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REVIEW

Early *versus* late urethral catheter removal after tubularized incised plate hypospadias repair: A systematic review and meta-analysis

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Summary ***Background: The optimal duration of urethral catheterization after tubularized incised plate hypospadias repair remains uncertain. This systematic review and meta-analysis compared early catheter removal at or before postoperative day 5 with late removal after postoperative day 5.***

Methods: PubMed, Google Scholar, ScienceDirect, and Scopus were searched from inception to July 2026. Comparative studies of pediatric patients undergoing primary tubularized incised plate repair were included when arm-level data were available for urethrocutaneous fistula, meatal stenosis, wound dehiscence, urinary retention, or bladder spasm. Risk of bias was assessed using RoB 2 for randomized trials and the Newcastle-Ottawa Scale for non-randomized studies.

Results: Nine studies were included, comprising seven randomized trials and two non-randomized comparative studies. Early catheter removal did not significantly affect urethrocutaneous fistula (risk ratio 0.81, 95% confidence interval 0.44 to 1.49; p = 0.50; I^2 = 72%), meatal stenosis (risk ratio 1.07, 95% confidence interval 0.38 to 3.01; p = 0.89; I^2 = 71%), wound dehiscence (risk ratio 0.82, 95% confidence interval 0.52 to 1.27; p = 0.37; I^2 = 0%), or urinary retention (risk difference 0.06, 95% confidence interval -0.01 to 0.13; p = 0.11; I^2 = 0%). Early removal reduced bladder spasm on the absolute scale, although heterogeneity was moderate.

Conclusions: Early catheter removal after tubularized incised plate repair was not associated with higher rates of urethrocutaneous fistula, meatal stenosis, wound dehiscence, or urinary retention. It may reduce bladder spasm, but heterogeneity and sparse events limit the certainty of this finding.

Early removal may reduce bladder spasm, although moderate heterogeneity and sparse events limit certainty.

KEY WORDS: Hypospadias; Tubularized incised plate; Urethral catheter; Catheter removal; Urethrocutaneous fistula.

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INTRODUCTION

Tubularized incised plate (TIP) urethroplasty has become the standard technique for most distal and many midpenile hypospadias repairs due to its reproducible functional and cosmetic outcomes. Snodgrass' original description established the principle of a deep midline incision of the urethral plate to facilitate tension-free tubularization and a vertically oriented meatus (1). Contemporary guidelines also position TIP as the preferred option for suitable primary repairs (2).

Postoperative urethral catheterization is routinely used after TIP to splint the neourethra, divert urine, and theoretically protect the suture line from early leakage or high-pressure voiding (2). However, indwelling catheters can drive discomfort, bladder spasm, tube blockage, and catheter-associated infection, creating a trade-off between potential protection of the repair and patient comfort and early recovery (3). This balance is clinically salient for families and nursing teams and influences length of stay and analgesic requirements.

The optimal duration of catheterization after TIP remains unsettled. Some surgeons advocate earlier removal to minimize catheter-related morbidity and facilitate mobilization, while others extend catheterization beyond 5 to 7 days to reduce concerns about fistula or dehiscence. Observational and randomized reports reflect this equipoise. A recent comparative TIP series found that early removal did not worsen long-term complications (4). A randomized study comparing multiple removal windows suggested that timing may be individualized without clear harm from earlier removal, although event rates were low and definitions varied (5). Even among contemporary cohorts using TIP, "*early*" and "*late*" are often operationalized with a 5-day cut point, yet practice remains heterogeneous (5, 6).

Given the frequency of TIP worldwide, the patient-centred importance of catheter-related symptoms, especially bladder spasm, and persistent concerns about *urethrocutaneous fistula* (UCF), meatal stenosis, and wound dehiscence, a focused synthesis on TIP is warranted. We therefore performed a systematic review and meta-analysis comparing early catheter removal, defined as removal at or before postoperative day 5, *versus* late catheter removal, defined as removal after postoperative day 5, after TIP. UCF was the primary endpoint, while meatal stenosis, wound dehiscence, urinary retention, and blad-

der spasm were secondary outcomes. Our aim was to clarify whether earlier removal compromises structural outcomes or improves comfort-related endpoints to inform practical evidence-based postoperative pathways for TIP.

Methods

Study design

This study is a systematic review with meta-analysis comparing early *versus* late urethral catheter removal after *tubularized incised plate* (TIP) hypospadias repair. The review followed the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) guidelines to ensure transparent and comprehensive reporting. The protocol was registered in PROSPERO prior to analysis (CRD420261410101).

