Early Versus Delayed Removal of Urinary Catheter After Pelvic Organ Prolapse Surgery and Vaginal Hysterectomy: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Khaled M. Hamam[1,2], Ahmed Said Ali[2,3], Esraa Ayman[4,2], Shimaa Hassan Abd Elhameid[5,2], Hussien Se'eda[6,8], Sarah Makram Elsayed[1,2], Ahmad Tareq Anwar[6,8], Fatma Mohamed Saad[7,8], Aya Ashraf Ali[6,8], Mohamed Ramadan[9], Amr Hassan Hussein[9]

Original Article

[1]Department of Medicine and Surgery, Faculty of Medicine and Surgery, October 6 University, Egypt

[2]International Medical Students Research Association

Department of Medicine and Surgery, Faculty of Medicine, [3]Al-Azhar University, [4]Menoufia University, [5]Cairo University, [6]Minia University, Egypt

[7]Faculty of Pharmacy, Minia University, Egypt.

[8]Minia Medical Research Society (MMRS), Minia University, Egypt

[9]Department of Obstetrics and Gynecology, Faculty of Medicine, Cairo University, Cairo, Egypt.

ABSTRACT

Introduction: There is no standard time for removing urinary catheters after pelvic organ prolapse (POP) surgeries and vaginal hysterectomy. We aimed to synthesize evidence about the benefits of early versus delayed catheter removal in decreasing post-operative complications after POP surgeries and vaginal hysterectomy.

Material and Methods: We searched the literature from inception till April 2019 using PubMed, Web of Science, Scopus, WHO Global Health Library (GHL), Virtual Health Library (VHL), System for Information on Grey Literature in Europe (SIGLE), POPLINE, and Cochrane Central Register of Controlled Trials (CENTRAL). We screened the retrieved records for their eligibility and extracted baseline and outcomes data. We performed quality assessment using the Cochrane risk of bias assessment tool. continuous data were pooled as mean difference (MD) and dichotomous data as relative risk (RR) with their corresponding 95% confidence intervals (CIs) in a random-effects model. We analyzed data using Review Manager 5.3 for windows.

Results: Nine studies (N= 1116 patients) were included in the final meta-analysis. Overall effect estimates favored early catheter removal group in comparison to delayed catheter removal group in the following outcomes; Urinary tract infection (UTI) (RR=0.42, 95% CI [0.24, 0.72], P=0.0002), Symptomatic urinary tract infection (SUTI) (RR=0.23, 95% CI [0.11, 0.48], P=0.0001), length of hospitalization (MD= -0.89, 95% CI [-1.26, -.52], P=0.0001). Whereas, the pooled effect estimates favored delayed removal group over the early removal group regarding re-catheterization (RR=2.75, 95% CI [1.86, 4.07], P=0.0001). There was no significant difference between the two groups regarding urinary retention (RR=1.45, 95% CI [0.80, 2.63], P=0.22).

Conclusion: Early catheter removal is better than delayed catheter removal in decreasing the risk of urinary tract infection, symptomatic urinary tract infection, the length of hospitalization. However, delayed catheter removal reduced post-operative re-catheterization events. The risk of urinary retention was comparable in the two study groups.

Key Words: Catheterization, delayed, early, pelvic organ prolapse, vaginal hysterectomy.

Received: 15 March 2022, **Accepted:** 14 April 2024

Corresponding Author: Amr Hassan Hussein, Department of Obstetrics and Gynecology, Faculty of Medicine, Cairo University, Egypt, **Tel.:** +20 10013 16900, **E-mail:** amrhassan100@gmail.com

ISSN: 2090-7265, 2025, Vol.15

DOI:10.21608/ebwhj.2022.127684.1173

INTRODUCTION

Pelvic organ prolapse (POP) is the descent of the anterior or posterior vaginal walls, uterus (cervix), or vaginal apex following a hysterectomy. It affects millions of women; roughly 200,000 inpatient prolapse surgical procedures are performed annually in the United States[1]. Pelvic organ prolapse accounts for nearly 15-18% of hysterectomies, and uterovaginal prolapse is the most common indication of post-menopausal women's hysterectomy[2]. About one in 12 women living in the community in the UK report symptoms of POP[3].

Treatment options for POP include observation, vaginal pessaries, and surgery. Eleven to 19 % of women will undergo surgery for prolapse or urinary incontinence by the age of 80 to 85 years, and 30 % of those women will require an additional prolapse or incontinence surgery[4]. Surgery is usually reserved for patients who have at least stage two POP on examination, report bothersome symptoms, and have failed or declined more conservative treatments. Procedures can be classified broadly into obliterative (colpocleisis) or reconstructive vaginal interventions, with the latter being the most commonly undertaken procedures. Anterior colporrhaphy is performed to correct midline defects and is typically performed transvaginally[5].

Potential perioperative complications of anterior colporrhaphy include; hemorrhage; bladder, urethral, or ureteral injury; hematoma, wound infection or dehiscence, vaginal pain, dyspareunia, urinary tract infection, de novo or worsening detrusor overactivity, urinary retention, urogenital fistula, urethral diverticulum. Most surgeons leave a bladder catheter in place following anterior colporrhaphy or any major pelvic surgery since many women have transient voiding dysfunction immediately after surgery[5,6].

Hysterectomy is one of the most common gynecologic surgeries for benign diseases. Abdominal, vaginal, and laparoscopic techniques are the main approaches for hysterectomy. Vaginal hysterectomy (VH) is a procedure in which the uterus is surgically removed through the vagina. If the uterus is not greatly enlarged, it may be better to use the vaginal rather than the abdominal approach[3,6]. Researchers show that vaginal hysterectomy has fewer complications, needs a shorter hospital stay, and enables more rapid healing compared with abdominal hysterectomy[5-7]. In a Cochrane Review of 34 randomized studies, the routes of hysterectomy in benign illnesses were also evaluated. Meta-analysis results have shown that vaginal hysterectomy has many benefits compared to the abdominal procedure regarding earlier return to ordinary activity and hospital discharge, fewer febrile episodes, and quicker recovery associated with less post-operative pain. As vaginal hysterectomy is among the safest and most cost-effective routes for hysterectomy, it is the first-line approach whenever possible[8].

