








# Early Catheter Removal Improves Recovery After Total Abdominal Hysterectomy: A Randomized Trial

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**Objective:** To evaluate whether early removal of the urinary indwelling catheter enhances postoperative recovery in women undergoing uncomplicated total abdominal hysterectomy (TAH).

**Methods:** This open-label randomized controlled trial was conducted at a university hospital in Thailand between August 2023 and July 2024. Women aged 18–65 years scheduled for TAH for benign gynecologic conditions were randomized to early catheter removal (12–16 hours postoperatively) or standard removal (20–24 hours). Primary outcomes were time to first ambulation and six-minute walk test (6MWT) distance on postoperative days (POD) 1 and 2. Secondary outcomes included time to first voiding, urinary retention, urinary tract infection (UTI), catheter-related discomfort, hospital stay, costs, and patient satisfaction.

**Results:** Of 105 patients screened, 100 were randomized; 93 completed the study (46 early removal, 47 standard removal). Baseline characteristics were comparable. Early catheter removal significantly reduced time to ambulation ( $18.69 \pm 4.11$  vs  $21.41 \pm 3.02$  hours,  $p < 0.001$ ) and time to first voiding ( $19.02 \pm 3.72$  vs  $21.99 \pm 3.46$  hours,  $p < 0.001$ ). 6MWT distances on POD1 and POD2 were slightly higher in the early group but not statistically different. Rates of urinary retention, symptomatic UTI, catheter-related discomfort, hospital stay, hospitalization costs, and patient satisfaction were similar across groups.

**Conclusion:** Early urinary catheter removal within 12–16 hours after uncomplicated TAH accelerates postoperative recovery, particularly ambulation and voiding, without increasing urinary complications, supporting its integration into ERAS protocols.

**Keywords:** catheter removal, hysterectomy, recovery

## Introduction

Enhanced Recovery After Surgery (ERAS) protocols are increasingly applied across surgical fields to enhance postoperative outcomes by reducing complications and expediting recovery.<sup>1</sup> Early ambulation is a core element of ERAS, as it helps lower the risk of respiratory complications, insulin resistance, muscle atrophy, and venous thromboembolism.<sup>2</sup> Successful early mobilization, however, is influenced by factors such as effective pain control and the timing of urinary catheter removal.<sup>1</sup>

In gynecologic surgery, particularly total abdominal hysterectomy (TAH), urinary catheterization is routinely performed to prevent bladder injury intraoperatively<sup>3,4</sup> and to monitor urinary output postoperatively.<sup>2–4</sup> Despite these benefits, prolonged catheterization is associated with increased risks of urinary tract infection (UTI), delayed mobilization, and extended hospital stays. Current ERAS guidelines recommend catheter removal within 24 hours after surgery,<sup>5</sup> yet the optimal timing remains unclear. Prior studies have reported mixed findings, particularly when considering variations in anesthetic techniques and perioperative care.<sup>6,7</sup>

Given these uncertainties, this study investigates the impact of early urinary catheter removal on postoperative recovery, focusing specifically on functional recovery assessed through early ambulation in women undergoing uncomplicated TAH for benign gynecologic conditions.

## Materials and Methods

This open-label, randomized controlled trial (RCT) was conducted at University Hospital, Thailand. All eligible participants were fully informed about the study, and written informed consent was obtained prior to enrollment. Women aged 18–65 years scheduled for total abdominal hysterectomy (TAH) for benign gynecologic conditions were recruited between August 2023 and July 2024. Exclusion criteria were: (1) refusal to participate; (2) history of chemotherapy; (3) neurological or spinal cord disorders; (4) pre-existing urinary dysfunction, including incontinence; (5) urinary tract infection confirmed by urine culture or analysis; (6) allergy to opioids, NSAIDs, or acetaminophen; (7) use of intravenous patient-controlled analgesia (PCA); and (8) anticipated catheter removal in the intervention group between 10 p.m. and 6 a.m. Participants were withdrawn if intraoperative complications occurred, including urinary tract or gastrointestinal injury, blood loss exceeding 1000 mL, postoperative intensive care unit admission, or if the operating surgeon requested catheter removal outside the assigned protocol.

Participants were randomized in a 1:1 ratio to either the intervention group (early urinary catheter removal at 12–16 hours postoperatively) or the control group (standard removal at 20–24 hours postoperatively). Randomization was performed using computer-generated numbers with varying block sizes. Allocation concealment was maintained using sequentially numbered, sealed, opaque envelopes.