Literature search

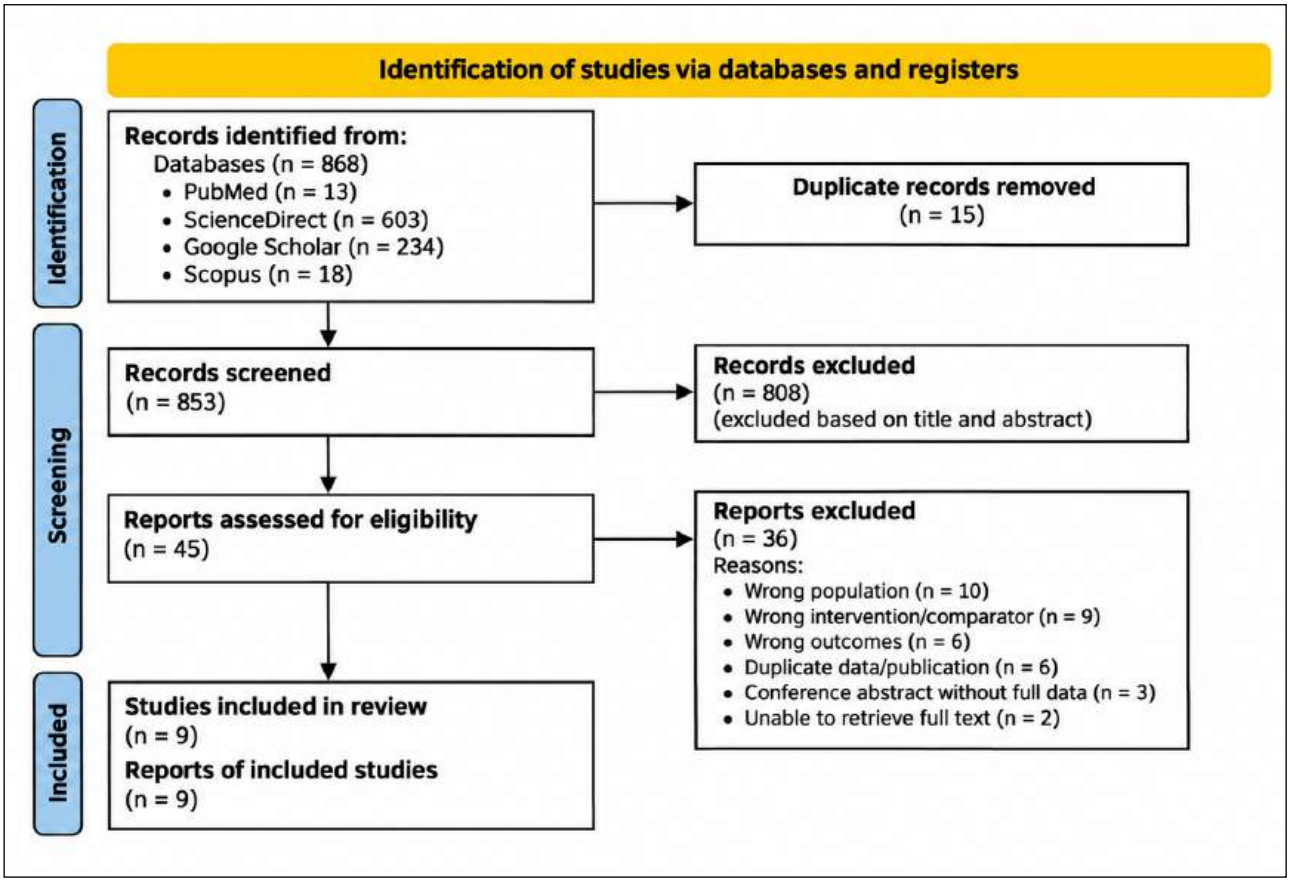
A comprehensive search was conducted in PubMed, Google Scholar, ScienceDirect, and Scopus from inception until July 2026. The search yielded 13 records from PubMed, 603 from ScienceDirect, 234 unique records from Google Scholar, and 18 from Scopus, for a total of 868 records. The search strategy used the following Boolean structure: ("*Hypospadia*" OR "*Proximal hypospadia*") AND ("*Tubularized incised plate*" OR "*TIP*") AND ("*Catheter*") AND ("*Early*" OR "*Late*") AND ("*Complication*" OR "*Fistula*" OR "*Bladder spasm*" OR "Outcome"). Nine studies were included, consisting of seven randomized trials and two non-randomized comparative studies.

