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Research Article

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Independent risk factors for delayed urinary catheter removal (>21 days) after open radical hysterectomy for cervical cancer: a retrospective study

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Abstract

Background: To identify independent risk factors for delayed urinary catheter removal (>21 days) after open radical hysterectomy for cervical cancer.

Methods: This retrospective study included 285 patients who underwent open radical hysterectomy for cervical cancer, divided into a delayed group (>21 days, n=52, 18.2%) and a non-delayed group (≤21 days, n=233, 81.8%). Continuous variables were compared with the Mann–Whitney U test and categorical variables with the χ^2 test or Fisher's exact test. Variables significant on univariate analysis were entered into multivariable logistic regression after screening for clinical relevance and collinearity, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Model fit was assessed with the Hosmer–Lemeshow test and discrimination with the C statistic (area under the curve, AUC). A two-sided $P<0.05$ was considered statistically significant.

Results: Multivariable logistic regression identified lymph node metastasis (OR 6.380, 95% CI 1.45–28.09, P=0.014), intraoperative complications (OR 3.579, 95% CI 1.13–11.38, P=0.031), tramadol use (OR 5.466, 95% CI 1.68–17.81, P=0.005), and intraoperative crystalloid volume (OR 1.456 per 500 mL, 95% CI 1.02–2.08, P=0.039) as independent risk factors for delayed catheter removal, whereas higher serum total bilirubin (OR 0.889, 95% CI 0.82–0.97, P=0.007) was independently associated with a lower risk. The model showed moderate discrimination (AUC 0.744) and adequate calibration (Hosmer–Lemeshow P=0.523).

Conclusions: Lymph node metastasis, intraoperative complications, tramadol use, and larger intraoperative crystalloid volume are independent risk factors for delayed urinary catheter

removal after open radical hysterectomy, whereas a higher preoperative serum total bilirubin level was independently associated with a lower risk.

Keywords: cervical cancer; radical hysterectomy; urinary catheter removal; risk factors; crystalloid; tramadol

Background

Cervical cancer is one of the most common malignancies of the female genital tract. GLOBOCAN 2022 estimated approximately 660,000 new cases and 350,000 deaths worldwide each year [1]. In China, cervical cancer incidence and mortality have remained on a high plateau, with rising trends in some regions [2]. Radical hysterectomy (RH) with pelvic lymphadenectomy is the standard surgical treatment for early-stage cervical cancer [3–5,33]. This procedure requires wide resection of the parametrium, upper vagina, and the uterosacral and cardinal ligaments; intraoperative injury to the inferior hypogastric plexus and pelvic splanchnic nerves by traction, transection, or thermal damage is therefore often unavoidable [6]. The resulting detrusor underactivity and impaired voiding reflexes manifest clinically as urinary retention, voiding difficulty, and delayed catheter removal.

Postoperative bladder dysfunction is one of the most common complications after RH and prolongs hospital stay and impairs quality of life [7,8,32]. A Dutch nationwide cohort study reported that 15% of patients required recatheterization for urinary retention within 30 days of RH [17]. The timing of catheter removal is directly related to voiding dysfunction [7], and an inadequately assessed removal trial may provoke or worsen retention [8]. Previous studies have focused largely on nerve-sparing techniques and surgical approach (open, laparoscopic, robotic) [6,9,10,12,18,19], whereas the influence of perioperative analgesic medications and intraoperative fluid management on this outcome remains largely unexamined.

The LACC trial and its final survival analysis demonstrated higher recurrence and mortality after minimally invasive RH than after open surgery [10,11], re-establishing open surgery as the standard [12–14] and prompting updates to international guidelines [31,33]. This has renewed attention to perioperative management in open cohorts. Enhanced recovery after surgery (ERAS) has provided a framework for optimizing perioperative care in gynecologic oncology [15,16], but the specific effects of fluid management and analgesic selection on bladder recovery have not

been fully clarified. Identifying modifiable risk factors for delayed catheter removal after open RH therefore has direct clinical value.

This study analyzed clinical data from patients who underwent open radical hysterectomy for cervical cancer to identify independent risk factors for delayed urinary catheter removal (>21 days), with the aim of informing precision management of postoperative bladder recovery and early identification of high-risk patients.

Materials and Methods

Study population

This retrospective study reviewed patients who underwent open radical hysterectomy for cervical cancer at the Department of Gynecologic Oncology, Peking University Cancer Hospital, between January 2018 and April 2026. Inclusion criteria were: (1) pathologically confirmed cervical cancer (squamous cell carcinoma, adenocarcinoma, adenosquamous carcinoma, or neuroendocrine carcinoma); and (2) open radical hysterectomy with pelvic lymphadenectomy (with or without para-aortic lymphadenectomy). Exclusion criteria were: (1) non-epithelial tumors such as malignant melanoma of the cervix (one case excluded); and (2) severely incomplete clinical data. A total of 285 patients were included. The study was approved by the Ethics Committee of Peking University Cancer Hospital (approval number 2026YJZ97); the requirement for informed consent was waived because of the retrospective design.

Outcome definition

A transurethral catheter was placed routinely before surgery and remained on continuous bladder drainage throughout the operation. At our center, the urinary catheter is routinely removed on postoperative day 14; if removal fails, a second attempt is made one week later (postoperative day 21). Failure to remove the catheter by day 21 was defined as delayed urinary catheter removal (a binary outcome). Patients were accordingly divided into a delayed group (>21 days, n=52, 18.2%) and a non-delayed group (≤21 days, n=233, 81.8%).

Data collection

Data were collected on demographics (age, height, weight, body mass index), medical history (smoking, alcohol use, comorbidities, obstetric and contraceptive history), preoperative laboratory parameters, tumor characteristics (FIGO stage, histological type, grade, tumor size, depth of invasion, lymphovascular space invasion, lymph node metastasis), preoperative

treatment, surgical details (approach, duration, blood loss, crystalloid/colloid/total infusion volume, extent of lymphadenectomy, ureteral stent placement), intraoperative complications, intraoperative anesthetic events and medications, and postoperative complications and recovery. A total of 260 variables were collected (including 99 anesthetic agents); after excluding low-frequency, redundant, or temporally ineligible variables, Table 1 presents 160 preoperative and intraoperative candidate variables, Table 2 presents 28 postoperative variables, and Supplementary Table S1 presents 99 anesthetic agents.