## Sample Size Calculation

The sample size calculation was based on the primary outcome of time to first ambulation, defined as the interval between the end of surgery and the patient's first walk. A previous study by Chen et al (2022)<sup>8</sup> compared early urinary catheter removal (within 6 hours) with standard removal (within 24 hours) in women undergoing gynecologic surgery under general anesthesia and reported a mean ambulation time of 22 hours in the standard group. Considering the inclusion of spinal anesthesia in our study, we hypothesized that early catheter removal at 12–16 hours would reduce the mean time to ambulation by approximately 4 hours compared with the standard group. With a significance level of 0.05 and a power of 90%, the required sample size was calculated to be 43 patients per group. Allowing for a 10% dropout rate, the final sample size was set at 100 patients (50 per group).

## Procedures

All patients underwent a baseline six-minute walk test (6MWT)<sup>9</sup> one day before surgery. A weight-adjusted dose of cefazolin, or an alternative for allergies, was given as prophylaxis. Following induction of general anesthesia, a 14-Fr Foley catheter was placed under aseptic technique, and total abdominal hysterectomy was performed in the standard manner with continuous bladder drainage. Catheter removal was assigned to either 12–16 hours (intervention) or 20–24 hours (control).

Perioperative and postoperative care followed ERAS protocols,<sup>10</sup> including balanced crystalloids, early diet within 24 hours, multimodal analgesia, and mobilization within the first day. After catheter removal, spontaneous voiding was encouraged; inability to void within 6 hours was defined as urinary retention and managed with intermittent catheterization. If residual urine exceeded 200 mL, the catheter was retained for at least 6 hours. Urine culture was obtained if urinary tract infection (UTI) symptoms occurred. The 6MWT was repeated on postoperative days 1 and 2, with pain (VAS)<sup>11</sup> and fall risk (Hendrich II)<sup>12</sup> assessed beforehand to ensure safety (VAS <6, Hendrich II <5).

Primary outcomes were time to first ambulation and 6MWT distance on days 1 and 2. Secondary outcomes included time to first void, urinary retention requiring re-catheterization, symptomatic UTIs, hospital stay, catheter-related discomfort (VAS), and patient satisfaction (Numerical Rating Scale).<sup>13</sup> Hospital stay was measured from surgery to fulfillment of discharge criteria.

## Data Collection and Statistical Analysis

Data were collected using structured case report forms and entered into a secure database. Analyses were performed with SPSS software. Continuous variables were summarized as means with standard deviations, and categorical variables as frequencies and percentages. Group comparisons were conducted using Student's *t*-test for continuous variables and Chi-square or Fisher's exact tests for categorical variables. Statistical significance was defined as  $p < 0.05$ .

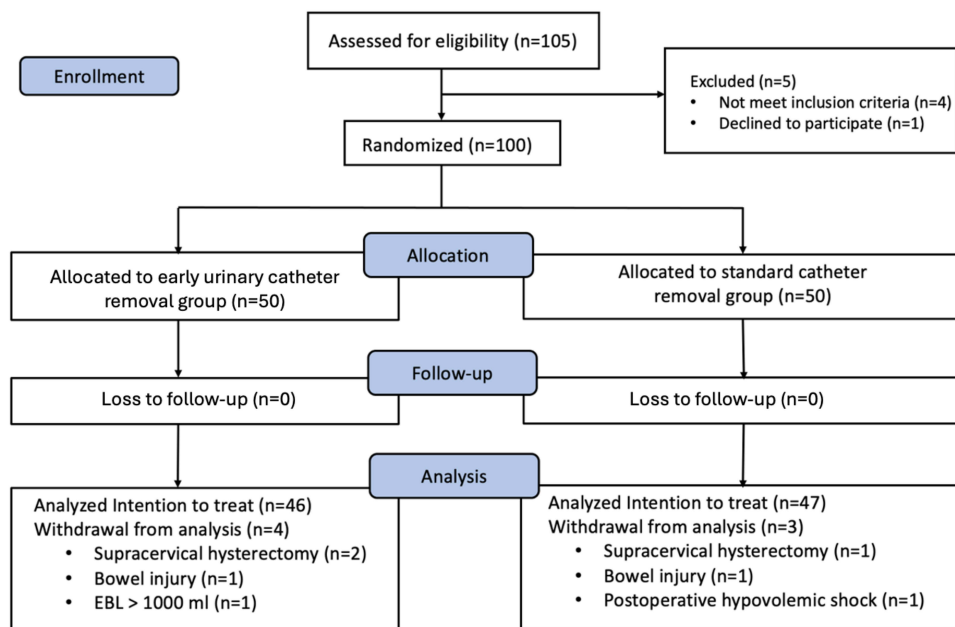


Figure 1 Consort flow diagram.