Infectious complications after hysterectomy are uncommon, accounting for 8.5% of cases. Carrubba *et al*. investigated the incidence of post-operative infections following hysterectomy by routes of surgery (vaginal, laparoscopic, and abdominal hysterectomies) in a retrospective cohort study. They found that VH was most commonly associated with UTI (8.1%, p= 0.002)[9]. Women who underwent hysterectomy for a benign gynecologic condition that was not combined with pelvic reconstructive surgery had an overall UTI rate of 7.3% (95% CI 5.6-9.3) vs 21.7% (95% CI 17.6-26.4) after hysterectomy combined with pelvic reconstructive surgery[10]. Increased white cell count, a high level of positive urinary culture, and even symptomatic urinary tract infection (SUTI) are associated with urinary catheterization[11].

However, insertion of a urinary catheter involves an increased risk of urinary tract infection, delayed ambulation, and urethral pain[12]. In addition, UTI can also lead to increased morbidity, hospitalization period, and healthcare costs. The time of post-operative removal of catheter differs significantly as it is based on customary rather than strong published evidence[11,13].

Reducing unnecessary catheterization and catheter removal if no longer needed are the most effective options for preventing infectious urinary catheter complications. The American Society of Infectious Diseases expert panel has developed evidence-based international clinical practice guidelines and strategies for reducing the risk of catheter-related asymptomatic bacteriuria and UTIs. They stated that the simplest strategy for preventing catheter-related urinary tract infection is catheter removal when the indication for insertion is no longer met. Daily evaluation of the ongoing need for indwelling catheters with removal when no longer indicated is essential to reduce complications[14].

Summitt *et al*. concluded that short-term catheter drainage is unnecessary following uncomplicated vaginal hysterectomy[15]. However, Dobbs *et al*. concluded that early removal of urinary catheters had a lower risk of morbidity rate compared with "in-out " urinary catheterization[16].

A meta-analysis of seven randomized trials suggested that the risk of UTI was reduced when urinary catheters were removed within one day postoperatively compared with three days (RR 0.50, 95% CI 0.29-0.87)[17].

No previously published systematic reviews compared the early versus delayed removal of the urinary catheter after common gynecological surgeries as vaginal hysterectomy and POP repair surgeries. Therefore, we aimed to synthesize the evidence from all published RCTs regarding the benefits of early versus delayed catheter removal in decreasing post-operative complications after POP surgeries and vaginal hysterectomy.

METHODS

We performed this systematic review and meta-analysis according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement guidelines[18]. Moreover, we performed all steps according to Cochrane handbook of systematic reviews of intervention[19].

Literature Search Strategy

We comprehensively searched the following electronic databases from their inception till April 2019; PubMed, Web of Science, Scopus, WHO Global Health Library (GHL), Virtual Health Library (VHL), System for Information on Grey Literature in Europe (SIGLE), POPLINE and Cochrane Central Register of Controlled Trials (CENTRAL). Combinations of the following keywords and MeSH terms were utilized: catheter, catheterization, Foley catheter, vaginal surgery, gynecologic surgery, prolapse, cystocel*, colporrhaphy, vaginal hysterectomy, removal, and duration. The search strategy was then developed for each database. No restrictions for language or publication period were applied. Moreover, we manually scanned the reference list of included RCTs and relevant reviews for potentially eligible studies.

Inclusion and Exclusion Criteria

We included studies with the following PICOS criteria:

1. Population: women undergoing vaginal surgery that required an indwelling catheter insertion such as POP surgery and vaginal hysterectomy.
2. Intervention: Early catheter removal (one day or less postoperatively).
3. Comparator: Delayed removal of the urinary catheter (more than one day postoperatively).
4. Outcomes: urinary tract infection (UTI), symptomatic urinary tract infection (SUTI), The length of hospitalization, re-catheterization, and urinary retention 5) Study design: randomized clinical trials (RCTs). When we found multiple reports for the same study population, we chose the most complete dataset to be analyzed.

We excluded studies with the following criteria:

1. Gynecological surgeries not performed through the vaginal route.
2. Overlapped data and studies whose data for extraction and analysis were unreliable.
3. Duplicate studies and incomplete dataset.
4. studies with no full text available.
5. Abstract-only articles (conference proceedings, letters, commentaries), or observational studies, thesis, books, reviews, editorials.

Duplicates were removed manually, and by using Endnote software, then all reviewers initially screened the titles and abstracts of all retrieved records to assess relevance to this meta-analysis, then full-text articles screening was performed to ensure the final eligibility to meta-analysis. Any disagreements were resolved by discussion and consensus.

Data Extraction

A standard data extraction Excel sheet was used to extract the included studies data. The following domains were extracted:

1. Study year and design.
2. Baseline characteristics of enrolled patients.
3. Risk of bias domains, and study outcomes.
4. Authors were contacted if important information were missing.

Risk of bias assessment

The risk of bias assessment of the included RCTs was performed in accordance with the handbook of Cochrane for systematic reviews of interventions 5.1.0 (March 2011 updated). We used the assessment risk of bias table provided in part 2 of the same book (Chapter 8.5). The Cochrane tool for assessing the risk of bias involves the following domains: sequence generation (selection bias), allocation sequence concealment (selection bias), blinding of patients and personnel (performance bias), blinding of outcome estimation (detection bias), insufficient outcome data (attrition bias), selection result reporting (reporting bias), and other possible sources of bias. The authors judgments for bias are reported as Low risk, High risk or Unclear risk[20].

Data synthesis

Dichotomous data were pooled as relative risk (RR) and 95% confidence interval (CI). Using the inverse-variance method, continuous data were pooled as mean difference (MD) and 95% confidence interval (CI). The random-effect model was used in case of significant heterogeneity. If the standard deviation (SD) from the mean is missing, according to Altman, we replaced it with standard error or 95% CI[21]. We used RevMan (Review Manager, version 5.3; The Cochrane Collaboration, 2011; The Nordic Cochrane Centre, Copenhagen, Denmark) for analysis.

Assessment of heterogeneity

We assessed heterogeneity through visual inspection of forest plots and measured by I-square (I2) and Chi-Square (X2) tests. Chi-Square tests the existence of significant heterogeneity, while I2 assesses the effect estimates variation based on heterogeneity if found. We interpreted the I2 test based on guidelines of Cochrane Handbook for Systematic Reviews and meta-analysis (0% to 40%: not important; 30% to 60%: moderate heterogeneity; 50% to 90%: substantial heterogeneity; and 75% to 100% for considerable heterogeneity). We considered the significant heterogeneity when Chi-Square *P-value* <0.1.