Statistical analysis

All tests were two-sided with a significance level of $\alpha=0.05$, performed using Python 3.12 (statsmodels, SciPy). Continuous variables were non-normally distributed and are presented as median (P25–P75), compared with the Mann–Whitney U test. Categorical variables are presented as n (%) and compared with the χ^2 test or Fisher's exact test when any expected frequency was below 5; a two-sided Fisher exact P value of 1.0000 denotes the observed table being the most probable configuration under the null (typically for rare events with zero or very few counts). To ensure that candidate risk factors temporally preceded the outcome, variables were divided into Table 1 (preoperative and intraoperative, risk-factor candidates) and Table 2 (postoperative, descriptive, excluded from the multivariable model to avoid reverse causation). Variable selection for the multivariable model followed predefined rules: (1) events constraint—with only 52 outcome events, a maximum of five predictors was allowed by the empirical rule of at least 10 events per variable (EPV≥10), so the 17 univariately significant variables could not all be entered; (2) temporal ordering—postoperative events (Table 2) were excluded; (3) sparse events—variables with three or fewer events, whose OR estimates are unstable, were excluded; (4) indication confounding—dexmedetomidine and prophylactic antibiotics, whose use reflects baseline status and physician preference, were not interpreted causally and were excluded; and (5) collinearity and redundancy—a variance inflation factor (VIF) greater than 10 was considered collinear; crystalloid volume was correlated with total infusion volume, blood loss, and operative time, so only the crystalloid volume with the strongest independent effect was retained as their representative, and variables redundant with those already selected (e.g., number of involved nodes versus lymph node metastasis) were dropped. FIGO stage, histological type, and histological grade were tested in the univariate screen but showed no significant association with delayed removal (P=0.70, 0.44, and 0.83, respectively) and were therefore not candidates for the

multivariable model; the ureteral stent was significantly associated on univariate analysis (9.6% vs 2.6%, P=0.032) but was not entered because adding a sixth predictor would reduce the events-per-variable ratio to 8.7, below the recommended minimum of 10. After these rules, five variables (lymph node metastasis, intraoperative complications, tramadol use, crystalloid volume, and total bilirubin) were entered by the enter method; all are obtainable preoperatively or intraoperatively, potentially modifiable or mechanistically clear, and mutually independent (VIF <1.1, maximum 1.04). For missing data, the five model variables had no missing values, and the model was fitted on all 285 patients (complete-case analysis); only 2 of the 260 collected variables had missing data (operative time, n=10; time to first defecation, essentially unrecorded and not analyzed), so no imputation was performed. The model reports β, standard error, Wald χ^2, OR, 95% CI, and P values. Goodness of fit was assessed with the Hosmer–Lemeshow test (10 groups), discrimination with the C statistic (AUC), and the Akaike information criterion (AIC), Bayesian information criterion (BIC), and McFadden pseudo-R^2 are reported.

Results

Baseline characteristics and univariate analysis

A total of 285 patients who underwent open radical hysterectomy were included; 52 (18.2%) had delayed catheter removal and 233 (81.8%) did not. Table 1 compares baseline and perioperative characteristics between the two groups (160 variables; 17 differed significantly).

Regarding tumor characteristics, the delayed group had larger tumors [3.5 (2.3–4.3) cm vs 2.5 (1.5–3.5) cm, P=0.004], deeper invasion [1.1 (0.6–1.5) cm vs 0.8 (0.4–1.2) cm, P=0.038], and higher rates of lymphovascular space invasion (50.0% vs 33.5%, P=0.038) and lymph node metastasis (11.5% vs 1.3%, P=0.002).

Regarding surgical details, the delayed group had greater intraoperative blood loss [300 (137.5–462.5) mL vs 200 (100.0–300.0) mL, P=0.044], larger crystalloid volume [1500 (1250–1850) mL vs 1400 (1100–1600) mL, P=0.030] and total infusion volume [2200 (2000–2712.5) mL vs 2050 (1800–2500) mL, P=0.031], and a higher rate of ureteral stent placement (9.6% vs 2.6%, P=0.032).

Regarding intraoperative complications, the delayed group had higher rates of any intraoperative complication (13.5% vs 3.4%, P=0.009) and bladder injury (9.6% vs 0.9%, P=0.003).

Regarding laboratory parameters, the delayed group had lower serum total bilirubin [9.7 (7.3–13.2) μmol/L vs 12.0 (9.6–15.0) μmol/L, P=0.003] and total cholesterol [4.5 (3.8–5.1) mmol/L vs 4.8 (4.3–5.3) mmol/L, P=0.022].

Regarding medications, the delayed group had lower rates of prophylactic antibiotic use (9.6% vs 23.2%, P=0.036) and dexmedetomidine use (26.9% vs 44.6%, P=0.020), and a higher rate of intraoperative tramadol use (15.4% vs 3.0%, P=0.002).

Postoperative events (Table 2, descriptive)

Table 2 (28 variables; 4 differed significantly) shows that, among events occurring at or after catheter removal, the delayed group had higher rates of urinary dysfunction (11.5% vs 2.1%, P=0.006), urinary tract infection (11.5% vs 3.9%, P=0.036), postoperative hemorrhage (11.5% vs 3.4%, P=0.025), and adjuvant chemotherapy (51.9% vs 36.1%, P=0.041). These events are concurrent with or subsequent to the outcome and are therefore described but not included in the risk-factor model.

Multivariable logistic regression (Table 3, Figure 1)

After applying the predefined variable-selection rules (events constraint, temporal ordering, exclusion of sparse and indication-confounded variables, and collinearity screening) described in the Methods, five variables were entered (events per variable 52/5=10.4). Lymph node metastasis (OR 6.380, 95% CI 1.45–28.09, P=0.014), intraoperative complications (OR 3.579, 95% CI 1.13–11.38, P=0.031), tramadol use (OR 5.466, 95% CI 1.68–17.81, P=0.005), and crystalloid volume (OR 1.456 per 500 mL, 95% CI 1.02–2.08, P=0.039) were independent risk factors for delayed catheter removal. Total bilirubin (OR 0.889, 95% CI 0.82–0.97, P=0.007) was independently associated with a lower risk, each 1 μmol/L increase being associated with an approximately 11% lower risk. The five predictors had variance inflation factors below 1.1 (maximum 1.04), indicating no meaningful collinearity. The model showed adequate fit (AIC 246.1, BIC 268.0, McFadden pseudo-R^2 0.1355), moderate discrimination (AUC 0.744, reported as a descriptive index only), and good calibration (Hosmer–Lemeshow χ^2=7.13, P=0.5231).

To assess robustness against alternative specifications of intraoperative fluid exposure, we refitted the multivariable model replacing crystalloid volume with total intraoperative fluid volume (per 500 mL) and estimated blood loss (per 100 mL), respectively. Lymph node metastasis, tramadol use, and lower total bilirubin remained independently associated with delayed catheter removal (all P<0.01) under both alternative specifications, supporting the stability of the main findings (Supplementary Table S2).

Intraoperative complications attenuated to borderline significance (P≈0.06–0.07), and neither total fluid volume nor blood loss showed an independent association (P=0.30 and 0.23), suggesting the crystalloid association is specific rather than a generic fluid-load effect.

Discussion

Principal findings

This retrospective analysis of 285 patients who underwent open radical hysterectomy found a delayed catheter removal (>21 days) rate of 18.2% (52/285). Multivariable logistic regression identified lymph node metastasis (OR 6.380), intraoperative complications (OR 3.579), tramadol use (OR 5.466), and larger intraoperative crystalloid volume (OR 1.456 per 500 mL) as independent risk factors, and higher serum total bilirubin (OR 0.889) as independently associated with a lower risk. These findings indicate that bladder recovery after radical hysterectomy is jointly influenced by tumor aggressiveness, surgical trauma, intraoperative fluid management, and perioperative medications.

