

Same day urinary catheter removal after pelvic organ prolapse surgery: a randomized controlled trial

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Abstract

Background/Objective:

To evaluate the effect of same-day urinary catheter removal on trial-of-catheter outcomes compared with standard voiding trial on post-operative day 1 in women undergoing major pelvic organ prolapse surgery.

Methods

We conducted a single-centre, parallel-group, superiority randomized controlled trial at KK Women's and Children's Hospital, Singapore, between 27 December 2023 and 16 May 2025. 97 participants undergoing pelvic organ prolapse surgery were randomized in a 1:1 allocation ratio to either same-day urinary catheter removal with trial off-catheter 6 hours after surgery (post-operative day 0) or standard catheter removal with trial off-catheter on post-operative day 1. Objective successful trial off-catheter was defined as voiding within 6 hours with post-void residual urine volume < 150mL, while subjective successful trial off-catheter was clinician-assessed. Secondary outcomes included time to ambulation, length of post-operative stay, rates of urinary tract infection and post-operative complications, pain, and anxiety scores. Follow-up was conducted until one month post-operatively. The study was approved by the SingHealth Centralised Institutional Review Board (Reference No. 2022–2758; approved 28 July 2023). Written informed consent was obtained from all participants before enrolment.

Results

Objective successful trial off-catheter rates were similar between groups (45.8% vs 46.9%, $p = 0.913$), with no significant difference in time to spontaneous void (298.5 ± 138.9 vs 322.8 ± 89.1 minutes, $p = 0.377$). Although subjective successful trial off-catheter was lower in the same-day removal group than in the control group (41.7% vs 71.4%, $p = 0.003$), patients undergoing same-day catheter removal ambulated earlier, with more ambulating on post-operative day 0 (52.1% vs 2.0%, $p < 0.001$), and a greater proportion discharged within 1–1.5 days post-operatively (37.5% vs 18.4%, $p = 0.036$). Rates of post-operative complications and urinary tract infections were low and comparable between groups.

Conclusion

Same-day urinary catheter removal following pelvic organ prolapse surgery is a safe and feasible strategy that facilitates earlier ambulation and shorter hospitalization without increasing post-operative complications. Although clinician-assessed trial off-catheter success was lower following same-day catheter removal, objectively defined trial off-catheter outcomes were similar between groups.

Trial Registration:

ClinicalTrials.gov NCT07768878; retrospectively registered on 2025-03-10 (<https://clinicaltrials.gov/study/NCT07768878>).

Background

Pelvic organ prolapse (POP) is increasingly prevalent in modern society, driven by ageing populations and rising obesity rates. At least half of adult women are affected by some degree of POP, and by age 85, an estimated 11–19% of women will have undergone at least one surgical procedure for this condition [1, 2]. Surgery remains the definitive treatment for women who have failed conservative management. In efforts to reduce healthcare costs and improve patient satisfaction, POP surgery has been performed as a same-day surgery in some countries [3]. However, implementation has been variable worldwide, likely due to differences in training, institutional culture, and a lack of robust safety evidence [4].

A significant barrier to same-day discharge is the timing of post-operative urinary catheter removal. Urinary retention and urinary tract infection (UTI) are primary concerns following POP surgery, and both complications negatively affect patient satisfaction and prolong hospitalization duration [5–7]. Traditionally, catheters have been removed on post-operative day (POD) 1, but few studies have directly examined the complications associated with same-day catheter removal [8, 9]. Despite emerging interest in same-day discharge pathways, the optimal timing for catheter removal after prolapse surgery remains uncertain. This randomized trial evaluates the safety and efficacy of same-day catheter removal within an Asian tertiary care population.

Primary Objective

To evaluate whether same-day catheter removal (POD 0) compared with standard removal on POD 1 increases the proportion of successful trial off-catheter (TOC) (defined as voiding within 6 hours with post-void residual urine (PVRU) <150mL) and time to spontaneous void in women undergoing major POP surgery.

Secondary Objectives

To evaluate whether same-day catheter removal encourages earlier ambulation, shortens duration to discharge, and increases patient satisfaction, while maintaining a similar rate of UTI.

Hypothesis

Primary Hypothesis: Same-day catheter removal improves objective successful TOC rates without increasing UTI rates (non-inferiority margin: 5%). Secondary Hypotheses: Same-day catheter removal reduces time to ambulation, duration to discharge and increases patient satisfaction, reflecting enhanced recovery.

Methods

Study Design

We conducted a randomized, parallel-arm trial in 97 patients undergoing major pelvic floor reconstructive surgery by urogynaecologists at KK Women's and Children's Hospital, a tertiary hospital, between 27 Dec 2023 and 16 May 2025. Women were randomized using computer generation in a 1:1 ratio to an early voiding trial 6 hours post-operatively on POD 0 versus the standard voiding trial at 6am on POD 1, which was the standard practice at our institution. Randomisation was concealed using opaque envelopes attached to patients' case files, managed by a research coordinator not involved in trial enrolment and clinical management. After conclusion of surgery in the operating room, randomisation assignment was revealed by the resident opening the envelope to be included in post-operative instructions. Women were followed up until one month post-operatively. This study was approved by the Institutional Review Board of SingHealth (2022–2758; 28 July 2023). Informed consent was taken for all participants involved in this study.