Subgroup analysis

We conducted a subgroup analysis to assess whether the effect estimates differ significantly according to POP with and without vaginal hysterectomy.

Publication bias

Since publication bias assessment was not reliable for less than ten pooled studies, according to Egger *et al*.[22]., we could not assess the existence of publication bias in our study by Egger's test for funnel plot asymmetry.

RESULTS

Study selection and study characteristics

We had 2207 citations after searching the seven electronic databases [PubMed, Web of Science, Scopus, WHO Global Health Library (GHL), Virtual Health Library (VHL), System for Information on Grey Literature in Europe (SIGLE), POPLINE, and Cochrane Central Register of Controlled Trials (CENTRAL)]. Authors started title, and abstract screening of the retrieved records, and 87 articles were eligible for full-text screening. Seventy-eight articles were excluded, and nine studies were finally included, as shown in the PRISMA flow diagram (Figure 1). The references of the included RCTs were searched manually, but no more reports have been added. The final analysis included a total of 1116 patients divided into two groups: early catheter removal (556 patients) and delayed removal (560 patients). The summary of the nine included RCTs is shown in (Table 1).

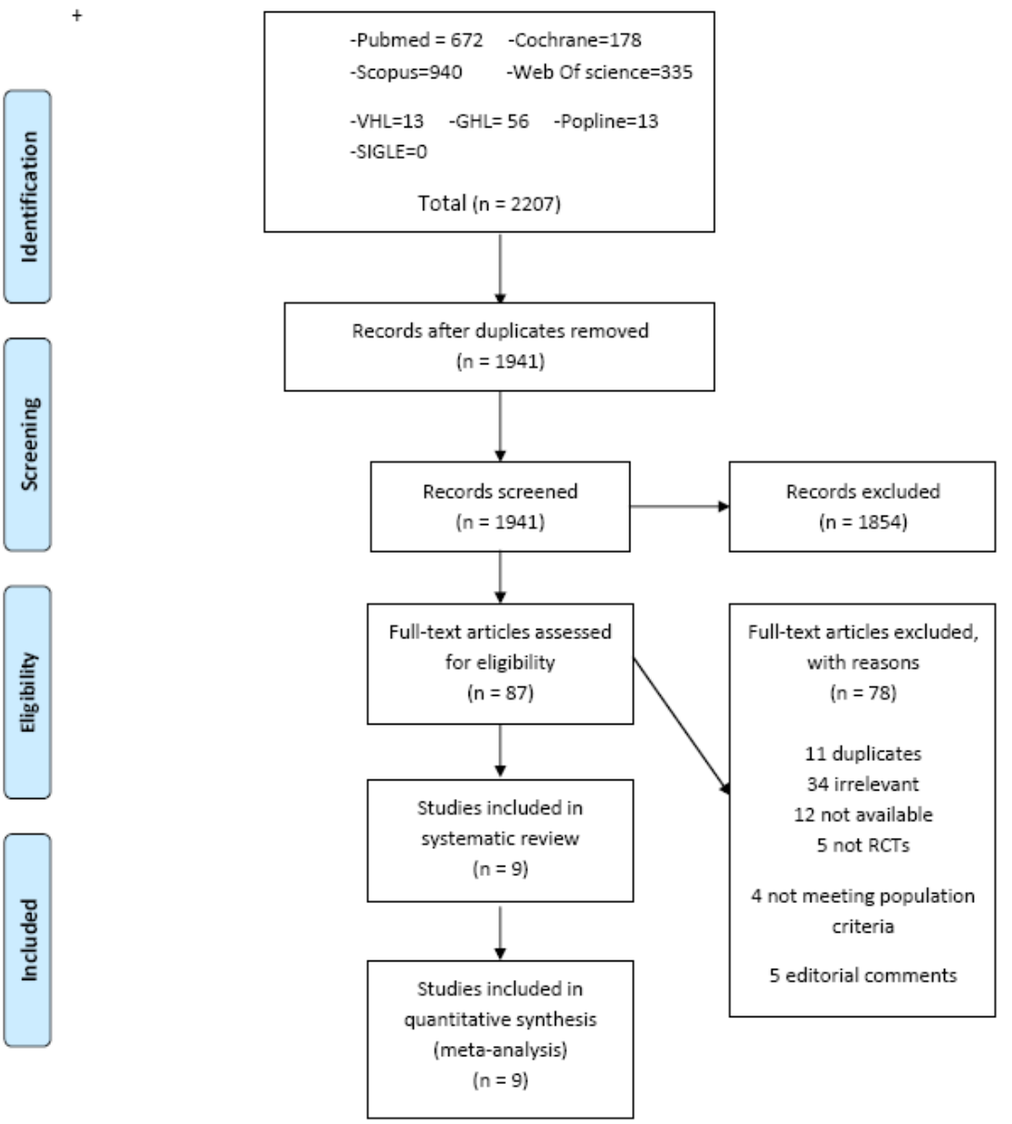

Fig. 1: PRISMA Flow Chart of the study selection process

Table 1: Baseline Characteristics of Included Studies

Author Year, Reference	Country	Study design	Population	Indwelling catheter after surgery, Immediate/ delayed (h)	Sample size, immediate/ delayed (n)	Age, Immediate/ delayed, Mean ± SD (years)	BMI (mean ± SD) Early/Delayed	Parity, Mean ± SD	Catheter type	Operation/s	Operating time minutes (Mean Early/delayd	Conclusion
Roya Kokabi, 2008[23]	Iran	RCT	patients undergoing anterior Colporrhaphy due to pelvic organ prolapse and stress incontinency operation	24/96	62/63	NA	NA	NA	a Foley catheter,	anterior and posterior colporrhaphy surgery	NA	The authors suggest that day four is the best time to remove the urinary Foley catheter after anterior and posterior Colporrhaphy
Ahmadi Shahnaz, ,2016[24]	Iran	RCT	women candidates for anterior colporrhaphy surgery	24/72	35/35	39.4±3.2/ 38.8±2.8	20±2.1/20±2.4	NA	NA	Anterior Colporrhaphy	NA	Short time catheterization is more satisfactory in comparison long catheterizations
Ching-Chung Liang, 2008[25]	Taiwan	RCT	patients with benign gynecologic disease undergoing laparoscopic-assisted vaginal hysterectomy	24/48	50/50	43.7±3.9/45.7±3.5	25.7	2.4±1.1/2.5±0.9	a rubber catheter	laparoscopic-assisted vaginal hysterectomy	142.5 ±102.2/143.9 ±81.5)	The data suggest that the most important predictor for postoperative adverse urinary events was the duration of catheterization. Short-term indwelling catheterization increased the incidence of UTI, but decreased the incidence of PUR among patients undergoing LAVH.