Rationale for the outcome definition

The threshold for postoperative urinary retention or delayed catheter removal varies across the literature, with common definitions of 7 days, 14 days, or the need for recatheterization [7,8]. Catheter management at our center follows a fixed clinical pathway with three clearly defined tiers: the catheter is routinely removed on postoperative day 14; a failed trial (e.g., a residual volume above the threshold) is classified as a mild extension, with removal reattempted one week later on day 21; failure to remove the catheter by day 21 defines marked delayed removal (>21 days). The >21-day threshold is therefore not an arbitrary cut-off but corresponds to a substantive stratification node within our institutional pathway: it identifies persistent voiding dysfunction that has not recovered after one routine trial and one extended wait and that requires continued catheterization, rather than a transient delay in emptying that resolves spontaneously. Compared with a 7-day threshold, this definition better reflects true postoperative bladder injury and is fully consistent with our clinical pathway, facilitating both clinical practice and outcome ascertainment.

Mechanisms of the risk and protective factors

(1) Lymph node metastasis. Lymph node metastasis was the strongest risk factor in this study (OR 6.380). It should be noted that only 9 patients in this cohort had nodal metastasis (6 in the delayed group and 3 in the non-delayed group); given this sparse exposure, the point estimate,

although large, has a wide 95% CI (1.45–28.09) and limited precision. Nodal status is a core determinant of the extent of radical surgery, and sentinel node biopsy accurately reflects nodal status [20]. Patients with nodal metastasis generally require wider parametrial resection and extended lymphadenectomy, increasing the likelihood of pelvic autonomic nerve injury. A meta-analysis of nerve-sparing RH showed that preserving the pelvic autonomic nerves improves postoperative bladder function and shortens catheter duration [6], and a nationwide cohort study indicated that surgical extent is closely associated with perioperative complications [17]. Together these support the mechanism by which nodal metastasis delays bladder recovery through greater surgical trauma and aggravated plexus injury.

(2) Intraoperative complications. Intraoperative complications, particularly bladder injury (9.6% vs 0.9%, P=0.003), were an independent risk factor (OR 3.579); this event was likewise infrequent in our cohort (15 patients: 7 in the delayed group and 8 in the non-delayed group), and the precision of the corresponding estimate is limited. Direct injury to the bladder and ureters, together with the tissue edema, nerve-ending injury, and local inflammation that accompany repair, directly impair detrusor function and prolong recovery. A nationwide cohort study showed that perioperative complications drive short-term complications such as urinary retention after RH [17], and comparisons of minimally invasive and open surgery indicate that surgical trauma is closely related to postoperative recovery [18,19].

(3) Tramadol. Direct clinical evidence linking tramadol to voiding difficulty is limited but consistent: the Netherlands Pharmacovigilance Foundation reported five cases of transient impairment of micturition or urinary retention occurring in temporal association with oral tramadol at therapeutic doses (≤150 mg/day) and resolving promptly after discontinuation [21], whereas larger-scale evidence in the surgical setting comes from studies of opioid-based patient-controlled analgesia, which has been associated with urinary retention after hysterectomy [22]. To our knowledge, no previous study has specifically examined intraoperative tramadol in relation to delayed catheter removal after radical hysterectomy. Mechanistically, opioids are an established cause of drug-induced urinary retention; because the micturition pathway is complex, such drugs may interfere with voiding through several distinct modes of action [36]. Beyond its weak μ-opioid receptor agonism and serotonin/norepinephrine reuptake inhibition, tramadol has been shown experimentally to inhibit detrusor contractility directly: in isolated caprine detrusor

strips, tramadol caused concentration-dependent inhibition of acetylcholine-induced contraction [37]. Notably, this inhibition was reversed by the β-adrenoceptor antagonist propranolol but not by the opioid antagonist naloxone, suggesting an indirect anticholinergic mechanism involving β-adrenoceptor stimulation rather than a classical opioid receptor-mediated effect [37]. The mechanism underlying tramadol-associated voiding dysfunction may therefore be more complex than a purely opioid-like action and warrants further investigation. In our cohort intraoperative tramadol use was significantly more common in the delayed group (15.4% vs 3.0%, P=0.002) and remained independently associated after adjustment (OR 5.466). It should be noted, however, that only 15 patients received intraoperative tramadol (8 in the delayed group and 7 in the non-delayed group); with so few exposed patients, the 95% CI for the OR is wide (1.68–17.81). Given its widespread perioperative use, analgesia should be selected cautiously in patients at high risk of bladder dysfunction, favoring non-opioid analgesia or regional blocks.

(4) Total bilirubin. Each 1 μmol/L increase in total bilirubin was associated with an approximately 11% lower risk of delayed removal (OR 0.889), one of the more notable findings of this study, but this should be interpreted as an independent association rather than a confirmed causal effect. Mechanistically, bilirubin and biliverdin form an endogenous antioxidant cycle; within the physiological range, bilirubin exerts antioxidant and anti-inflammatory effects that could theoretically attenuate surgical stress and ischemia–reperfusion injury [23]. However, this extrapolation is incomplete: the supporting evidence derives mainly from other surgical populations (e.g., delirium after joint replacement) [23], whose populations and outcomes differ substantially from ours and cannot be directly applied; moreover, serum total bilirubin is influenced by preoperative nutritional status, liver function, and inflammation, and these inadequately controlled confounders could also explain the observed association. Inflammatory and nutritional serum markers predict perioperative morbidity in gynecologic oncology [24], suggesting that bilirubin may partly reflect overall nutritional and inflammatory status. A higher preoperative serum total bilirubin was therefore independently associated with a lower risk of delayed catheter removal, and its clinical relevance warrants confirmation in larger prospective studies with more complete control of confounders.

(5) Crystalloid. Intraoperative crystalloid volume showed an independent dose–response relationship with delayed removal, with a 1.456-fold higher risk per 500 mL (95% CI 1.02–2.08).