Participants

Patients were recruited from urogynecology clinics by the study team members. Inclusion criteria included patients undergoing vaginal surgery which included pelvic floor repair or vault suspension with planned overnight hospitalization, and who were independent in their activities of daily living (ADL) with good discharge support. Exclusion criteria included any patients with chronic or recurrent urinary retention (defined as a PVRU of > 150mL), neurogenic bladder, existing UTI at the time of operation, and bilateral hydronephrosis.

Data Collection

After obtaining informed consent, patient demographics, pelvic examination data, operation data, PVRU volume, time to ambulation and discharge, and one-month complications were retrieved from the electronic medical records. Patients completed baseline questionnaires that included a pain visual analog scale (VAS) and State-Trait Anxiety Inventory state subscale (STAI-S) in their native language [10, 11].

Procedures

All patients followed a standardised post-operative protocol – early mobilisation as tolerated according to enhanced recovery after surgery (ERAS) principles, standard fluid management of 1.5L/day maintenance drip and oral intake as tolerated, use of a 14 French in-dwelling urinary catheter, and bedside bladder scanning to measure PVRU.

The voiding trial protocol used was an attempt to void within 6 hours of catheter removal. Two definitions of successful TOC were evaluated:

1. Objective successful TOC: defined as successful voiding within 6 hours with PVRU < 150mL
2. Subjective successful TOC: defined as clinician-assessed successful catheter removal without the need for further catheterisation

Patients who did not meet the objective criteria could still be considered to have passed TOC at clinical discretion depending on volume voided, symptoms and overall post-operative condition. Patients who failed TOC were re-catheterised and re-attempted according to clinical discretion.

Outcomes

Primary Outcomes:

- Objective successful TOC
- Subjective successful TOC
- Time to spontaneous void

Secondary Outcomes:

- Time to ambulation (days)
- Length of post-operative stay (days)
- UTI rate within one month of operation
- Post-operative complications (e.g. bleeding, haematoma, nausea/vomiting, pain, infection)
- Unplanned visits within one week
- Pain scores (VAS)
- Anxiety scores (STAI-S)

Statistical analysis

Data analysis was performed using IBM SPSS Statistics (Version 30) and Microsoft Excel. Continuous variables were evaluated for normality and compared using independent t-test or Wilcoxon rank-sum test, as appropriate. Categorical variables were analysed using the Chi-square test or Fisher's exact test. Missing data was excluded from the specific analyses involving those fields using pairwise deletion. Statistical significance was defined as a two-sided p-value < 0.05.

The primary sample size was determined pragmatically based on feasibility within the study period using the ClinCalc Sample Size Calculator for comparison of two independent groups with continuous data. This is based on an anticipated mean time from operation to successful catheter removal of 2.0 ± 1.0 days in the standard treatment group. Assuming a 30% reduction in the intervention group, a two-sided

significance level (α) of 0.05, 90% power, and a 1:1 allocation ratio, a minimum sample size of 42 participants per group was required. To account for potential withdrawals and missing data, recruitment continued beyond the minimum target. A total of 97 participants were ultimately enrolled and randomized, with 48 allocated to the same-day catheter removal group and 49 to the POD 1 catheter removal group, all of whom completed follow-up and were included in the final analysis. With 48 patients per group, the study also achieved 80% power ($\alpha = 0.05$) to detect a 20% difference in objective TOC success (from 50% to 70%).

Results

A total of 97 patients undergoing major POP surgery were randomized, with 48 allocated to the study group (same-day catheter removal) and 49 allocated to the control group (POD 1 catheter removal). All patients completed follow-up and were included in the final analysis. Participant recruitment, randomization, allocation, follow-up, and analysis are summarized in the CONSORT flow diagram (Fig. 1). Baseline demographic and clinical characteristics were generally well balanced between groups (Table 1). The mean age of participants was 65.4 ± 7.7 years and the mean BMI was 24.6 ± 3.2 kg/m². Most participants were postmenopausal and of Chinese ethnicity.

Despite blinding and randomisation, the authors note that the study group had significantly higher POP-Q point Aa values (1.96 ± 1.49 vs 1.45 ± 1.37 , $p = 0.025$), higher POP-Q point Ba values (3.46 ± 2.49 vs 2.59 ± 2.46 , $p = 0.028$), and a higher mean stage of anterior vaginal prolapse (2.88 ± 0.70 vs 2.63 ± 0.60 , $p = 0.017$). The study group also had higher mean stages of apical prolapse and posterior vaginal prolapse compared to the control group, though this was not statistically significant.