## Results

A total of 105 patients were screened, of whom five were excluded for not meeting eligibility criteria or declining participation. The remaining 100 were randomized equally into intervention and control groups. After randomization, seven patients (four in the intervention group and three in the control group) were withdrawn due to intraoperative or postoperative complications (eg, supracervical hysterectomy, bowel injury, excessive blood loss >1000 mL, or hypovolemic shock). The final analysis included 93 patients (46 in the intervention group and 47 in the control group) (Figure 1).

Baseline demographic and clinical characteristics were comparable between groups (Table 1). Uterine fibroid was the most common surgical indication, accounting for 40% of cases in both groups. Approximately 75% of patients received combined general and spinal anesthesia. Operative duration and estimated blood loss were also similar.

Patients in the early catheter removal group achieved ambulation significantly sooner than those in the control group (18.69 ± 4.11 vs 21.41 ± 3.02 hours, p < 0.001). Six-minute walk distances on postoperative days 1 and 2 were slightly

Table 1 Patient Baseline Characteristics

Characteristics	Early Removal n= 46 (%)	Control Group n= 47 (%)
Age (years), mean ± SD	46.15 ± 6.59	49.26 ± 7.07
BMI (kg/m <sup>2</sup> ), mean ± SD	25.03 ± 4.03	26.55 ± 4.49
Menopause status		
Pre-menopause	32 (69.6%)	28 (59.6%)
Post-menopause	14 (30.4%)	19 (40.4%)
Parity		
Nulliparous	34 (73.9%)	12 (26.1%)
Multiparous	31 (67.4%)	15 (32.6%)

(Continued)

**Table 1** (Continued).

Characteristics	Early Removal n= 46 (%)	Control Group n= 47 (%)
Comorbidity		
None	23 (50.0%)	22 (46.8%)
Diabetes mellitus	4 (8.7%)	9 (19.1%)
Hypertension	12 (26.1%)	11 (23.4%)
ASA classification		
1	13 (28.3%)	12 (25.5%)
2	33 (71.7%)	32 (68.1%)
3	0 (0.0%)	3 (6.4%)
Baseline six-minute walk distance before operation (meters), mean $\pm$ SD	291.74 $\pm$ 91.82	265.11 $\pm$ 95.37
Abdominal incision type		
Vertical midline	26 (56.5%)	28 (59.6%)
Pfannenstiel	19 (41.3%)	19 (40.4%)
Maylard	1 (2.2%)	0 (0.0%)
Indication for hysterectomy		
Fibroid tumors	18 (39.1%)	19 (40.4%)
Adenomyosis	13 (28.3%)	11 (23.4%)
Abnormal uterine bleeding	0 (0.0%)	1 (2.1%)
Ovarian tumor	6 (13.0%)	8 (17.0%)
Endometrial cancer	1 (2.2%)	3 (6.4%)
Others	8 (17.4%)	5 (10.6%)
Procedure		
TAH with BS	15 (32.6%)	10 (21.3%)
TAH with Uni SO	2 (4.3%)	5 (10.6%)
TAH with BSO	21 (45.7%)	24 (51.1%)
TAH with BSO with omentectomy	4 (8.7%)	6 (12.8%)
TAH with BSO with omentectomy with lymphadenectomy	2 (4.3%)	2 (4.3%)
Others	2 (2.2%)	0 (0.0%)
Anesthetic procedure		
General anesthesia	11 (23.9%)	12 (25.5%)
General anesthesia combined with spinal anesthesia	35 (76.1%)	35 (74.5%)
Duration of operation (min), mean $\pm$ SD	146.48 $\pm$ 47.38	139.38 $\pm$ 37.88
Estimate of blood loss (mL), mean $\pm$ SD	279.35 $\pm$ 213.00	250.43 $\pm$ 212.84

**Abbreviations:** BMI, body mass index; ASA classification, American Society of Anesthesiologists classification; TAH, total abdominal hysterectomy; BS, bilateral salpingectomy; Uni SO, unilateral salpingo-oophorectomy; BSO, bilateral salpingo-oophorectomy.

higher in the early removal group but did not differ significantly between groups ( $p = 0.272$  and  $p = 0.163$ , respectively). Pre-test pain scores (VAS) on POD1 and POD2 were also comparable (Table 2).