Rhiannon Bray, 2016[26]	UK	RCT	patients admitted for vaginal surgery for pelvic organ prolapse.	0/48	31/29	59.5±15.6/63.5±14.4	NA	NA	NA	anterior or posterior colporrhaphy with or without vaginal hysterectomy	NA	After vaginal surgery for pelvic organ prolapse, the majority of patients do not require extended catheterization. Early removal of a catheter reduces urinary tract infection and significantly decreases hospital stay. Such a policy should result in improved patient satisfaction and reduced hospital costs.
Annemarie Van Der Steen, 2011[27]	The Netherlands	RCT	patients undergoing vaginal prolapse surgery with anterior colporrhaphy	24/72	82/88	60 for both groups	NA	NA	a suprapubic catheter (Cystofix®, Braun	anterior colporrhaphy, Vaginal hysterectomy and Manchester-Fothergill	NA	Starting a voiding trial 1 day after vaginal prolapse surgery leads to shorter duration of catheterization and hospital stay.
B Shrestha, 2012[28]	Nepal	RCT	All women who underwent vaginal hysterectomy, anterior colporrhaphy and Manchester operations	24/72	50/50	53.35 ±10.94 for all 100 patients	NA	NA	Foley catheter	vaginal hysterectomy, anterior colporrhaphy and Manchester operations	NA	Despite increased recatheterization rate, early removal of in-dwelling catheters after uncomplicated vaginal hysterectomy pelvic fl oor repair and anterior colporrhaphy decreased mean catheterization time, mean hospital stay and asymtomatic urinary tract infection
Ute Kringel, 2009[29]	Germany	RCT	Patients with an indicated anterior colporrhaphy plus an optional further procedure (i.e., hysterectomy)	24/96	100/100	64.3±10.3/63.5±11.3	26.6 26.5	2.16±.09/ 2.24±.91	A silicon Foley catheter (Teleflex Medical GmbH/Ruesch, Kernen, Germany)	vaginal hysterectomy, anterior colporrhaphy, posterior colporrhaphy.	78.7 ±26.5/83 ±26.7	The optimal bladder catheter after anterior colporrhaphy was the IUC for 24 h

R.A. Hakvoort, 2004[30]	The Netherland	RCT	Patients undergoing anterior colporrhaphy	0/96	48/46	64±14.3/64±14.43	NA	NA	Foley catheter (Charrie're 14	anterior colporrhaphy only or with post and/or vaginal hysterectomy	65/65	The disadvantages of prolonged catheterization outweigh the advantages, therefore, removal of the catheter on the morning after surgery may be preferable and longer term catheterization should only be undertaken where there are specific indications
Gourisankar Kamilya, 2010[31]	India	RCT	Patient admitted for vaginal prolapse surgery	24/96	98/99	46.9±12.02 /47.9±12.778	NA	2.4±1.1/3.88±2.08	Foley catheter	Vaginal hysterectomy with pelvic floor repair, Fothergill's operation, Pelvic floor repair.	77.2 ±12.1/76.7 ±11.78	The early removal of catheter seems more advantageous, with lower incidence of urinary tract infection and a shorter hospital stay although associated with an increased risk of recatheterisation

Quality assessment

Our included RCTs have varied in quality from moderate to high according to the risk of bias assessment tool. Quality assessment domains summary is shown in (Figure 2).

Study Outcomes

Re-catheterization

Five included studies with a total of 293 patients in early catheter removal group and 293 patients in delayed catheter removal group reported re-catheterization after vaginal surgeries. Our analysis favored delayed catheter removal in terms of recatheterization after vaginal surgeries (RR=2.75, 95% CI [1.86, 4.07], P=0.0001). The pooled studies were homogenous (I2=36%, P=0.18), as shown in (Figure 3).

Urinary retention

Four included studies with a total of 235 patients in early catheter removal group and 235 patients in delayed catheter removal group reported urinary retention after vaginal surgeries. Our analysis showed no significant difference in urinary retention between the two groups (RR=1.45, 95% CI [0.80, 2.63], P=0.22). Pooled studies were homogenous (I2=0%, P=0.72), as shown in (Figure 4).

The length of hospital stay

Six included studies with a total of 394 patients in early catheter removal group and 397 patients in delayed catheter removal group reported length of hospital stay after vaginal surgeries. Pooled estimates favored early catheter removal in terms of length of hospital stay (MD= -0.89, 95% CI [-1.26, -.52], P=0.0001). The pooled studies were heterogeneous (I2=80%, P=0.0001), as shown in (Figure 5).

Urinary tract infection (UTI)

Nine included studies with a total of 556 patients in early catheter removal group and 560 patients in delayed catheter removal group reported urinary tract infection after vaginal surgeries. Our analysis showed a significant difference between the two groups regarding urinary tract infection (RR=0.42, 95% CI [0.24, 0.72], P=0.0002) favoring early catheter removal. The pooled studies were homogenous (I2=67%, P=0.002), as shown in (Figure 6).

Subgroups analysis according to pelvic organ prolapse with vaginal hysterectomy

Nine included studies with a total of 556 patients in early catheter removal group and 560 patients in delayed catheter removal group reported POP with vaginal hysterectomy. The total RR of POP with vaginal hysterectomy favored early removal over delayed removal of urinary catheter (RR=0.36, 95% CI [0.18, 0.71], P=0.0003, I2=74%, $P<0.0006$) and the overall RR of POP without vaginal

hysterectomy favored neither early nor delayed catheter removal (RR=0.69, 95% CI [0.33, 1.45], P=0.32, I2=0%, *P*<0.77) respectively. Moreover, the overall combined RR favored early catheter removal over delayed catheter removal in terms of POP with and without vaginal hysterectomy (RR=0.42, 95% CI [0.24, 0.72], P=0.0002). The pooled studies were homogenous (I2=67%, *P*<0.002), as shown in (Figure 7).