Table 1
Baseline characteristics

Parameters	Overall population (n = 97)	Study group (n = 48)	Control group (n = 49)	p value
Age (years) Mean $\pm$ SD (range)	65.4 $\pm$ 7.7 (45–82)	65.6 $\pm$ 6.8 (51–78)	65.2 $\pm$ 8.6 (45–82)	0.806
BMI (kg/m ²) Mean $\pm$ SD (range)	24.6 $\pm$ 3.2 (19.2–34.1)	24.8 $\pm$ 3.4 (19.2–31.1)	24.3 $\pm$ 3.0 (20.2–34.1)	0.392
Race n (%)	76 (78.4)	35 (72.9)	41 (83.7)	0.121
(a) Chinese	13 (13.4)	8 (16.7)	5 (10.2)	
(b) Malay	6 (6.2)	5 (10.4)	1 (2.0)	
(c) Indian	2 (2.0)	0	2 (4.1)	
(d) Others				
Current smoker n (%)	n = 66	n = 34	n = 32	1.000
(a) Yes	1 (1.5)	1 (2.9)	0	0.493
(b) No	64 (97.0)	32 (94.2)	32 (100)	1.000
(c) Ex	1 (1.5)	1 (2.9)	0	
No. of vaginal births n (%)	3 (3.1)	2 (4.2)	1 (2.0)	0.617
(a) 0	13 (13.4)	9 (18.8)	4 (8.2)	0.126
(b) 1	40 (41.2)	17 (35.4)	23 (46.9)	0.249
(c) 2	32 (33.0)	16 (33.3)	16 (32.7)	0.943
(d) 3	8 (8.3)	4 (8.3)	4 (8.2)	1.000
(e) 4	1 (1.0)	0 (0)	1 (2.0)	1.000
(f) $\geq$ 5	2.3 $\pm$ 1.0	2.2 $\pm$ 1.0	2.4 $\pm$ 0.9	0.411
(g) Mean $\pm$ SD	2.0 (1.0)	2.0 (1.0)	2.0 (1.0)	0.931
(h) Median (IQR)				
Postmenopausal n (%)	92 (94.8)	47 (97.9)	45 (91.8)	0.362
Pre-existing diabetes mellitus n (%)	8 (8.2)	5 (10.4)	3 (6.1)	0.487
History of anxiety or depression n (%)	2 (2.1)	2 (4.2)	0	0.242

Parameters	Overall population (n = 97)	Study group (n = 48)	Control group (n = 49)	p value
Previous abdominal or pelvic surgery n (%)	31 (32.0)	16 (33.3)	15 (30.6)	0.774
Medical co-morbidities n (%)	75 (77.3)	37 (77.1)	38 (77.6)	0.956
Surgery area n (%)	90 (92.8)	45 (93.8)	45 (91.8)	1.000
(a) Anterior compartment	92 (94.8)	46 (95.8)	46 (93.9)	1.000
(b) Posterior compartment	86 (88.7)	42 (87.5)	44 (89.8)	0.721
(c) Apical compartment				
POP-Q point Aa; Mean $\pm$ SD (range)	1.70 $\pm$ 1.44 (-3-3)	1.96 $\pm$ 1.49 (-3-3)	1.45 $\pm$ 1.37 (-2-3)	0.025
POP-Q point Ba; Mean $\pm$ SD (range)	3.02 $\pm$ 2.50 (-3-9)	3.46 $\pm$ 2.49 (-3-9)	2.59 $\pm$ 2.46 (-2-9)	0.028
POP-Q point C; Mean $\pm$ SD (range)	4.65 $\pm$ 2.71 (-1-11)	4.98 $\pm$ 2.68 (-1-11)	4.33 $\pm$ 2.73 (0-11)	0.183
Number of compartments n (%)	2 (2.1)	1 (2.1)	1 (2.0)	1.000
(a) 1	19 (19.6)	9 (18.8)	10 (20.4)	0.837
(b) 2	76 (78.3)	38 (79.1)	38 (77.6)	0.847
(c) 3				
Stage of anterior vaginal prolapse n (%)	1 (1.0)	1 (2.1)	0 (0)	0.495
(a) 0	2 (2.1)	1 (2.1)	1 (2.0)	1.000
(b) 1	24 (24.7)	6 (12.5)	18 (36.8)	0.006
(c) 2	63 (65.0)	35 (72.9)	28 (57.1)	0.104
(d) 3	7 (7.2)	5 (10.4)	2 (4.1)	0.268
(e) 4	2.75 $\pm$ 0.66	2.88 $\pm$ 0.70	2.63 $\pm$ 0.60	0.017
(f) Mean $\pm$ SD	3 (1.0)	3 (0)	3 (1.0)	0.416
(g) Median (IQR)				
Stage of apical prolapse n (%)	0	0	0	-