Study selection

Two independent reviewers screened titles and abstracts and then assessed full texts against the eligibility criteria. Discrepancies were resolved through discussion or consultation with a third reviewer. We included comparative original studies of pediatric patients undergoing primary TIP hypospadias repair that explicitly compared early urethral catheter removal, defined as removal at or before postoperative day 5, with late removal, defined as removal after postoperative day 5. Studies were eligible if they reported at least one prespecified outcome with extractable arm-level data, namely UCF, meatal stenosis, wound dehiscence, urinary retention, or bladder spasm. Both randomized controlled trials and comparative observational designs were considered.

We excluded non-comparative designs, review articles, editorials, letters, case reports, and animal studies. We also excluded cohorts that combined multiple surgical techniques when TIP-specific data could not be separated, reoperative cases without separable primary TIP data, and studies that did not provide numeric outcome counts stratified by catheter-timing group. The PRISMA flow diagram summarizes study selection (Figure 1).

Figure 1.
PRISMA flow diagram.



Data extraction and synthesis

Data extraction was performed independently by two reviewers using a piloted form. Extracted variables included first author, year, country, design, sample size, patient age, repair location when reported, details of stenting and dressings, definitions of early and late removal, follow-up duration, and event counts for UCF, meatal stenosis, wound dehiscence, urinary retention, and bladder spasm. Any disagreements were resolved by consensus with a third reviewer. All extracted data were tabulated in Microsoft Excel and cross-checked prior to analysis.

Risk of bias assessment

Randomized trials were assessed with the RoB 2 tool at the domain and overall levels. Non-randomized studies were assessed with the Newcastle-Ottawa Scale, covering selection, comparability, and outcome domains. Two reviewers conducted the assessments independently, with adjudication by a third reviewer when needed. Results are summarized in table and figure form in the supplement.

Results

Nine comparative studies were included, consisting of seven randomized trials and two non-randomized studies. Not all studies reported every endpoint, leading to variation in the number of studies and participants available for each outcome. Early catheter removal was defined as removal on or before postoperative day 5, while late removal was defined as removal after postoperative day 5. Two recent randomized trials were included: *Aslam et al. (2026)* (16), which compared stent removal on postoperative day 3 *versus* day 8 in 168 children, and *Qadir et al. (2025)* (17), which compared removal on postoperative day 5 *versus* day 10 in 86 children. Study characteristics are summarized in Table 1.

Among the seven randomized trials, four studies (*Almeldin 2024, Fakhry 2021, Radwan 2012, and Hashim 2017*) (7-10) were previously judged to have low risk of bias across all RoB 2 domains. *Kishk (2018)* (5) had some concerns related to the randomization process and selection of the reported result. The newly included *Aslam (2026)* (16) and *Qadir (2025)* (17) trials were judged as having some concerns overall because allocation concealment and prespecified analysis plans were not clearly reported (Table 2). For the two non-randomized studies, *Kumar (2022)* (4) scored 8 of 9 stars on the Newcastle-Ottawa Scale and was judged to have low risk, whereas *Gabra (2024)* (11) scored 6 of 9 stars and was judged to have moderate risk (Table 3).

Urethrocutaneous fistula was reported by all nine studies, with 72 events among 386 patients in the early-removal groups and 87 events among 479 patients in the late-removal groups. Random-effects analysis showed no significant difference between early and late removal (risk ratio 0.81, 95% confidence interval 0.44 to 1.49; p = 0.50).

Table 1.
Study characteristics.

Study	Year	Design	Early timing	Late timing	N early	N late	Outcomes reported
Almeldin	2024 (7)	RCT	2 days	5 days	21	21	UCF, meatal stenosis, wound infection, urinary retention, bladder spasm
Fakhry	2021 (8)	RCT	2 days	7 days	20	20	UCF, meatal stenosis, wound infection, urinary retention
Radwan	2012 (9)	RCT	4 days	7 and 9 days	63	126	UCF, meatal stenosis
Hashim	2017 (10)	RCT	1 day	6 days	31	31	UCF, meatal stenosis, wound infection
Kishk	2018 (5)	RCT	1 day	7 days	40	40	UCF, meatal stenosis, wound infection, bladder spasm
Gabra	2024 (11)	Retrospective	< 5 days	> 5 days	53	44	UCF, meatal stenosis, wound infection
Kumar	2022 (4)	Prospective	< 5 days	> 5 days	32	30	UCF, meatal stenosis, wound infection, urinary retention, bladder spasm
Aslam	2026 (16)	RCT	3 days	8 days	84	84	UCF, wound disruption, urinary tract infection
Qadir	2025 (17)	RCT	5 days	10 days	43	43	UCF, wound dehiscence, urinary retention, urinary tract infection, wound infection, urinary extravasation

RCT: randomized controlled trial; UCF: urethrocutaneous fistula.