Symptomatic UTI

Three included studies with a total of 229 patients in early catheter removal group and 228 patients in delayed catheter removal group reported symptomatic urinary tract infection after vaginal surgeries. The overall RR of symptomatic urinary tract infection favored early removal over delayed removal (RR=0.23, 95% CI [0.11, 0.48], P=0.0001). The pooled studies were homogenous (I2=0%, P=0.45), as shown in (Figure 8).

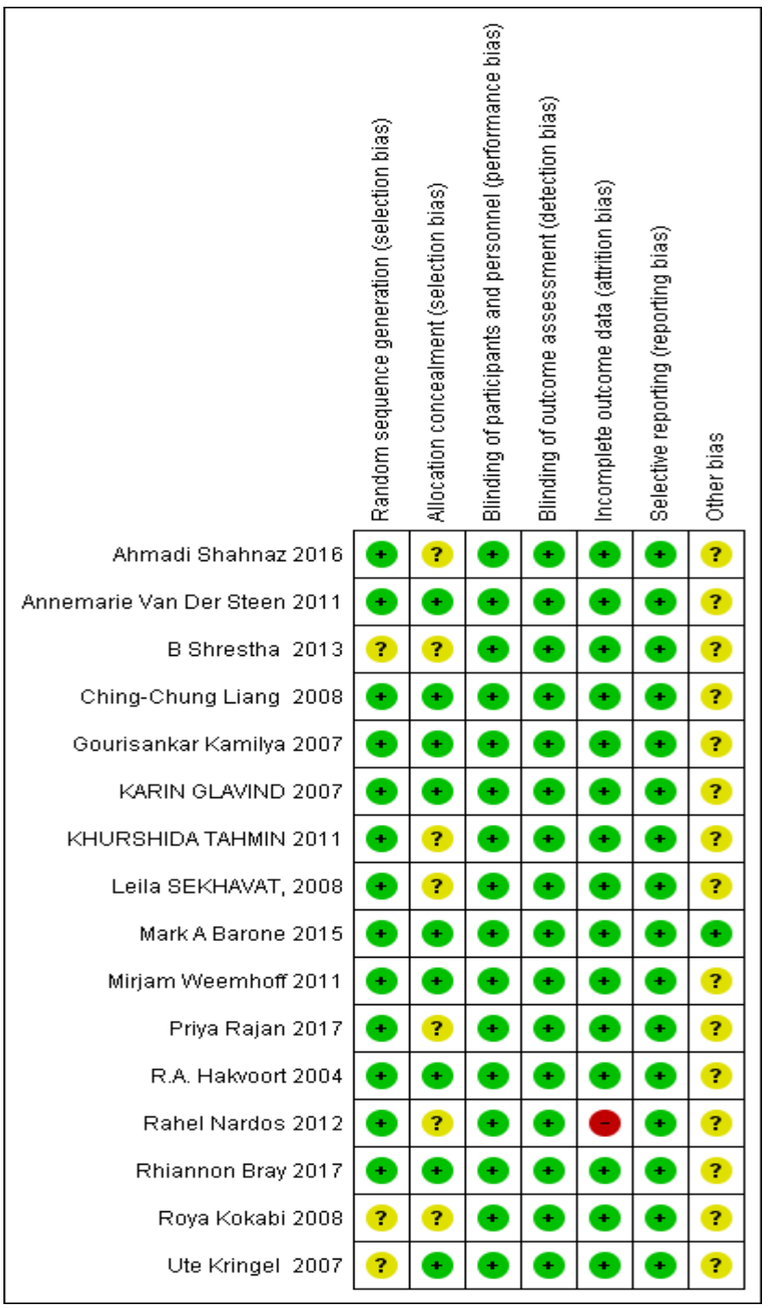

Fig. 2: Risk of bias summary graph

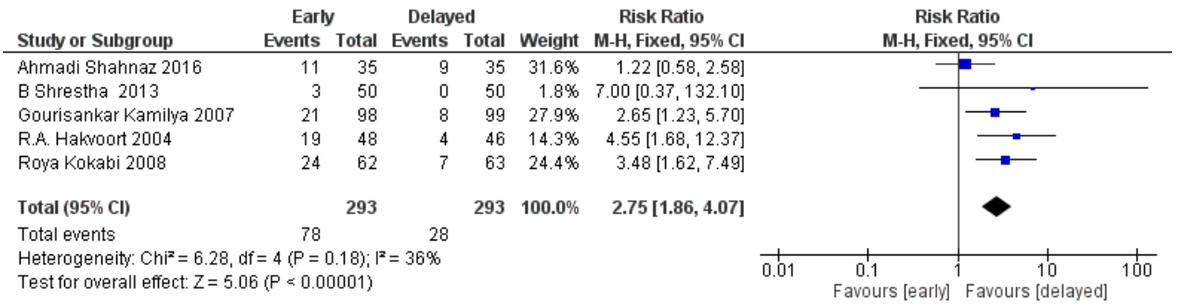

Fig. 3: Forest plot for Re-catheterization

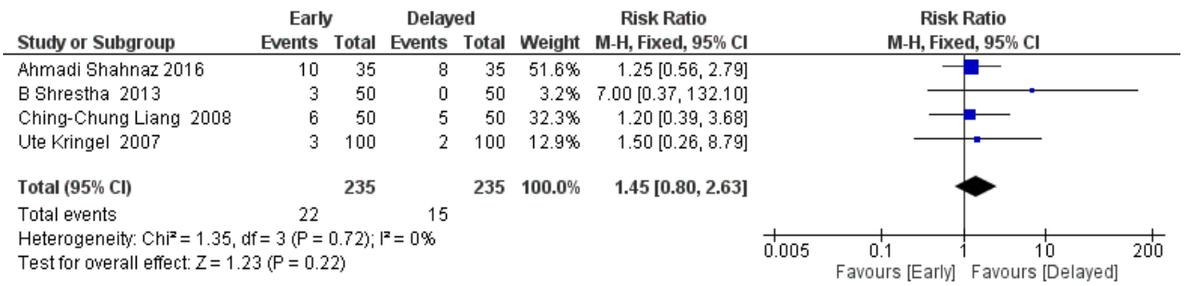

Fig. 4: Forest plot for urinary retention

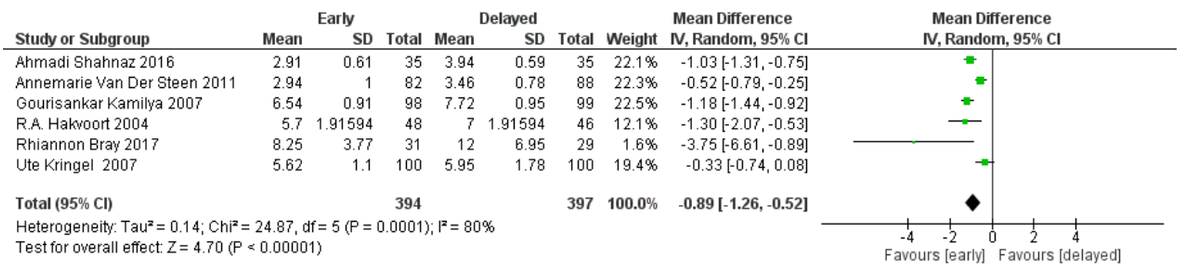

Fig. 5: Forest plot for length of hospital stay

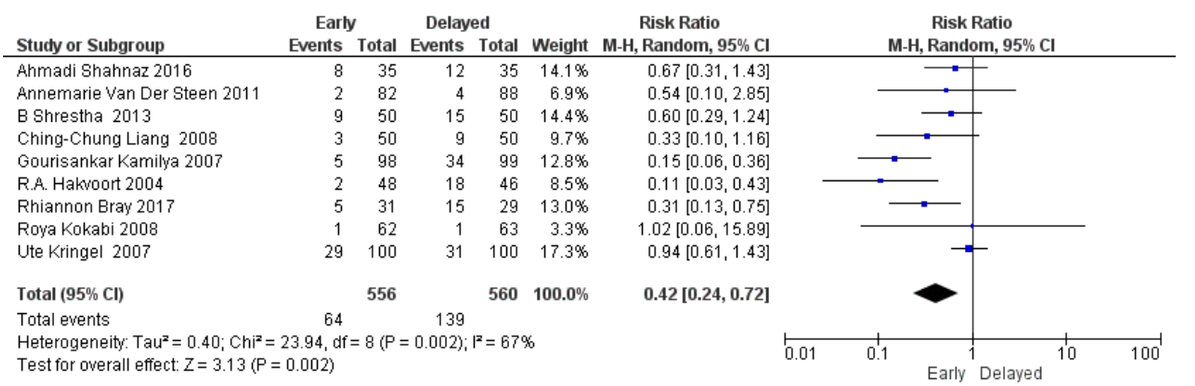

Fig. 6: Forest plot for UTI

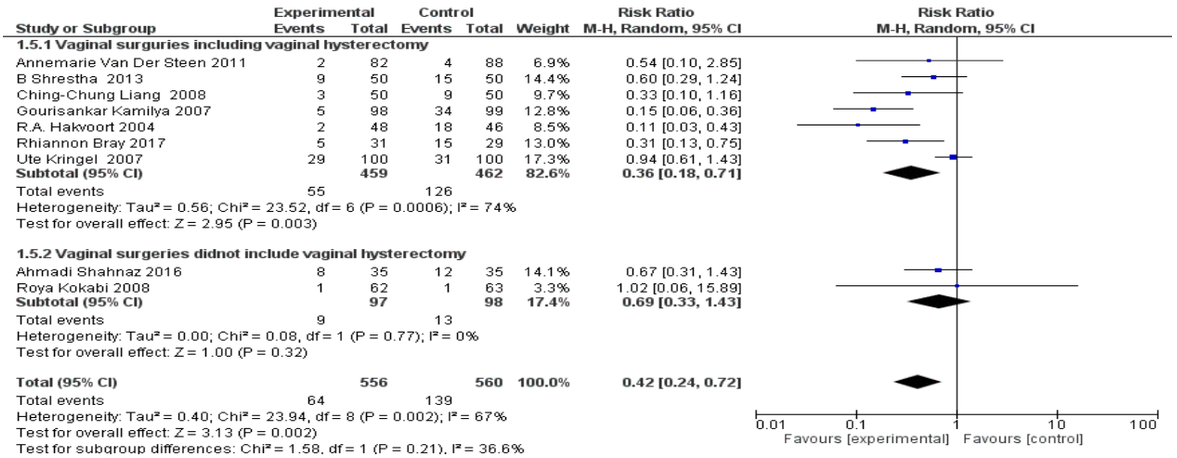

Fig. 7: Forest plot for subgroup analysis according to vaginal surgeries with or without hysterectomy

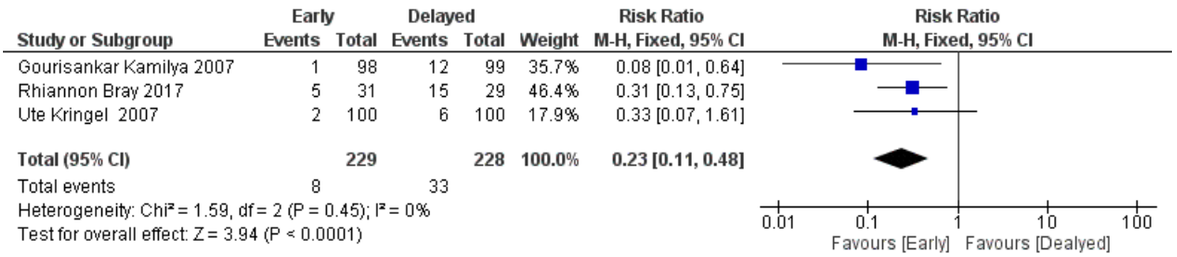

Fig. 8: Forest plot for symptomatic UTI

DISCUSSION

To the best of our knowledge, this is the first study that evaluates and compares the effect of early catheter removal versus delayed catheter removal after common vaginal surgeries such as vaginal hysterectomy and repair surgeries for POP. We found that early catheter removal (one day or less) was superior to delayed catheter removal (more than one day). Early catheter removal showed a significant decrease in post-operative urinary tract infection, symptomatic urinary tract infection, however, the results showed moderate heterogeneity. After subgroup analysis, we found that the results of studies that included different types of surgeries were heterogeneous, where the results of vaginal prolapse surgeries only were homogenous. Therefore, we believe that the reason behind such heterogeneity is the difference in the nature of surgeries and the length of hospital stay. On the other side, delayed catheter removal showed less incidence of re-catheterization events. Moreover, our analysis showed no statistically significant difference in the incidence of urinary retention between early catheter removal and delayed catheter removal.