Parameters	Overall population (n = 97)	Study group (n = 48)	Control group (n = 49)	p value
(a) 1	12 (12.4)	4 (8.3)	8 (16.3)	0.232
(b) 2	61 (62.9)	29 (60.4)	32 (65.3)	0.618
(c) 3	24 (24.7)	15 (31.3)	9 (18.4)	0.142
(d) 4	3.12 ± 0.60	3.23 ± 0.59	3.02 ± 0.59	0.087
(e) Mean ± SD	3 (0)	3 (1)	3 (0)	0.217
(f) Median (IQR)				
Stage of posterior vaginal prolapse n (%)	4 (4.1)	2 (4.2)	2 (4.1)	1.000
(a) 1	74 (76.3)	36 (75.0)	38 (77.6)	0.768
(b) 2	17 (17.5)	9 (18.8)	8 (16.3)	0.754
(c) 3	2 (2.1)	1 (2.0)	1 (2.0)	1.000
(d) 4	2.18 ± 0.52	2.19 ± 0.53	2.16 ± 0.51	0.797
(e) Mean ± SD	2 (0)	2 (0)	2 (0)	0.960
(f) Median (IQR)				
Baseline VAS pain score; Mean ± SD (range)	0.19 ± 0.80 (0–5)	0.21 ± 0.92 (0–5)	0.17 ± 0.66 (0–4)	0.727
Baseline STAI-S anxiety score; Mean ± SD (range)	11.31 ± 5.07 (6–24)	11.67 ± 5.51 (6–24)	10.96 ± 4.62 (6–21)	0.720

Intra-operative characteristics were comparable between groups (Table 2). There were no significant differences in operative duration, estimated blood loss, intra-operative fluid administration, anaesthetic modality, or surgical procedures performed. Approximately a quarter of surgeries (24.7%) were completed after 3pm, with similar distributions between study and control groups.

Table 2
Intra-operative factors

Parameters	Overall population (n = 97)	Study group (n = 48)	Control group (n = 49)	p value
Length of surgery (minutes) Mean $\pm$ SD (range)	112.1 $\pm$ 26.5 (56–188)	111.8 $\pm$ 24.4 (59–164)	112.4 $\pm$ 28.7 (56–188)	0.721
Estimated blood loss (EBL) (ml) Mean $\pm$ SD (range)	n = 96 145.8 $\pm$ 104.8 (50–700)	n = 47 153.1 $\pm$ 96.9 (50–650)	138.7 $\pm$ 112.3 (50–700)	0.128
Intravenous fluids (ml) Mean $\pm$ SD (range)	n = 95 1146.3 $\pm$ 341.4 (300–2000)	n = 47 1131.9 $\pm$ 320.4 (300–2000)	n = 48 1160.4 $\pm$ 363.6 (500–2000)	0.636
Anaesthesia n (%)	95 (98.0)	46 (95.8)	49 (100)	0.242
(a) General	1 (1.0)	1 (2.1)	0	0.495
(b) Regional	1 (1.0)	1 (2.1)	0	0.495
(c) Spinal				
Procedure n (%)	89 (91.8)	43 (89.6)	46 (93.9)	0.487
(a) Vaginal hysterectomy/ total hysterectomy	90 (92.8)	45 (93.8)	45 (91.8)	1.000
(b) Anterior repair (AR)	92 (94.8)	46 (95.8)	46 (93.9)	1.000
(c) Posterior repair (PR)	82 (84.5)	42 (87.5)	40 (81.6)	0.424
(d) Sacrospinous ligament fixation (SSF)	6 (6.2)	2 (4.2)	4 (8.2)	0.678
(e) McCall's culdoplasty	8 (8.2)	3 (6.3)	5 (10.2)	0.715
(f) Uterosacral ligament fixation (USLS)	12 (12.4)	6 (12.5)	6 (12.2)	0.970
(g) Bilateral salpingoophorectomy	33 (89.2)	18 (37.5)	15 (30.6)	0.474
(h) Cystoscopy				
Route n (%)	86 (88.7)	42 (87.5)	44 (89.8)	0.721
(a) Vaginal hysterectomy	3 (3.1)	1 (2.1)	2 (4.1)	1.000

Parameters	Overall population (n = 97)	Study group (n = 48)	Control group (n = 49)	p value
(b) Vaginal natural orifice transendoscopic surgery (vNOTES)				
Vaginal packing n (%)	97 (100)	48 (100)	49 (100)	-
Surgery end after 3pm n (%)	24 (24.7)	13 (27.1)	11 (22.4)	0.597
Intra-operative complications n (%)	1 (1.0)	1 (2.1)	0	0.495

In terms of primary outcomes (Table 3A), objective successful TOC following the first TOC attempt did not differ significantly between the study and control groups (45.8% vs 46.9%, $p = 0.913$). Likewise, there was no significant difference in time to spontaneous void between the study and control groups (298.4 ± 138.9 min vs 322.8 ± 89.0 min, $p = 0.377$). Subjective successful TOC was lower in the study group compared with the control group (41.7% vs 71.4%, $p = 0.003$).

