigned according to predefined patient-level UTI risk or case-complexity criteria, the possibility of residual confounding inherent to the non-randomized design remains. The sample size was relatively small, limiting the power to detect differences in low-frequency outcomes such as UTI. In addition, only 12 postoperative UTI events occurred, limiting the stability of the multivariable model and increasing the risk of overfitting. The reasons for delayed catheter removal were not systematically recorded, which limits interpretation of this delay as an independent postoperative risk factor and suggests that it may also reflect more complex surgical or recovery-related circumstances. Therefore, adjusted ORs should be interpreted as exploratory estimates rather than definitive evidence of independent causal relationships. Urine cultures were obtained only when clinically indicated, rather than systematically from all patients. Therefore, asymptomatic bacteriuria or minimally symptomatic infections may have been missed, and ascertainment bias cannot be completely excluded. In addition, postoperative urinary assessment was performed

by the surgical team, which was aware of group allocation; therefore, differential ascertainment between groups cannot be completely excluded. Species-level microbiological data from positive urine cultures were not systematically recorded; therefore, postoperative UTI episodes could not be further characterized according to causative pathogens or antimicrobial resistance patterns. However, the same clinical threshold for urine testing was applied in both groups. The study was conducted at a single center, which may limit generalizability.

Conclusion

This prospective observational study did not demonstrate a statistically significant reduction in postoperative UTI when vulvar re-antisepsis was performed before CO_2 cystoscopy following laparoscopic hysterectomy. Delayed catheter removal was associated with postoperative UTI, suggesting that catheter management may be clinically important in this setting. Given the limited number of events and the non-randomized design, these findings should be interpreted as hypothesis-generating.

Ethics

Ethics Committee Approval: The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the University of Health Sciences Türkiye, İzmir Tepecik Training and Research Hospital Non-Interventional Research Ethics Committee (approval number: 2025/08-24, date: 11.09.2025).
Informed Consent: Written informed consent was obtained from all participants before enrollment.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.K., S.K., U.D., A.B., Concept: A.K., S.S.K., V.K., A.B., Design: A.K., S.S.K., V.K., A.B., Data Collection or Processing: A.K., N.Ö.K., A.G., Analysis or Interpretation: A.K., S.S.K., S.K., U.D., N.Ö.K., A.G., A.H.İ., Literature Search: A.K., S.S.K., S.K., U.D., A.G., A.H.İ., Writing: A.K., S.S.K., V.K., A.H.İ.
Conflict of Interest: No conflict of interest was declared by the authors.
Financial Disclosure: The authors declared that this study received no financial support.

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