Urinary catheters prevent intraoperative bladder injury and reduce bladder volume and urine retention after surgery. The timing of catheter removal was controversial. So, to solve this entire debate, we carried out the present systematic review and meta-analysis. Previous studies suggested that early catheter removal is superior to delayed catheter removal because it decreases the length of hospitalization stay[23,24]. Liang *et al*. and Bary *et al*. stated that early removal of an indwelling urinary catheter reduces the incidence of urinary tract infections and significantly decreases the duration of hospital stay[25,26]. This policy should improve patient satisfaction and reduce hospital costs[26,27]. Moreover, delayed catheter removal results in an increased risk of infection and an increase in the length of hospital stay[28,29]. Many RCTs, such as Hakvoort *et al*. demonstrated that early removal of urinary catheters after surgery might be preferable over longer-term catheterization[30,31].

Indeed, Tahmin *et al*. and Barone *et al*. stated that early catheter removal is better than delayed catheter removal because of the reduction in the risk of urinary tract infection and the length of hospitalization with early catheter removal[32,33]. Agreeing with our meta-analysis, Rajan *et al*. and Glavind *et al*. showed that early catheter removal (after 3 hours) is better than delayed catheter removal (24 hours); however, they found that urinary re-catheterization events were needed more frequently in the early catheter removal group than the delayed catheter removal group[34,35].

The urethral catheter was commonly inserted intraoperatively to keep the bladder empty during and after the procedure. During the procedure, the patient is unconscious and unaware of the need to urinate[33]. Although urethral catheter has advantages, it has some

disadvantages. Urethral catheterization is a painful, expensive, uncomfortable technique that increases the risk of urinary tract infection and urinary incontinence[36].

A recently conducted systematic review and meta-analysis by Menshawy *et al*. assessed the early and delayed removal of the urinary catheter following elective cesarean delivery and discovered a significant reduction in the incidence of bacteriuria and decrease in urinary frequency and urinary dysuria in case of the early removal of urinary catheter[37].

The strengths and the limitations of the study

We performed this review according to the PRISMA statement. All the included studies were RCTs, which presented a low risk of randomization bias and good patient follow-up. Another strength point was the comprehensive search of published clinical trials studies from multiple electronic databases. However, the presented meta-analysis had some limitations: we excluded non-English studies; however, we believe this did not affect the results as the recent evidence suggests that exclusion of non-English studies is not associated with a significant bias to the meta-analysis results. The small number of included studies also limited our meta-analysis. We could not define a specific standard time for early and delayed catheter removal after vaginal surgeries.

CONCLUSION

Our meta-analysis was done on nine randomized controlled trials. We did not find a standard time for early or delayed catheter removal. We considered that (one day or less) is early and (more than one day) is delayed and performed our analysis. We suggested that early catheter removal is better than delayed catheter removal in decreasing the risk of urinary tract infection, the length of hospital stay, symptomatic urinary tract infection. Whereas delayed catheter removal decreases re-catheterization, there wasn't a significant difference between the two groups regarding urinary retention. Further RCTs are still required to prove the ideal time to remove the catheter.

AUTHOR CONTRIBUTIONS

KMH&ASA contributed to data collection, data analysis, and manuscript writing. EA&SHA contributed to data analysis, manuscript writing, and critical review. HS &SME &ATA and FMS performed the study selection and contributed to data collection, data tabulation, and manuscript writing. AAA, ATA, and FMS contributed to data analysis, manuscript writing, and critical review. MR&AHH was responsible for project development and contributed to data tabulation, manuscript writing, manuscript editing, and critical review. All authors (undergraduate researchers; KMH, ASA, EA, SHA, HS, SME, AAA, ATA, FMS, and Obgyn consultants; MR&AHH) approved the final manuscript version.

ACKNOWLEDGMENT

We would like to thank Dr. Ahmed Samy, assistant professor of obstetrics and gynecology, Cairo university, for providing informative and skillful mentorship through different stages of this work. We also thank Mrs. Yasmin Negm (Teacher at Om El Momineen Primary School, Helwan, Egypt) for her invaluable efforts in recording and organizing study data and computer works.

CONFLICT OF INTERESTS

There are no conflicts of interest.

REFERENCE

1. Jones KA, Shepherd JP, Oliphant SS, Wang L, Bunker CH, Lowder JL. (2010): Trends in inpatient prolapse procedures in the United States,1979-2006. Obstet Gynecol.;116:926-931.
2. Whiteman MK, Hillis SD, Jamieson DJ, *et al*. (2008): Inpatient hysterectomy surveillance in the United States, 2000-2004. Am J Obstet Gynecol.2008;198:34:34-7.
3. Cooper J, Annappa M, Dracocardos D, Cooper W, Muller S, Mallen C. (2015): Prevalence of genital prolapse symptoms in primary care : a cross-sectional survey.Int Urogynecol J.;26:505-10.
4. Olsen AL, Smith VJ, Bergstrom J, Colling JC, Clark AL.(1997): Epidemiology of Surgically Managed Pelvic Organ Prolapse and Urinary Incontinence. Obstet Gynecol.;89:501-6.
5. Alshankiti H, Houlihan S, Robert M. (2019): Incidence and contributing factors of perioperative complications in surgical procedures for pelvic organ prolapse. Int Urogynecol J.; 21:1-9.
6. Garry R, Fountain J, Mason S, Napp V. (2004):The eVALuate study: two parallel randomised trials, one comparing laparoscopic with abdominal hysterectomy,the other comparing laparoscopic with vaginal hysterectomy.The BMJ.;17:328-129.
7. Miskry T1, Magos A. (2003):Randomized, prospective, double-blind comparison of abdominal and vaginal hysterectomy in women without uterovaginal prolapse. Acta Obstet Gynecol Scand.;82:351-8.
8. Nieboer TE, Johnson N, Lethaby A, *et al*. (2009): Surgical approach to hysterectomy for benign gynecological disease. Cochrane Database Syst Rev. ; 8:CD003677.
9. Carrubba AR, Whitmore GT, Radhakrishnan SJ, Sheeder J, Muffly TM. (2019): Post-operative infections in women undergoing hysterectomy for benign indications: a cohort study.Minerva Ginecol. ;30.
10. El-nashar SA, Singh R, Schmitt JJ, Leon DC, Arora C, Gebhart JB, *et al*. (2018):for Benign Gynecologic Conditions or Pelvic Reconstructive Surgery. Obstet Gynecol.;132(6):1347-1357.
11. Ahmed MR, Sayed WA, Atwa KA, Metwally L. (2014):Timing of urinary catheter removal after uncomplicated total abdominal hysterectomy: a prospective randomized trial.EJOG.;176:60-3.