Early catheter removal was associated with a shorter time to first voiding ( $19.02 \pm 3.72$  vs  $21.99 \pm 3.46$  hours,  $p < 0.001$ ). Re-catheterization was required in one patient (2.2%) in the early group and none in the control group. Rates of symptomatic UTIs and positive urine cultures were low and not significantly different (Table 3). Length of hospital stay, catheter-related discomfort, hospitalization costs, and overall patient satisfaction (NRS) did not differ significantly between groups.

**Table 2 Primary Outcomes**

Primary Outcomes	Early Removal (n= 46)	Control Group (n= 47)	p-value	Mean Difference	95% CI
Time of first ambulation (hours), mean ± SD	18.69 ± 4.11	21.41 ± 3.02	<0.001	2.71 ± 0.75	1.23–4.19
Six-minute walk distance in POD1 (meters), mean ± SD	175.80 ± 81.12	158.454 ± 69.12	0.272	-17.35 ± 15.71	-48.56–13.86
Six-minute walk distance in POD2 (meters), mean ± SD	229.68 ± 90.33	206.07 ± 70.65	0.163	-23.60 ± 16.80	-56.97–9.75
Difference distance between baseline and POD1 (meters), mean ± SD	-115.94 ± 67.63	-106.16 ± 92.69	0.565	9.78 ± 16.92	-23.83–43.39
Difference distance between baseline and POD2 (meters), mean ± SD	-62.06 ± 69.98	-59.04 ± 83.22	0.850	3.02 ± 15.96	-28.68–34.72
Pain score before six-minute walk test in POD1 (VAS score), mean ± SD	3.61 ± 2.01	3.69 ± 2.29	0.870	0.08 ± 0.46	-0.84–0.99
Pain score before six-minute walk test in POD2 (VAS score), median (IQR)	2 (1, 3)	2 (0.5, 3)	0.363	-0.36 ± 0.47	-1.10–0.39

**Abbreviations:** POD1, postoperative day 1; POD2, postoperative day 2; VAS, visual analogue scale.

**Table 3 Secondary Outcomes**

Secondary Outcomes	Early Removal (n= 46)	Control Group (n= 47)	p-value	Mean Difference or RR	95% CI
Time of first voiding (hours), median (IQR)	19.5 (16.33, 21.83)	21.62 (19.83, 23.33)	<0.001	2.79 ± 7.48	1.30, 4.27
Re-catheterization					
In POD1 (%)	1 (2.2%)	0 (0.0%)	0.495	1.022	0.979,1.067
In POD2 (%)	0 (0.0%)	1 (2.1%)	>0.999	0.979	0.938,1.021
Postoperative urinary tract infection					
Symptomatic (%)	1 (2.2%)	3 (6.4%)	0.317	0.326	0.033,3.254
Positive urine culture (%)	0 (0.0%)	0 (0.0%)	0.000	-	-
Length of hospital stay (days), median (IQR)	4.5 (4, 6)	5 (4, 6)	0.897	-0.07 ± 0.55	-1.17,1.025
Discomfort related to retaining urinary catheter (VAS score), median (IQR)	3 (2, 5)	3 (0, 4)	0.177	-0.69 ± 0.56	-1.80,0.418
Cost of hospital stay (THB), median (IQR)	40412 (35,957.25, 53,858)	36,830.5 (33,236.5, 48,293.5)	0.118	-5493.57 ± 4798.70	-15,029.99,4042.84
Satisfaction score (NRS score), median (IQR)	9 (8, 10)	9 (8, 10)	0.855	-0.20 ± 0.52	-1.24,0.84

**Abbreviations:** POD1, postoperative day 1; POD2, postoperative day 2; VAS, visual analogue scale; THB,Thai baht; NRS, numeric rating scale; RR, Relative risk.

In subgroup analysis by anesthetic technique (Table 4), early catheter removal consistently reduced the time to first ambulation (18.29 ± 3.37 vs 21.60 ± 3.15 hours, p < 0.001) and shortened time to first voiding, without significantly affecting re-catheterization rates.