Study ID	D1	D2	D3	D4	D5	Overall
Almeldin, 2024	Low	Low	Low	Low	Low	Low
Fakhry, 2021	Low	Low	Low	Low	Low	Low
Radwan, 2012	Low	Low	Low	Low	Low	Low
Hashim, 2017	Low	Low	Low	Low	Low	Low
Kishk, 2018	Some concerns	Low	Low	Low	Some concerns	Some concerns
Aslam, 2026	Some concerns	Low	Low	Low	Some concerns	Some concerns
Qadir, 2025	Some concerns	Low	Low	Low	Some concerns	Some concerns

D1: randomization process; D2: deviations from intended interventions; D3: missing outcome data; D4: measurement of the outcome; D5: selection of the reported result.

Table 2.
RoB 2 result of the randomized studies.

Study	Selection	Comparability	Outcome	Total	Risk of bias
Gabra, 2024	4	1	1	6	Moderate
Kumar, 2022	4	1	3	8	Low

Table 3.
Newcastle-Ottawa Scale result for non-randomized studies.

Figure 2.
Forest plot for urethrocutaneous fistula.

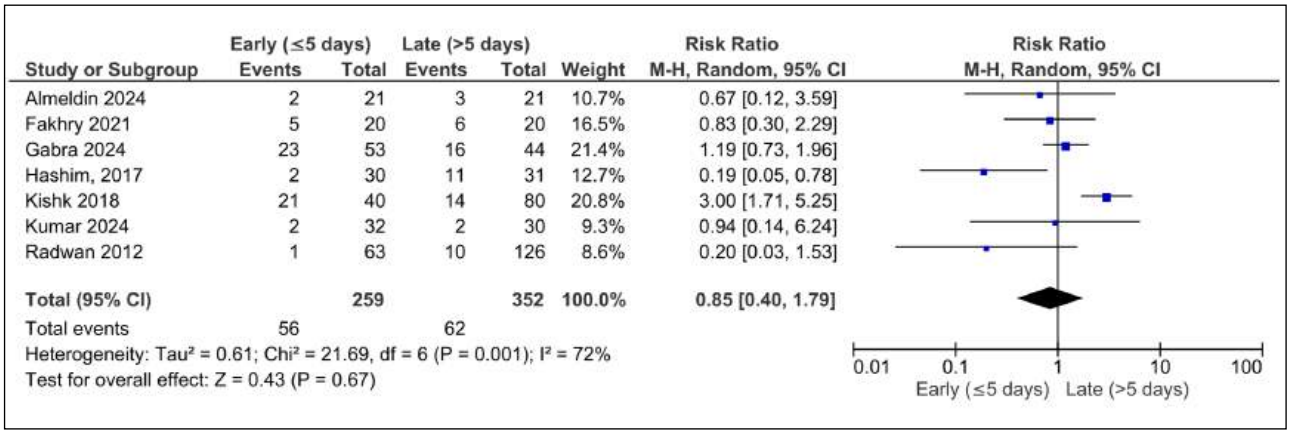
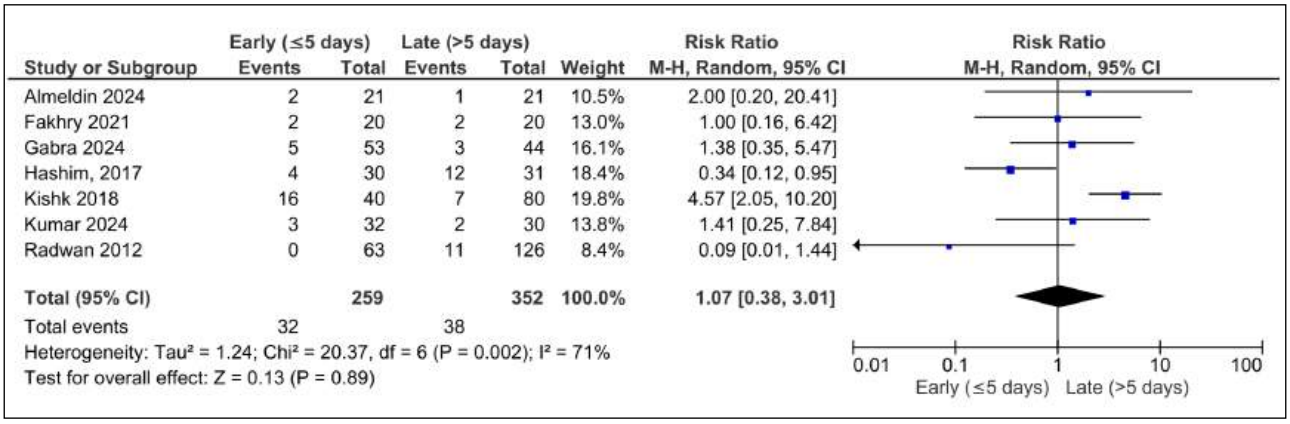


Figure 3.
Forest plot for meatal stenosis.