Table 3
A: Primary outcomes

Parameters	Overall population (n = 97)	Study group (n = 48)	Control group (n = 49)	p value
Time to spontaneous void (minutes) Mean $\pm$ SD (range)	n = 55 313.5 $\pm$ 110.1 (61–721)	n = 21 298.4 $\pm$ 138.9 (76–121)	n = 34 322.8 $\pm$ 89.0 (61–538)	0.377
Subjective successful TOC after 1st attempt n (%)	55 (56.7)	20 (41.7)	35 (71.4)	0.003
Objective successful TOC after 1st attempt n (%)	45 (46.4)	22 (45.8)	23 (46.9)	0.913
Number of successful IDC removal attempt (PVRU < 150ml strictly) n (%)	45 (46.4)	22 (45.8)	23 (46.9)	0.913
(a) 1st attempt	18 (18.6)	11 (22.9)	7 (14.3)	0.274
(b) 2nd attempt	8 (8.2)	4 (8.3)	4 (8.2)	1.000
(c) 3rd attempt	1 (1.0)	0	1 (2.0)	1.000
(d) 4th attempt	3 (3.1)	1 (2.1)	2 (4.1)	1.000
(e) Home with IDC				
Number of attempts for patients who never achieved objective successful TOC n (%)	n = 22 13 (59.1)	n = 10 2 (20)	n = 12 11 (91.7)	0.002 0.003
(a) 1st attempt	6 (27.3)	6 (60)	0	0.571
(b) 2nd attempt	3 (13.6)	2 (20)	1 (8.3)	
(c) 3rd attempt				

Looking at the secondary outcomes (Table 3B), patients in the study group demonstrated significantly earlier post-operative ambulation compared with the control group. 52.1% of patients in the study group ambulated on POD 0 compared with only 2.0% in the control group ($p < 0.001$). Mean number of days to ambulation was significantly shorter in the study group (0.50 ± 0.55 days vs 0.98 ± 0.14 days, $p < 0.001$). Length of post-operative stay was also significantly shorter in the study group. A greater proportion of patients in the study group were discharged within 1–1.5 days compared with the control group (37.5% vs 18.4%, $p = 0.036$). Post-operative pain scores and anxiety scores were comparable between groups at all post-operative time points. There were no significant differences in post-operative complications, reoperation, unplanned visits within one week, or UTI rates. Post-operative UTI occurred in one patient in the control group and none in the study group ($p = 1.000$).

Table 3
B: Secondary outcomes

Parameters	Overall population (n = 97)	Study group (n = 48)	Control group (n = 49)	p value
Functional Recovery				
Ambulation n (%)	26 (26.8)	25 (52.1)	1 (2.0)	< 0.001
(a) POD 0	70 (72.2)	22 (45.8)	48 (98.0)	< 0.001
(b) POD 1	1 (1.0)	0	0	0.495
(c) POD 2	0	1 (2.1)	0	-
(d) POD 3	0.74 ± 0.46	0	0.98 ± 0.14	< 0.001
(e) Mean ± SD	1 (1)	0.50 ± 0.55	1 (0)	0.992
(f) Median (IQR)		0 (1)		
Length of post-operative stay (days) n (%)				
(a) 1–1.5 days	27 (27.8)	18 (37.5)	9 (18.4)	0.036
(b) 2–2.5 days	51 (52.6)	20 (41.7)	31 (63.2)	0.033
(c) ≥ 3 days	19 (19.6)	9 (18.4)	9 (18.4)	0.760
(d) Mean ± SD	2.28 ± 0.87	10 (20.8)	2.35 ± 0.84	0.208
(e) Median (IQR)	2 (1)	2.21 ± 0.9	2 (0.5)	0.735
		2 (1)		
Patient-reported Outcomes				
Post-operative VAS pain score; Mean ± SD (range)	2.79 ± 2.55 (0–10)	3.07 ± 2.65 (0–8)	2.52 ± 2.44 (0–10)	0.286
(a) POD 0	n = 92	n = 46	n = 46	0.297
(b) POD 1	0.68 ± 1.38	0.47 ± 0.98	0.89 ± 1.68	0.995
(c) POD 2	(0–7)	(0–3)	(0–7)	
	n = 89	n = 43	n = 46	
	0.36 ± 0.83 (0–3)	0.40 ± 0.93 (0–3)	0.33 ± 0.73 (0–3)	

Parameters	Overall population (n = 97)	Study group (n = 48)	Control group (n = 49)	p value
Difference between post-operative VAS vs baseline; Mean $\pm$ SD (range)	n = 96 2.64 $\pm$ 2.60 (-4-10)	2.86 $\pm$ 2.66 (0-8)	n = 48 2.41 $\pm$ 2.55	0.497 0.338 0.969
(a) POD 0		n = 46	(-4-10)	
(b) POD 1	n = 91 0.49 $\pm$ 1.67 (-5-7)	0.25 $\pm$ 1.43 (-5-3)	n = 45 0.73 $\pm$ 1.88	
(c) POD 2	n = 88 0.16 $\pm$ 1.21 (-5-3)	n = 43 0.16 $\pm$ 1.41 (-5-3)	(-4-7) n = 45 0.16 $\pm$ 1.00 (-4-3)	
Post-operative STAI-S anxiety score on POD 1; Mean $\pm$ SD (range)	n = 94 10.43 $\pm$ 3.54 (6-19)	n = 45 10.71 $\pm$ 3.71 (6-18)	10.16 $\pm$ 3.39 (6-19)	0.524
Difference between baseline & post-operative STAI-S anxiety score; Mean $\pm$ SD (range)	n = 96 -0.97 $\pm$ 4.99 (-14-9)	-1.22 $\pm$ 5.14 (-14-8)	n = 48 -0.71 $\pm$ 4.88 (-11-9)	0.719
Safety Outcomes				
Reoperation n (%)	0	0	0	-
Unplanned visits within one week n (%)	0	0	0	-
Post-operative complications within one month n (%)	3 (3.1)	0	3 (6.1)	0.242
(a) Haematoma	2	0	2	0.495
(b) Infection	1	0	1	1.000
Post-operative UTI n (%)	1 (1.0)	0	1 (2.0)	1.000