Because a transurethral catheter was placed routinely and kept on continuous drainage in all patients, bladder overdistension is unlikely to explain this association. The effect of crystalloid is more plausibly mediated through two pathways. First, large crystalloid infusion causes tissue edema and third-space fluid accumulation. Intravenously administered fluid leaks and accumulates dose-dependently in the interstitial space and contributes to interstitial edema; when the drainage capacity of the lymphatic system is exceeded, tissue edema develops and leads to organ dysfunction by impairing the diffusion of oxygen and metabolites and reducing tissue perfusion [34]. Under general anesthesia the elimination half-life of crystalloids may be prolonged up to tenfold relative to the conscious state, and interstitial edema formed during surgery causes the distributed fluid to remain in the interstitial tissue for a prolonged period [34]; excessive intravenous fluid administration also adds to tissue inflammation and compromises tissue healing [35]. By extension, edema of the pelvic tissues and bladder wall may impair detrusor compliance and pelvic nerve recovery, thereby delaying catheter removal. Second, we also considered that crystalloid volume might merely be a surrogate for operative complexity, trauma, and duration. However, in this cohort neither operative time (P=0.8153) nor duration of anesthesia (P=0.4251) was associated with delayed removal; if crystalloid merely reflected operative complexity, these more direct duration measures should have been associated as well. This negative finding weakens the surrogate interpretation and, in turn, supports a degree of specificity for the fluid-related mechanism described above—that is, the effect more plausibly arises from the volume load and tissue edema attributable to crystalloid itself rather than from generalized surgical trauma. We acknowledge that crystalloid volume correlated with total infusion volume and blood loss on univariate analysis, and that the multivariable model retained only crystalloid as the representative with the strongest independent effect after collinearity screening; this selection remains data-driven and is addressed in the Limitations. Goal-directed fluid therapy reduces complications and improves outcomes in gynecologic oncology surgery [25,26], supporting a role for judicious, individualized fluid management in lowering postoperative retention risk. However, dichotomizing crystalloid volume at the median abolished the effect (P=0.137), and P=0.039 is a borderline result, indicating a dose-dependent and modest effect that should not be interpreted as a hard threshold or overstated for its certainty.

Characteristics and strengths of the study cohort

The composition of this cohort aids interpretation of the results. First, all 285 patients underwent open RH, with a completely uniform surgical approach. Since the LACC trial, most new cohorts have been predominantly minimally invasive or mixed, and surgical approach itself is associated with bladder recovery [10,12,18,19]; the exclusively open design removes this confounder at the source. Second, all operations were performed by chief physicians at a single center with extensive experience in radical hysterectomy, yielding relatively homogeneous surgical technique and reducing the influence of operator experience on complications and bladder outcomes, which in turn allows the effects of tumor aggressiveness, intraoperative fluid volume, and analgesic medications to emerge more clearly. Third, perioperative care followed a consistent pathway, including a uniform day-14 removal and a one-week extension, ensuring a consistent outcome definition. In this homogeneous open cohort we still observed a dose–response effect of crystalloid volume and an independent association of higher total bilirubin with a lower risk, indicating that fluid management and analgesic choice remain modifiable perioperative levers even with senior surgeons and standardized pathways; this is the main contribution of our study to the literature.

Comparison with previous studies

The reported incidence of bladder dysfunction after radical hysterectomy varies widely—from 12% to 85%—depending on the definition used and the duration of follow-up [38], which complicates direct comparison across studies. Within this context, our rate of delayed catheter removal (>21 days) of 18.2% lies at the lower end of this spectrum, consistent with a cohort composed exclusively of open procedures performed by experienced surgeons under a standardized catheter-management pathway. By comparison, 19.4% of patients still required catheterization at discharge in a recent single-center series of type B1/C1 radical hysterectomy [39], and a mean catheter duration of 8.3–13.1 days was reported in a large cohort applying a systematized critical pathway for postoperative urological management after radical hysterectomy [40]; the 14-day routine removal with a one-week extension at our center therefore represents a deliberately conservative strategy aimed at minimizing recatheterization. Regarding lymph node metastasis, the literature has traditionally attributed postoperative bladder dysfunction primarily to the extent of surgery, with type III resection carrying a higher risk than type II in the Querleu–Morrow classification [4,38], and ongoing surgical de-escalation for low-risk cervical cancer further shifts the operative landscape [13]. Our finding that nodal status itself—an oncologic variable rather than an operative one—was the strongest independent risk factor extends this picture: tumor biology may contribute both indirectly, by mandating wider parametrial resection and more extensive lymphadenectomy, and potentially directly, through tumor-related pelvic autonomic involvement. This distinction carries practical weight, because

nodal status is largely fixed before surgery whereas the extent of resection is at least partially modifiable, reinforcing the value of preoperative risk stratification and of nerve-sparing techniques where oncologically safe [6].

Limitations

This study has several limitations. First, the single-center retrospective design carries selection and information bias, and the timing of catheter removal, which lacks a standardized protocol, was to some extent influenced by clinician judgment [30]. Second, the sample was modest, with only 52 outcome events and no a priori sample-size calculation; the events-per-variable ratio of 10.4 only meets the minimum requirement of 10 events per variable, and the power for effects such as crystalloid volume may be limited. More importantly, exposure was sparse for all three binary risk factors: lymph node metastasis in only 9 patients (6 with the outcome), intraoperative complications in 15 (7 with the outcome), and intraoperative tramadol in 15 (8 with the outcome). For binary predictors, the stability of the estimate depends on the number of events among exposed patients, and the exposed-group event counts for these variables (6–8) all fell below the conventionally recommended value of 10, raising the possibility of sparse-data bias. We therefore performed a sensitivity analysis using Firth penalized logistic regression (Supplementary Table S3), the standard approach to sparse-data bias: after correction the ORs were 5.698 (95% CI 1.32–24.61) for lymph node metastasis, 3.512 (1.11–11.09) for intraoperative complications, 5.221 (1.62–16.87) for tramadol, 0.895 (0.83–0.97) for total bilirubin, and 1.447 (1.02–2.06) for crystalloid per 500 mL. Relative to conventional maximum likelihood estimates, these values changed by only −10.7% to +0.7% and all remained statistically significant ($P<0.05$), indicating that, although sparse exposure limited the precision of the estimates (wide CIs), it did not materially distort the direction or magnitude of the associations. Third, univariate comparisons across 160 variables were performed without correction for multiple testing; with 160 comparisons the Bonferroni-corrected significance threshold would be $P<0.00031$ (0.05/160), which none of the univariate associations attained. We therefore treated the univariate screen as exploratory and used it only to select candidates for the multivariable model (restricted to five predictors by prespecified rules), rather than applying a formal multiplicity correction that would be overly conservative for an association study; the independent associations reported derive from the multivariable model. Low-frequency events such as atracurium use and sentinel lymph node biopsy, and variables with indication confounding such as dexmedetomidine and prophylactic antibiotics, were excluded from the final model because of collinearity or causal-

direction concerns. Fourth, the model lacks internal and external validation. Because the selection of crystalloid among correlated fluid indicators (crystalloid, total infusion volume, blood loss, and operative time) was data-driven, the estimated ORs may be overoptimistic. Bootstrap internal validation and optimism correction are tools for developing prediction models (TRIPOD) rather than standard requirements for an association study; we therefore did not perform them, and the descriptive AUC (0.744) is reported only as an indication of discrimination. The reproducibility of the ORs awaits confirmation in multicenter prospective studies. Fifth, tramadol was administered intraoperatively, but its exact regimen (single versus repeated bolus, rescue versus scheduled administration) and total dose were not captured in detail; Supplementary Table S1 reports only the median dose among users, and this unmeasured heterogeneity may affect the interpretation of the tramadol association. Sixth, some anesthetic medications were recorded as blood concentrations with inconsistent units, precluding further dose–response analysis. In addition, preoperative nutritional status and frailty influence postoperative complications in gynecologic oncology [27–29]; although serum nutritional markers were included, nutritional and frailty status were not systematically assessed and may constitute residual confounding.