12. Li L, Wen J, Wang L, Li YP, Li Y. (2011): Is routine indwelling catheterisation of the bladder for caesarean section necessary ? A systematic review. BJOG.;118.400-9.

13. Schiøtz HA, (1991):Catheterization routines after gynecologic surgery in Norway.Tidsskr Nor Laegeforen.;111.841-3.

14. Hooton TM, Bradley SF, Cardenas DD. (2010): Diagnosis, Prevention, and Treatment of Catheter-Associated Urinary Tract Infection in Adults. IDSA.;50:625-63.

15. Summitt RL, Stovall TG, Bran DF. (1994): Prospective comparison of indwelling bladder catheter drainage versus no catheter after vaginal hysterectomy.Am J Obstet Gynecol.;170 :1815-8.

16. Bbs DO, On JACKS, Ls WI, Rpe THO, Centre M. (1997): A prospective, randomized trial comparing continuous bladder drainage with catheterization at abdominal hysterectomy. ANZJSurg.;67:554-6.

17. Phipps S, Yn L, Mcclinton S, Barry C, Rane A, Jmo ND. (2006): Short term urinary catheter policies following urogenital surgery in adults (Review).CDSR.;19:004-374.

18. Moher D, Liberati A, Tetzlaff J, Altman D; PRISMAGroup. (2009): Preferred reporting items for systematic reviewsand meta-analyses: the prisma statement. Ann Intern Med.;151:264-9.

19. Higgins, J.P., Green, S., 2008. Cochrane Handbook for Systematic Reviews of, The Cochrane Collaboration. https://doi.org/10.10029780470712184/

20. Green, S., Higgins P., T., J., Alderson, P., Clarke, M., Mulrow D, C., Oxman D, A., 2011. Cochrane Handbook: Cochrane Reviews: Ch 8: Assessing risk. f bias in included studies, in: Cochrane Handbook for: Systematic Reviews of Interventions. pp. 3-10.

21. Altman DG, Matthews JNS. (1996) Statistics notes. Interaction 2: Compare effect sizes not P values. Bmj.;313:862.

22. Egger M, Smith GD, Schneider M, Minder C. (1997): Bias in meta-analysis detected by a simple , graphical test. BMJ.;13;315(7109):629-34.

23. Kokabi R1, Fereidouni Z, Meshkibaf MH, Miladpoor B. (2010): Post Operative Voiding Efficacy after Anterior Colporrhaphy. Acta Med Iran.;48:33-5.

24. Shahnaz A, Elham R, Kambiz A, Sara K. (2016):Comparison of 1 versus 3 Days Post-operative Catheterization after Anterior Colporrhaphy. Int Urogynecol J.;22:477-83.

25. Liang CC1, Lee CL, Chang TC, Chang YL, Wang CJ, Soong YK. (2009): Post-operative urinary outcomes in catheterized and non-catheterized patients undergoing laparoscopic-assisted vaginal hysterectomy-a randomized controlled trial. Int Urogynecol J Pelvic Floor Dysfunct.;20:295-300.

26. Bray R, Cartwright R, Digesu A, Fernando R, Khullar V. (2017):A randomised controlled trial comparing immediate versus delayed catheter removal following vaginal prolapse surgery. Eur J Obstet Gynecol Reprod Biol.;210:314-318

27. Steen A Van Der, Detollenaere R, Boon J Den, Eijndhoven H Van. (2011): One-day versus 3-day suprapubic catheterization after vaginal prolapse surgery : a prospective randomized trial. Int Urogynecol J.;22:563-567.

28. Shrestha B, Marhatha R, Kayastha S, Jaishi S. (2013): Short-term versus long-term catheterization after vaginal prolapse surgery. Nepal Med Coll J.;15:102-5.

29. Kringel U, Reimer T, Tomczak S Green S, Kundt G, Gerber B. (2010): Post-operative infections due to bladder catheters after anterior colporrhaphy : a prospective, randomized three-arm study. Int Urogynecol J.;21:1499-504.

30. Hakvoort RA, Elberink R, Vollebregt A, Ploeg T Van Der, Emanuel MH. (2004): How long should urinary bladder catheterisation be continued after vaginal prolapse surgery? A randomised controlled trial comparing short term versus long term catheterisation after vaginal prolapse surgery. BJOG.;111:28-30.

31. Kamilya G, Seal SL, Mukherji J, Bhattacharyya SK, Hazra A. (2010): A randomized controlled trial comparing short versus long-term catheterization after uncomplicated vaginal prolapse surgery.J Obstet Gynaecol Res.;36:154-8.

32. Tahmin K, Nahar S, Hena B. (2013):Short term versus conventional Catheterisation after Genital Prolapse Surgery. Obstet Gynaecol.;26:68-71.

33. Barone MA, Widmer M, Arrowsmith S. (2015): Breakdown of simple female genital fistula repair after 7 day versus 14 day post-operative bladder catheterisation : a randomised , controlled , open-label , non-inferiority trial. Lancet.;4:56- 62.

34. Rajan P, Raghavan SS, Sharma D. (2017): Study comparing 3 hour and 24 hour post- operative removal of bladder catheter and vaginal pack following vaginal surgery : a randomised controlled trial.BMC Women's Health.;11:17- 78.

35. Glavind K, Mørup L, Madsen H, Glavind J. (2008):The effect of early removal of indwelling urinary catheter on post-operative urinary complications in anterior colporrhaphy surgery. Aust N Z J Obstet Gynaecol.;48:48-52.

36. Sun Y, Tang C, Luo D, Yang L, Shen H. (2016): The treatment of anterior vaginal wall prolapsed by repair with mesh versus colporrhaphy. Int Urol Nephrol.;48:155-267.

37. Menshawy A, Ghanem E, Menshawy E, Masoud AT. (2018): Early versus delayed removal of indwelling urinary catheter after elective cesarean delivery: systematic review and meta-analysis of randomized controlled trials. J Matern Fetal Neonatal Med.; 6:1-161.