Subgroup analyses were performed to evaluate the association between the timing of surgery completion and TOC outcomes (Tables 4 to 6). When looking at the overall study population, patients

whose surgeries were completed before 3pm demonstrated both higher objective and subjective successful TOC rates compared with surgeries completed after 3pm, both of which were statistically significant ($p = 0.037$ and $p = 0.035$) (Table 5). When study and control group were analysed individually for TOC outcomes, surgery end time did not have a significant difference, likely owing to small sample size for analysis.

Table 4
Number of attempts needed to achieve objective successful TOC vs surgery end time

	Operation end before 3pm				Operation end after 3pm			
	Overall population (n = 73)	Study group (n = 35)	Control group (n = 38)	p value	Overall population (n = 24)	Study group (n = 13)	Control group (n = 11)	p value
Number of attempts to achieve objective successful TOC n (%)	37 (50.7)	18 (51.4)	19 (50.0)	0.903	8 (33.3)	4 (30.8)	4 (36.4)	1.000
(a) 1st attempt	14 (19.2)	7 (20.0)	7 (18.4)	0.864	4 (16.7)	4 (30.8)	0	0.098
(b) 2nd attempt								

Table 5
Subjective successful TOC attempts vs surgery end time

	Overall population (n = 97)	Operation end before 3pm (n = 73)	Operation end after 3pm (n = 24)	p value
Subjective successful TOC attempts n (%)	55 (56.7)	37 (50.7)	18 (75.0)	0.037
(a) 1st attempt	n = 50	n = 40	n = 10	0.035
(b) 2nd attempt	26 (52.0)	24 (60.0)	2 (20.0)	

Table 6
Number of attempts after subjective successful TOC vs surgery end time

	Operation end before 3pm				Operation end after 3pm			
	Overall population (n = 73)	Study group (n = 35)	Control group (n = 38)	p value	Overall population (n = 24)	Study group (n = 13)	Control group (n = 11)	p value
Number of attempts needed to achieve subjective successful TOC n (%)	37 (50.7) n = 40	12 (34.3) n = 25	25 (65.8) n = 15	0.007 0.182	18 (75.0) n = 10	8 (61.5) n = 6	10 (90.9) n = 4	0.166 0.467
(a) 1st attempt	24 (60.0)	17 (68.0)	7 (46.7)		2 (20.0)	2 (33.3)	0	
(b) 2nd attempt								

Discussion

Principal Findings

This randomized controlled trial demonstrates that same-day urinary catheter removal following POP surgery is safe and associated with enhanced post-operative recovery, particularly earlier ambulation and shorter hospitalization, without increasing UTI or post-operative complication rates. Although objectively defined successful TOC using strict PVRU criteria was similar between groups, subjective successful TOC rates were lower in the same-day catheter removal group. There was no significant difference in time to spontaneous void, suggesting that earlier catheter removal does not necessarily accelerate physiological recovery of bladder function. Nevertheless, both groups ultimately achieved comparable post-operative bladder outcomes without differences in complications, supporting the safety and feasibility of same-day catheter removal following pelvic reconstructive surgery.

Interpretation of Findings

The objective successful TOC rates were comparable between same-day and POD 1 catheter removal, suggesting that clinically assessed TOC outcomes may not fully correspond to objectively measured bladder emptying parameters. In contrast, the lower subjective successful TOC rates observed in the early catheter removal group likely reflect transient post-operative bladder dysfunction related to incomplete recovery from anaesthesia and peri-operative effects on detrusor function, though these variables are difficult to measure objectively in a clinical setting.

Importantly, same-day catheter removal was associated with clear post-operative recovery benefits. Patients undergoing early catheter removal demonstrated substantially earlier ambulation and a greater proportion achieved discharge within 1 to 1.5 days. These findings support the incorporation of same-day catheter removal into ERAS pathways for selected patients undergoing POP surgery.

Importance of Surgical Timing

Subgroup analysis suggested that surgery completion time may influence post-operative voiding outcomes, with lower objective and subjective successful TOC rates observed in surgeries completed after 3pm. Surgeries that end after 3pm may require the patient to void late in the evening, potentially conflicting with circadian rhythms, leading to reduced ambulation and impaired spontaneous voiding. These findings suggest that surgical timing may be an important consideration when implementing same-day voiding protocols. However, this subgroup analysis was exploratory and requires validation in larger studies. Clinicians may consider reserving same day catheter removal for patients whose surgeries have earlier end time to allow for completion of the voiding trial before bedtime.