Furthermore, although intraoperative complications were significant in the primary model (OR 3.579), their association attenuated to borderline in the sensitivity analyses. This most likely reflects limited statistical power—only 15 patients had an intraoperative complication and the total number of events was modest (52)—rather than a lack of clinical relevance. Direct bladder or ureteric injury during surgery can impair detrusor function and prolong bladder recovery, which is biologically plausible; intraoperative complications should therefore still be regarded as a clinically meaningful risk factor.

Conclusions

Lymph node metastasis, intraoperative complications, tramadol use, and larger intraoperative crystalloid volume are independent risk factors for delayed urinary catheter removal (>21 days) after open radical hysterectomy for cervical cancer, whereas a higher preoperative serum total bilirubin level was independently associated with a lower risk. For patients with these risk factors, perioperative care should include close monitoring of bladder function, preservation of the pelvic autonomic nerves whenever possible, judicious fluid management, and careful analgesic selection to promote bladder recovery and shorten catheter duration.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Peking University Cancer Hospital & Institute (approval no. 2026YJZ97). The requirement for individual informed consent was waived owing to the retrospective design.

Consent for publication

Not applicable.

Availability of data and materials

The patient-level dataset contains potentially identifying clinical information and is not publicly available. The data are available from the corresponding author on reasonable request, subject to institutional approval.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Hanlong Li: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing - original draft, Visualization. Wenzhi Zhu: Data curation, Formal analysis, Writing - original draft (co-first author). Jiaonan Yang: Data curation, Investigation, Writing - review & editing. Xiaoxi Li: Data curation, Investigation, Writing - review & editing. Hongyu Tan: Conceptualization, Supervision, Project administration, Writing - review & editing. All authors have read and approved the final manuscript.

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Not applicable.

Use of artificial intelligence

During the preparation of this work, the authors used an AI assistant (WorkBuddy, powered by the GLM large language model; Z.ai, Beijing, China) between August and September 2026 for three purposes only: (1) checking and debugging of the statistical analysis code (Python 3.12); (2) English language polishing of the manuscript, tables, and supplementary materials; and (3) internal AI-assisted review of the manuscript for clarity and consistency. The AI tool was not used for study design, data collection, statistical analysis, or interpretation of the results, and had no access to patient-level data. All AI-assisted content was verified by the authors, who take full responsibility for the integrity of the work.

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Figure and Table legends

Table 1. Baseline and perioperative characteristics of the delayed and non-delayed groups (160 preoperative and intraoperative variables).

Table 2. Postoperative events by group (28 variables, descriptive).

Table 3. Multivariable logistic regression analysis of factors associated with delayed urinary catheter removal.

Figure 1. Forest plot of factors independently associated with delayed urinary catheter removal (ORs with 95% CIs).

Table 1. Baseline and perioperative characteristics of patients with and without delayed urinary catheter removal (>21 days)

Variable	Non-delayed (n=233)	Delayed (n=52)	Statistic	P
General characteristics				
Age (years)	41.0 (37.0–49.0)	42.0 (38.0–46.0)	Z=0.38	0.7067
Height (cm)	160.0 (156.0–163.0)	159.0 (155.8–162.0)	Z=0.58	0.5588
Weight (kg)	61.9 (56.0–68.0)	61.0 (54.0–66.8)	Z=0.77	0.4419
Body mass index (kg/m²)	24.5 (21.9–26.4)	23.7 (21.9–26.2)	Z=1.04	0.2999
Medical history				
Smoking history	11 (4.7%)	6 (11.5%)	Fisher	0.0964
Alcohol consumption	8 (3.4%)	2 (3.8%)	Fisher	1.0000
Hypertension	21 (9.0%)	6 (11.5%)	Fisher	0.6009
Diabetes mellitus	11 (4.7%)	6 (11.5%)	Fisher	0.0964
Coronary artery disease	0 (0.0%)	0 (0.0%)	Fisher	1.0000
COPD	1 (0.4%)	0 (0.0%)	Fisher	1.0000
History of thromboembolism	0 (0.0%)	0 (0.0%)	Fisher	1.0000
Contraceptive method			χ^2=1.26	0.8679
None	122	23		
Condom	69	18		
Intrauterine device	29	7		

Other	10	3		
Tubal ligation	3	1		
Gravidity	3.0 (2.0–4.0)	3.0 (2.0–4.0)	Z=0.06	0.9529
Parity	1.0 (1.0–2.0)	1.0 (1.0–2.0)	Z=-0.03	0.9778
History of miscarriage	187 (80.3%)	41 (78.8%)	Fisher	0.8484
Age at menarche (years)	14.0 (13.0–15.0)	14.0 (13.0–15.0)	Z=-0.98	0.3167
Prior abdominal/gynecologic surgery	133 (57.1%)	27 (51.9%)	Fisher	0.5382
History of cervical precancerous lesions	38 (16.3%)	10 (19.2%)	Fisher	0.6818
Other comorbidities	26 (11.2%)	6 (11.5%)	Fisher	1.0000
Preoperative laboratory tests (continuous)				
Hemoglobin (g/L)	130.0 (120.0–138.0)	126.5 (116.8–134.0)	Z=1.65	0.0981
White blood cell count (×10⁹/L)	5.8 (4.9–7.0)	5.9 (5.0–7.1)	Z=-0.39	0.7008
Neutrophil count (×10⁹/L)	3.8 (2.9–4.8)	3.9 (3.0–5.3)	Z=-0.56	0.5779
Lymphocyte count (×10⁹/L)	1.6 (1.3–1.9)	1.6 (1.2–1.9)	Z=0.17	0.8641
Platelet count (×10⁹/L)	250.0 (207.0–298.0)	249.0 (212.8–281.8)	Z=-0.04	0.9666
Hematocrit (%)	39.3 (36.8–41.5)	38.7 (35.8–40.6)	Z=1.22	0.2228
Albumin (g/L)	45.3 (43.7–47.0)	45.0 (42.9–46.1)	Z=1.57	0.1167
Total protein (g/L)	73.3 (69.6–76.9)	73.3 (70.1–75.6)	Z=0.62	0.5391
Total bilirubin (μmol/L)	12.0 (9.6–15.0)	9.7 (7.3–13.2)	Z=2.94	0.0032*
Alanine aminotransferase (U/L)	15.0 (11.0–22.0)	14.5 (9.8–18.0)	Z=1.52	0.1282
Aspartate aminotransferase (U/L)	17.0 (14.0–22.0)	15.0 (14.0–20.2)	Z=0.89	0.3736
Creatinine (μmol/L)	52.0 (48.0–58.0)	50.5 (46.0–56.8)	Z=1.42	0.1556
Creatine kinase (U/L)	62.0 (51.0–79.0)	58.0 (47.0–69.2)	Z=1.62	0.1056
Blood glucose (mmol/L)	5.1 (4.8–5.5)	5.2 (4.8–5.5)	Z=-0.23	0.8218
Lactate dehydrogenase (U/L)	171.0 (152.0–190.0)	167.0 (151.8–184.8)	Z=0.56	0.5734
Total cholesterol (mmol/L)	4.8 (4.3–5.3)	4.5 (3.8–5.1)	Z=2.29	0.0218*
LDL cholesterol (mmol/L)	2.9 (2.4–3.4)	2.7 (2.3–3.2)	Z=1.86	0.0631
HDL cholesterol (mmol/L)	1.3 (1.1–1.5)	1.3 (1.1–1.4)	Z=0.37	0.7111
Apolipoprotein A1 (g/L)	1.4 (1.3–1.6)	1.4 (1.2–1.5)	Z=0.75	0.4549
Apolipoprotein B (g/L)	0.9 (0.7–1.1)	0.8 (0.7–1.0)	Z=1.48	0.1397