**Table 4 Subgroup Analysis According to Anesthetic Procedure**

Primary Outcomes	Early Removal	Control Group	p-value	Mean Difference or RR	95% CI
<b>General anesthesia combined with spinal anesthesia</b>	(N=35)	(N=35)			
Time of first ambulation (hours), mean ± SD	18.29 ± 3.37	21.60 ± 3.15	<0.001	3.31 ± 0.78	1.76,4.87
Time of first voiding (hours), mean ± SD	18.92 ± 3.13	22.11 ± 3.77	<0.001	3.19 ± 0.84	1.52,4.86
Re-catheterization in POD1	1 (2.9%)	0 (0.0%)	0.314	1.029	0.973,1.090

**Abbreviations:** POD1, postoperative day 1; POD2, postoperative day; RR, Relative risk.

## Discussion

The findings of this randomized controlled trial indicate that early removal of the urinary indwelling catheter, within 12 to 16 hours after uncomplicated total abdominal hysterectomy, enhances postoperative recovery without increasing urinary complications. Specifically, early catheter removal significantly reduced both the time to first ambulation and the time to first voiding compared to standard removal at 20 to 24 hours postoperatively.

These results align with previous studies,<sup>8</sup> confirming that early catheter removal facilitates earlier mobilization. In our study, the mean time to first ambulation was  $18.69 \pm 4.11$  hours in the early removal group versus  $21.41 \pm 3.02$  hours in the control group ( $p < 0.001$ ), supporting existing ERAS guidelines that advocate early mobilization to improve postoperative outcomes.<sup>10</sup>

Similarly, Chiewhatpong et al [2021]<sup>14</sup> reported higher six-minute walk distances on postoperative days 1 and 2 in the ERAS group, though differences were not statistically significant. This suggests that while early catheter removal accelerates mobilization, overall functional recovery—as measured by walking distance—remains comparable by the second postoperative day. The lack of significance may be attributed to sample size, interpatient variability, or the short observation period, yet the trend toward improved performance in the early removal group underscores the safety and potential benefits of early ambulation.

A key concern with early catheter removal is the risk of urinary retention and subsequent need for re-catheterization. While some studies<sup>6,15,16</sup> have reported higher rates of urinary retention when catheters are removed immediately or within 6 hours after uncomplicated total abdominal hysterectomy, this is not a universal finding.<sup>8,17</sup> In the present study, only one patient (2.2%) in the early removal group (12–16 hours postoperatively) required re-catheterization, a rate not significantly different from the control group. Additionally, early catheter removal did not increase the incidence of postoperative urinary tract infections (UTIs), a complication commonly associated with prolonged catheter use. These results are consistent with previous studies<sup>3,4,6</sup> demonstrating that early catheter removal can reduce UTI risk. The lack of significant differences in both symptomatic UTIs and re-catheterization rates supports the safety of early urinary catheter removal in patients undergoing uncomplicated total abdominal hysterectomy.

Although early catheter removal led to faster ambulation and voiding, the length of hospital stay was similar between the groups, likely influenced by institutional policies or patient-specific factors rather than the catheter protocol. Consistent with Joshi et al [2014],<sup>18</sup> catheter-related discomfort, measured by VAS scores, did not differ significantly between groups. While some previous studies reported that immediate or early catheter removal reduced both time to first ambulation<sup>4</sup> and hospital stay,<sup>3,8</sup> these effects were not observed in the current study.

Similarly, total hospitalization costs and patient satisfaction were comparable between groups, suggesting that early catheter removal does not increase healthcare expenses or negatively affect patient experience. Notably, patient satisfaction remained high in both groups, with mean NRS scores exceeding 8, underscoring the overall effectiveness of ERAS protocols.

This randomized controlled trial utilized well-defined, objective outcome measures—time to first ambulation, time to first voiding, and six-minute walk distance—strengthening the reliability and clarity of the findings. Randomization helped reduce selection bias, baseline characteristics were balanced between groups, and a low withdrawal rate (<10%) minimized attrition bias. Although participant blinding was not feasible, standardized instructions on early ambulation helped limit measurement bias. Study limitations include its single-center design, which may restrict the generalizability of the findings, and the absence of long-term assessment of urinary outcomes. Furthermore, the results cannot be directly extrapolated to other hysterectomy approaches, such as laparoscopic or vaginal procedures, since the study exclusively involved total abdominal hysterectomy.

## Conclusion

Early removal of the urinary indwelling catheter following uncomplicated total abdominal hysterectomy facilitated earlier ambulation without increasing the risk of postoperative complications.

## Clinical Trial Registration

The study's registration number on ClinicalTrials.gov is TCTR20230830002 (The registration date is August 30, 2023), and the first participant enrollment date is August 31, 2023.

## Data Sharing Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

## Ethics Approval and Informed Consent

This study was approved by the Khon Kaen University Ethics Committee for Human Research (HE661140). This study was conducted in accordance with the principles of the Declaration of Helsinki.

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## Disclosure

The authors declare that they have no conflicts of interest in this work.

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