Rethinking Voiding Trial Criteria

An important finding from this study is the discrepancy between objective and subjective definitions of successful TOC. While subjective TOC success differed significantly between groups, objective successful TOC using strict criteria was similar, suggesting that clinician judgement incorporates additional contextual factors beyond PVRU thresholds alone when assessing post-operative bladder recovery. For instance, several patients who did not strictly meet objective successful TOC, including PVRU > 150 mL or voiding beyond 6 hours, were nevertheless considered clinically successful without immediate re-catheterization. Notably, these patients did not experience higher rates of complications or subsequent UTI in their admission or post-operative outpatient recovery. While this individualised approach reflects real-world clinical practice, it introduces potential bias, which we addressed by reporting and comparing both objective and subjective outcomes. These findings highlight the potential limitations of rigid PVRU volume-driven TOC definitions and support consideration of a more individualized approach to post-operative bladder management without compromising patient safety. Objective TOC remains the more robust endpoint for comparison with existing literature.

Comparison with Literature

Our findings are broadly consistent with those reported by Carter-Brooks et al. [8], who demonstrated that same day voiding trials after major pelvic floor reconstructive surgery did not prolong catheter use and facilitated earlier ambulation. Like their study, we found no increase in post-operative complications or UTIs with same-day catheter removal, while patients in the early removal group ambulated earlier and had shorter hospitalization stays.

However, there are several notable differences between the studies. Carter-Brooks et al. [8] reported a shorter time to spontaneous void in the early voiding group after adjusted and per-protocol analyses, whereas our study did not demonstrate a statistically significant reduction in time to spontaneous void

between groups. In addition, while their early voiding group achieved spontaneous voiding after the first trial more frequently than our cohort, our objectively defined TOC success rates remained comparable between study arms despite lower clinician-assessed success in the same-day removal group. These differences may reflect variations in study design, TOC definitions, patient population, timing of catheter removal (4 hours post-operatively in Carter-Brooks et al. [8] versus 6 hours in our study), differing surgical case mixes, or insufficient power to detect small differences in our sample.

Importantly, both studies support the feasibility and safety of earlier catheter removal following prolapse surgery within enhanced recovery pathways. Our findings additionally suggest that surgeries ending later in the day may be associated with lower TOC success rates, which may help guide individualized post-operative bladder management strategies.

Strengths

This study was conducted as a randomized controlled trial, which minimizes selection bias and strengthens the validity of the findings. Surgical procedures were standardized and performed by urogynaecologists within a single tertiary care centre, ensuring a minimum and consistent standard in operative experience and peri-operative care. In addition, the study incorporated a comprehensive range of outcomes, including both objective clinical measures and patient-reported outcomes such as pain and anxiety scores. Follow-up was continued to one month post-operatively, allowing for assessment of early complications.

Limitations

This study has several limitations. As a single-centre study, the findings may have limited generalizability to other settings without established enhanced recovery protocols, community settings and patient populations which may have different cultural expectations around hospitalisations. The relatively small sample size may also have limited statistical power for uncommon outcomes such as UTI and post-operative complications.

Furthermore, patients and clinicians were not blinded during post-operative care, which may have introduced bias in subjective outcomes. Specifically, clinicians aware of early catheter removal may have exercised greater caution when declaring subjective TOC success, potentially explaining the lower clinician-assessed success rate in the study group despite comparable objective outcomes. This discrepancy underscores the critical importance of utilising objective, standardised outcome measures in unblinded clinical trials.

Finally, although baseline characteristics were generally comparable, the study group demonstrated statistically significantly more advanced anterior compartment prolapse, which may represent a potential confounder in TOC success rates. While more severe anterior compartment prolapse typically reduces TOC success, the similar objective outcomes between groups suggests that early catheter removal does not exacerbate this risk. However, future studies should stratify or adjust for prolapse severity to isolate the effect of catheter timing.

Future Directions

Future studies should further evaluate optimal timing of post-operative catheter removal and TOC protocols following POP surgery, particularly in relation to surgery completion time. Larger multicentre studies are needed to validate these findings and determine whether more flexible TOC criteria can be safely implemented without increasing post-operative urinary complications. Further evaluation of cost-savings brought about by earlier discharge would also help quantify the potential benefits of early IDC removal.

Conclusion

Same-day urinary catheter removal following POP surgery is a safe and feasible strategy that achieves comparable objective voiding outcomes to standard POD 1 removal while facilitating earlier ambulation and shorter hospitalization without increasing post-operative complications or UTI. Although subjective successful TOC rates were lower following same-day catheter removal, objective successful TOC rates were similar between groups. Surgical timing may influence post-operative voiding outcomes, particularly in surgeries completed later in the day. These findings support consideration of a more individualized approach to post-operative bladder management within enhanced recovery pathways following pelvic reconstructive surgery.