Preoperative laboratory tests (categorical)				
Anemia	29 (12.4%)	6 (11.5%)	Fisher	1.0000
Hyperglycemia	16 (6.9%)	7 (13.5%)	Fisher	0.1539
Leukocytosis	7 (3.0%)	2 (3.8%)	Fisher	0.6703
Neutrophilia	11 (4.7%)	3 (5.8%)	Fisher	0.7253
Thrombocytosis	6 (2.6%)	1 (1.9%)	Fisher	1.0000
Elevated ALT	9 (3.9%)	4 (7.7%)	Fisher	0.2650
Elevated AST	4 (1.7%)	3 (5.8%)	Fisher	0.1167
Hyperbilirubinemia	11 (4.7%)	1 (1.9%)	Fisher	0.7012
Elevated LDH	2 (0.9%)	0 (0.0%)	Fisher	1.0000
Elevated creatinine	1 (0.4%)	0 (0.0%)	Fisher	1.0000
Elevated creatine kinase	2 (0.9%)	0 (0.0%)	Fisher	1.0000
Hypercholesterolemia	65 (27.9%)	11 (21.2%)	Fisher	0.3874
Elevated LDL cholesterol	63 (27.0%)	10 (19.2%)	Fisher	0.2936
Elevated apolipoprotein B	33 (14.2%)	3 (5.8%)	Fisher	0.1110
Tumor characteristics				
FIGO stage			Fisher	0.6954
Stage I	223	51		
Stage II or higher	10	1		
Histological type			χ^2=2.71	0.4382
Squamous cell carcinoma	174	34		
Adenocarcinoma	48	13		
Neuroendocrine carcinoma	9	4		
Adenosquamous carcinoma	2	1		
Histological grade			χ^2=0.38	0.8256
Poorly differentiated	108	22		
Moderately differentiated	107	25		
Well differentiated	18	5		

Tumor size (cm)	2.5 (1.5–3.5)	3.5 (2.3–4.3)	Z=-2.92	0.0035*
Depth of invasion (cm)	0.8 (0.4–1.2)	1.1 (0.6–1.5)	Z=-2.07	0.0380*
Stromal thickness (cm)	1.8 (1.6–2.0)	1.8 (1.7–2.0)	Z=-0.76	0.4450
Lymphovascular space invasion (LVSI)	78 (33.5%)	26 (50.0%)	Fisher	0.0375*
Perineural invasion	17 (7.3%)	4 (7.7%)	Fisher	1.0000
Parametrial involvement	8 (3.4%)	4 (7.7%)	Fisher	0.2412
Lymph node metastasis	3 (1.3%)	6 (11.5%)	Fisher	0.0015*
Number of lymph nodes removed	20.0 (15.0–26.0)	21.0 (17.0–26.2)	Z=-1.24	0.2165
Sentinel lymph node biopsy	17 (7.3%)	0 (0.0%)	Fisher	0.0492*
Para-aortic lymphadenectomy (yes/no)	4 (1.7%)	1 (1.9%)	Fisher	1.0000
Negative surgical margins	2 (0.9%)	0 (0.0%)	Fisher	1.0000
Preoperative treatment				
Neoadjuvant therapy	5 (2.1%)	0 (0.0%)	Fisher	0.5886
Neoadjuvant chemotherapy	6 (2.6%)	0 (0.0%)	Fisher	0.5963
Neoadjuvant radiotherapy	5 (2.1%)	0 (0.0%)	Fisher	0.5886
Surgical details				
ASA grade I	103 (44.2%)	29 (55.8%)	Fisher	1.0000
Operative time (min)	201.0 (169.0–229.0)	196.5 (165.0–242.2)	Z=-0.23	0.8153
Estimated blood loss (mL)	200.0 (100.0–300.0)	300.0 (137.5–462.5)	Z=-1.98	0.0439*
Blood transfusion (mL)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=-0.18	0.6266
Crystalloid infusion (mL)	1400.0 (1100.0–1600.0)	1500.0 (1250.0–1850.0)	Z=-2.16	0.0300*
Colloid infusion (mL)	500.0 (500.0–1000.0)	500.0 (500.0–1000.0)	Z=-0.73	0.4365
Total intraoperative fluid (mL)	2050.0 (1800.0–2500.0)	2200.0 (2000.0–2712.5)	Z=-2.16	0.0308*
Urine output (mL)	500.0 (350.0–800.0)	500.0 (300.0–700.0)	Z=0.82	0.4131
Para-aortic lymphadenectomy	9 (3.9%)	3 (5.8%)	Fisher	0.4636
Pelvic lymphadenectomy	219 (94.0%)	52 (100.0%)	Fisher	0.0810
Ureterolysis	150 (64.4%)	29 (55.8%)	Fisher	0.2685
Ureteral stent placement	6 (2.6%)	5 (9.6%)	Fisher	0.0323*
Lysis of adhesions	229 (98.3%)	50 (96.2%)	Fisher	0.3012
Omentectomy	2 (0.9%)	1 (1.9%)	Fisher	0.4549

Intraoperative complications				
Intraoperative complications	8 (3.4%)	7 (13.5%)	Fisher	0.0090*
Bladder injury	2 (0.9%)	5 (9.6%)	Fisher	0.0027*
Rectal injury	1 (0.4%)	0 (0.0%)	Fisher	1.0000
Ureteral injury	3 (1.3%)	0 (0.0%)	Fisher	1.0000
Obturator nerve injury	0 (0.0%)	0 (0.0%)	Fisher	1.0000
Active intraperitoneal/pelvic hemorrhage	2 (0.9%)	2 (3.8%)	Fisher	0.1533
Intraoperative events / anesthesia				
Intraoperative hypotension	107 (45.9%)	26 (50.0%)	Fisher	0.6459
Minimum systolic BP at induction (mmHg)	95.0 (90.0–100.0)	95.0 (85.0–100.0)	Z=-0.25	0.7967
Duration of anesthesia (min)	255.0 (228.0–282.0)	257.5 (223.5–297.5)	Z=-0.80	0.4251
Total adverse events (n)	1.0 (1.0–2.0)	1.0 (1.0–2.0)	Z=0.48	0.6112
Hypotension episodes (n)	0.0 (0.0–1.0)	0.5 (0.0–1.0)	Z=-0.37	0.6768
Cumulative hypotension duration (min)	0.0 (0.0–23.0)	0.0 (0.0–25.0)	Z=-0.56	0.5331
BIS <40 episodes (n)	0.0 (0.0–1.0)	0.0 (0.0–1.0)	Z=0.31	0.7195
Cumulative BIS <40 duration (min)	0.0 (0.0–30.0)	0.0 (0.0–30.0)	Z=0.23	0.7937
BIS >60 episodes (n)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.14	0.7186
Cumulative BIS >60 duration (min)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.09	0.8148
Bradycardia episodes (n)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.42	0.4659
Cumulative bradycardia duration (min)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.37	0.4825
Tachycardia episodes (n)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.24	0.5425
Cumulative tachycardia duration (min)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.27	0.4236
Hypoxemia episodes (n)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.10	0.5074
Cumulative hypoxemia duration (min)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.10	0.5074
Abnormal $ETCO_2$ episodes (n)	0.0 (0.0–0.0)	0.0 (0.0–1.0)	Z=-0.66	0.3560
Cumulative abnormal $ETCO_2$ duration (min)	0.0 (0.0–0.0)	0.0 (0.0–3.8)	Z=-1.19	0.0671
Hypertension episodes (n)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.66	0.2766
Cumulative hypertension duration (min)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	Z=0.62	0.2798
Prophylactic antibiotics				

Prophylactic antibiotic use	54 (23.2%)	5 (9.6%)	Fisher	0.0360*
Anesthetic drugs (use)				
Dexamethasone	165 (70.8%)	32 (61.5%)	Fisher	0.2448
Amobarbital sodium	11 (4.7%)	4 (7.7%)	Fisher	0.4881
Midazolam	18 (7.7%)	5 (9.6%)	Fisher	0.5836
Atropine	38 (16.3%)	6 (11.5%)	Fisher	0.5247
Remifentanil	14 (6.0%)	2 (3.8%)	Fisher	0.7447
Etomidate	109 (46.8%)	22 (42.3%)	Fisher	0.6449
Propofol (induction)	152 (65.2%)	33 (63.5%)	Fisher	0.8726
Dexmedetomidine	104 (44.6%)	14 (26.9%)	Fisher	0.0200*
Cisatracurium	129 (55.4%)	32 (61.5%)	Fisher	0.4431
Sufentanil	111 (47.6%)	29 (55.8%)	Fisher	0.3575
Esmolol	58 (24.9%)	15 (28.8%)	Fisher	0.5989
Propofol (maintenance)	90 (38.6%)	20 (38.5%)	Fisher	1.0000
Sevoflurane	121 (51.9%)	22 (42.3%)	Fisher	0.2232
Cisatracurium (maintenance)	109 (46.8%)	32 (61.5%)	Fisher	0.0656
Rocuronium	35 (15.0%)	11 (21.2%)	Fisher	0.2984
Remifentanil (maintenance)	145 (62.2%)	35 (67.3%)	Fisher	0.5286
Dezocine	41 (17.6%)	5 (9.6%)	Fisher	0.2108
Pentazocine	20 (8.6%)	7 (13.5%)	Fisher	0.2956
Flurbiprofen axetil	23 (9.9%)	2 (3.8%)	Fisher	0.2749
Palonosetron	9 (3.9%)	0 (0.0%)	Fisher	0.3727
Dolasetron	27 (11.6%)	8 (15.4%)	Fisher	0.4836
Esmolol (maintenance)	13 (5.6%)	6 (11.5%)	Fisher	0.1282
Phenylephrine	48 (20.6%)	8 (15.4%)	Fisher	0.4461
Ephedrine	83 (35.6%)	18 (34.6%)	Fisher	1.0000
Atropine (maintenance)	114 (48.9%)	20 (38.5%)	Fisher	0.2188
Oxycodone	66 (28.3%)	14 (26.9%)	Fisher	1.0000
Hydromorphone	36 (15.5%)	4 (7.7%)	Fisher	0.1865
Tramadol	7 (3.0%)	8 (15.4%)	Fisher	0.0017*
Nalbuphine	5 (2.1%)	2 (3.8%)	Fisher	0.6151

Fentanyl	8 (3.4%)	2 (3.8%)	Fisher	1.0000
Esketamine	38 (16.3%)	5 (9.6%)	Fisher	0.2861
Remimazolam	9 (3.9%)	2 (3.8%)	Fisher	1.0000
Penehyclidine	8 (3.4%)	5 (9.6%)	Fisher	0.0669
Anisodamine	47 (20.2%)	10 (19.2%)	Fisher	1.0000
Atracurium	1 (0.4%)	4 (7.7%)	Fisher	0.0043*
Methoxamine	56 (24.0%)	7 (13.5%)	Fisher	0.1378
Nitroglycerin	18 (7.7%)	5 (9.6%)	Fisher	0.5836
Ondansetron	34 (14.6%)	11 (21.2%)	Fisher	0.2916
Tropisetron	16 (6.9%)	3 (5.8%)	Fisher	1.0000
Azasetron	7 (3.0%)	0 (0.0%)	Fisher	0.3568
Metoclopramide	7 (3.0%)	0 (0.0%)	Fisher	0.3568
Fosaprepitant	5 (2.1%)	1 (1.9%)	Fisher	1.0000
Tranexamic acid	10 (4.3%)	6 (11.5%)	Fisher	0.0867
Lidocaine	4 (1.7%)	1 (1.9%)	Fisher	1.0000
Ropivacaine	8 (3.4%)	1 (1.9%)	Fisher	1.0000
Ipratropium bromide	9 (3.9%)	1 (1.9%)	Fisher	0.6954
Furosemide	4 (1.7%)	1 (1.9%)	Fisher	1.0000
Heparin	6 (2.6%)	0 (0.0%)	Fisher	0.5963
Potassium chloride	4 (1.7%)	0 (0.0%)	Fisher	1.0000

Table 2. Postoperative characteristics of patients with and without delayed urinary catheter removal (>21 days)

Variable	Non-delayed (n=233)	Delayed (n=52)	Statistic	P
Postoperative complications				
Wound infection	3 (1.3%)	0 (0.0%)	Fisher	1.0000
Wound fat liquefaction	0 (0.0%)	1 (1.9%)	Fisher	0.1825
Wound bleeding	1 (0.4%)	0 (0.0%)	Fisher	1.0000
Intra-abdominal infection	7 (3.0%)	3 (5.8%)	Fisher	0.3967
Pelvic infection	5 (2.1%)	1 (1.9%)	Fisher	1.0000
Postoperative hemorrhage (persistent	8 (3.4%)	6 (11.5%)	Fisher	0.0257*