Declarations

Ethics approval and consent to participate -

This study was approved by the Institutional Review Board of SingHealth (Reference number: 2022–2758; Approved on July 28, 2023). Written informed consent was obtained from all participants prior to trial enrolment. Research was conducted in accordance with the declaration of Helsinki and also local regulatory laws like the Human Biomedical Research Act (HBRA).

Consent for publication -

Not applicable.

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CONSORT guidelines – In accordance with BMC Series editorial policies, this study adheres to Consolidated Standards of Reporting Trials (CONSORT) guidelines for reporting clinical trials.

Author Contribution

Authors' contributions • Chin HMS: Project development, Data analysis, Manuscript Writing • Huang EY: Project development, Data analysis, Manuscript Writing • Wong TM: Data analysis, Manuscript Writing • Chua HL: Project development, Data analysis, Manuscript Writing • Li XY: Project development, Data analysis, Manuscript Writing

Data Availability

De-identified patient data and materials can be accessed upon request to li.xinyi@singhealth.com.sg.

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Figures

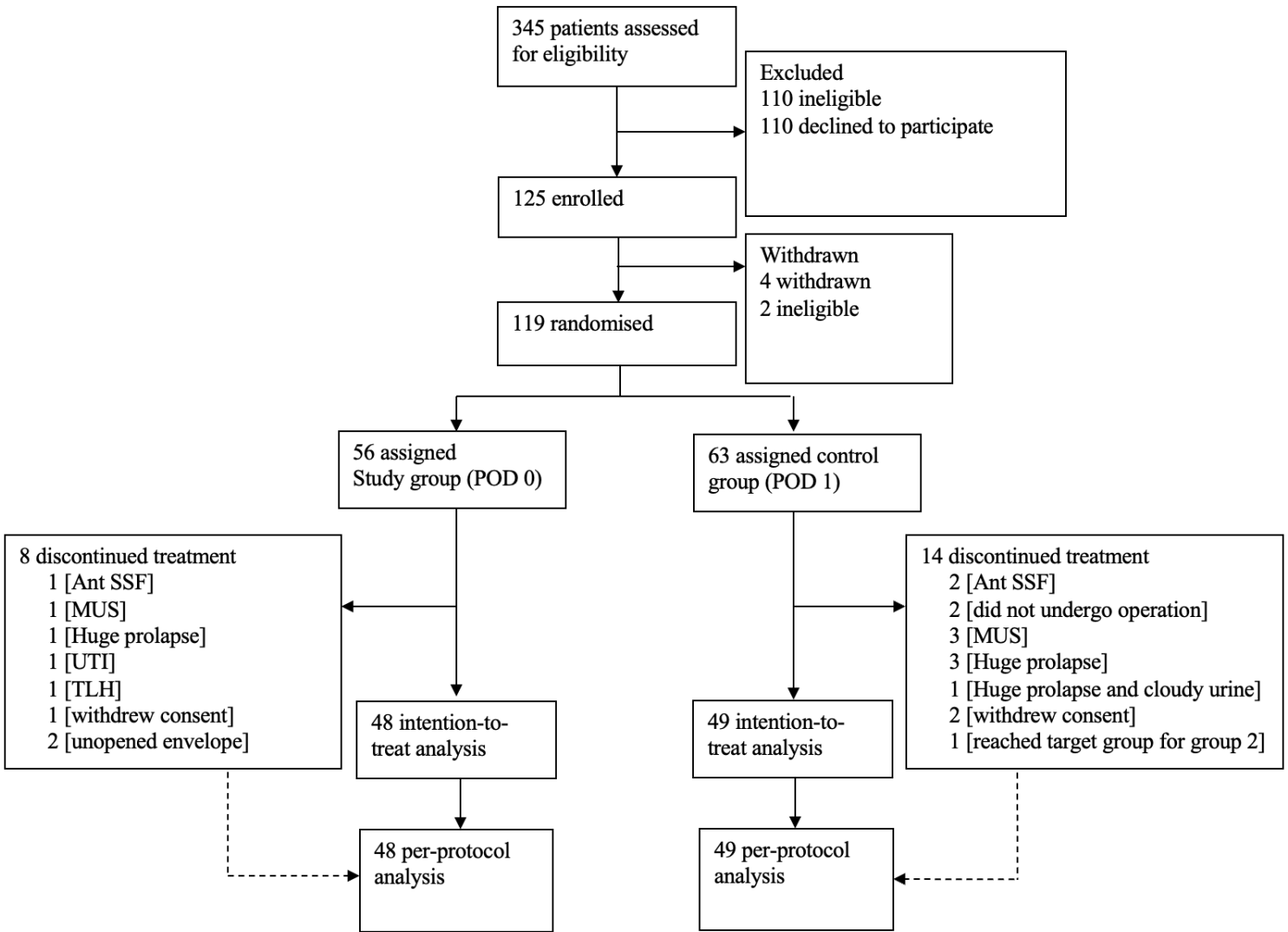


Figure 1

CONSORT flow diagram of trial participants

Supplementary Files

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- [CONSORTeditablistfrIDC.docx](#)