BP/Hb decline)				
Bacteremia	2 (0.9%)	1 (1.9%)	Fisher	0.4549
Pulmonary complications	2 (0.9%)	1 (1.9%)	Fisher	0.4549
Bowel dysfunction	57 (24.5%)	15 (28.8%)	Fisher	0.5965
Intestinal obstruction	11 (4.7%)	4 (7.7%)	Fisher	0.4881
Urinary dysfunction	5 (2.1%)	6 (11.5%)	Fisher	0.0062*
Urinary tract infection	9 (3.9%)	6 (11.5%)	Fisher	0.0368*
Thrombosis	1 (0.4%)	0 (0.0%)	Fisher	1.0000
Overall postoperative complications	82 (35.2%)	26 (50.0%)	Fisher	0.0576
Voiding dysfunction	10 (4.3%)	5 (9.6%)	Fisher	0.1610
Postoperative recovery				
Length of hospital stay (days)	12.0 (10.0–13.0)	12.0 (9.0–14.0)	Z=-1.02	0.3017
Postoperative nausea and vomiting (PONV)	15 (6.4%)	5 (9.6%)	Fisher	0.3801
Postoperative pain	74 (31.8%)	17 (32.7%)	Fisher	0.8711
Postoperative pain score	2.0 (1.0–4.0)	2.0 (1.0–4.0)	Z=-0.72	0.4618
Patient-controlled analgesia (PCA)	0.0 (0.0–1.0)	0.0 (0.0–1.0)	Z=1.26	0.1446
Rescue analgesia	20 (8.6%)	5 (9.6%)	Fisher	0.7884
Rescue analgesic			Fisher	1.0000
None	228	51		
Terecoxib	5	1		
Time to first flatus (days)	3.0 (3.0–3.0)	3.0 (2.0–3.0)	Z=1.66	0.0519
Time to first ambulation (days)	1.0 (1.0–1.0)	1.0 (1.0–1.0)	Z=-0.08	0.8418
Escalated antibiotic therapy	5 (2.1%)	3 (5.8%)	Fisher	0.1632
Postoperative destination	6 (2.6%)	3 (5.8%)	Fisher	1.0000
Postoperative adjuvant therapy				
Postoperative radiotherapy				
Postoperative chemotherapy	84 (36.1%)	27 (51.9%)	Fisher	0.0409*
Concurrent chemoradiotherapy	14 (6.0%)	6 (11.5%)	Fisher	0.2236

Table 3. Multivariate logistic regression of risk factors for delayed urinary catheter removal (>21 days) after open radical hysterectomy for cervical cancer (N=285)

Variable	β	SE	Wald χ^2	OR	95% CI	P	LRT χ^2	LRT P
Lymph node metastasis	1.853	0.756	6.01	6.380	1.45–28.09	0.0142*	6.34	0.012
Intraoperative complications	1.275	0.590	4.67	3.579	1.13–11.38	0.0307*	4.33	0.037
Tramadol	1.699	0.603	7.95	5.466	1.68–17.81	0.0048*	7.61	0.006
Total bilirubin (μmol/L)	-0.117	0.043	7.40	0.889	0.82–0.97	0.0065*	9.11	0.003
Crystalloid volume (per 500 mL)	0.376	0.182	4.25	1.456	1.02–2.08	0.0393*	4.30	0.038

Note: Model fit: AIC=246.1, BIC=268.0, McFadden pseudo-R^2=0.1355; AUC=0.744; Hosmer–Lemeshow χ^2=7.13, P=0.5231; EPV=52/5=10.4

Figures

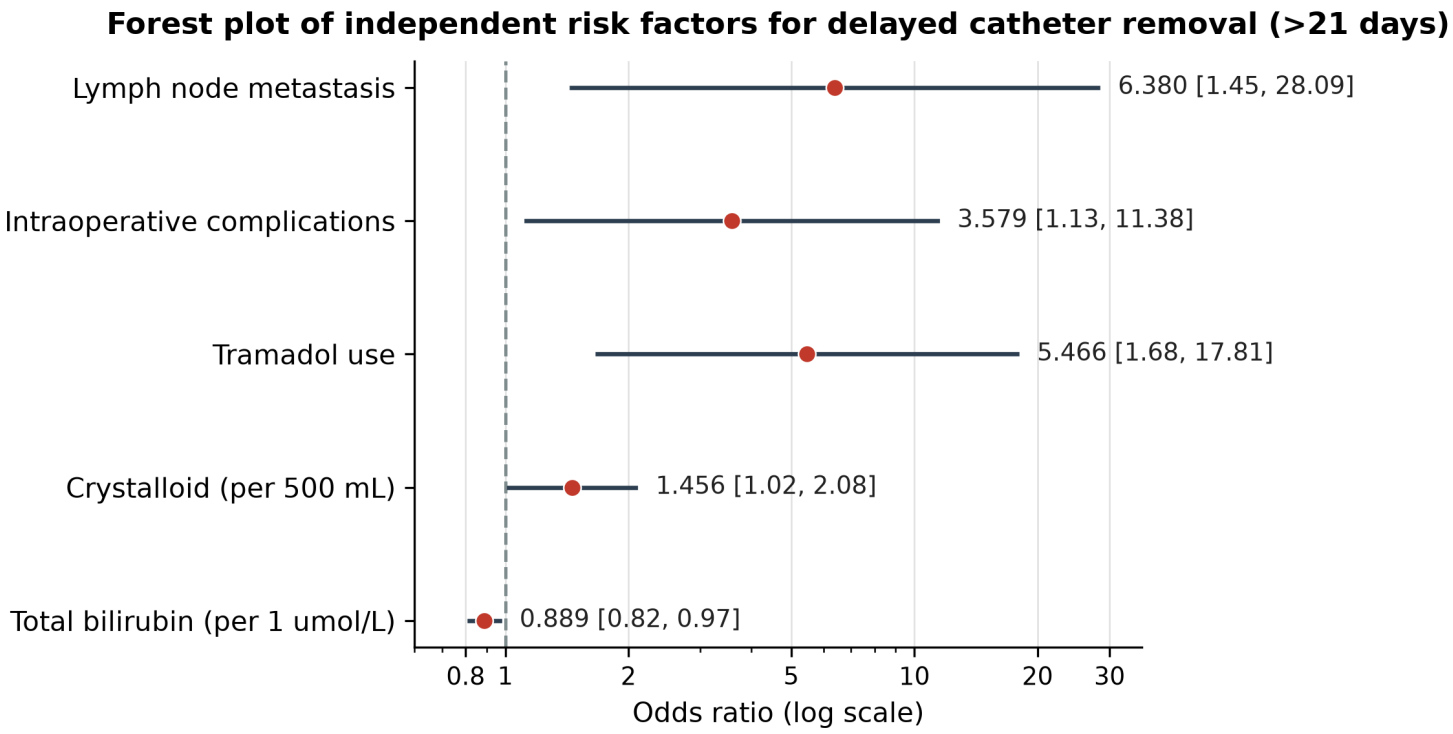


Figure 1

Forest plot of factors independently associated with delayed urinary catheter removal (ORs with 95% CIs).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementary.docx