Heterogeneity was substantial ($\tau^2 = 0.54$; $\chi^2 = 28.42$, df = 8, p = 0.0004; $I^2 = 72\%$) (Figure 2).

Meatal stenosis was reported by seven studies, with 32 events among 259 patients in the early-removal groups and 38 events among 352 patients in the late-removal groups. There was no significant difference between groups (risk ratio 1.07, 95% confidence interval 0.38 to 3.01; p = 0.89). Heterogeneity was high ($\tau^2 = 1.24$; $\chi^2 = 20.37$, df = 6, p = 0.002; $I^2 = 71\%$) (Figure 3).

Wound dehiscence was reported by eight studies, with 31 events among 323 patients in the early-removal groups and 48 events among 353 patients in the late-removal groups. The pooled estimate showed no significant difference, although the direction favored early removal (risk ratio 0.82, 95% confidence interval 0.52 to 1.27; p = 0.37). No statistical heterogeneity was detected ($I^2 = 0\%$) (Figure 4).

Urinary retention was reported by four studies, with 13 events among 116 patients in the early-removal groups and six events among 114 patients in the late-removal groups. Fixed-effect risk-difference analysis showed a small, non-significant absolute increase with early removal (risk difference 0.06, 95% confidence interval -0.01 to 0.13; p = 0.11). Heterogeneity was absent ($I^2 = 0\%$) (Figure 5).

Bladder spasm was reported by four studies, with one event among 113 patients in the early-removal groups and 19 events among 155 patients in the late-removal groups. The existing fixed-effect risk-difference analysis favored early removal (risk difference -0.11, 95% confidence interval -0.17 to -0.05; p = 0.0004), with moderate heterogeneity ($I^2 = 59\%$) (Figure 6). No new bladder-spasm data were contributed by *Aslam 2026* (16) or *Qadir 2025* (17).

Overall, the pooled analyses showed no statistically significant differences between early and late catheter removal for urethrocutaneous fistula, meatal stenosis, wound dehiscence, or urinary retention. Bladder spasm favored early removal, but the moderate heterogeneity and sparse event counts warrant cautious interpretation.

Figure 4.
Forest plot for wound dehiscence.

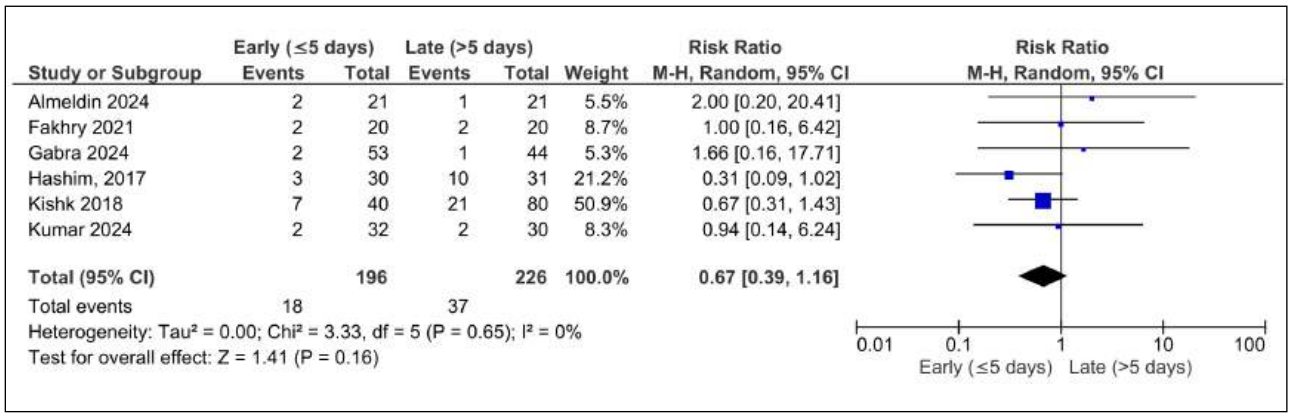


Figure 5.
Forest plot for urinary retention.

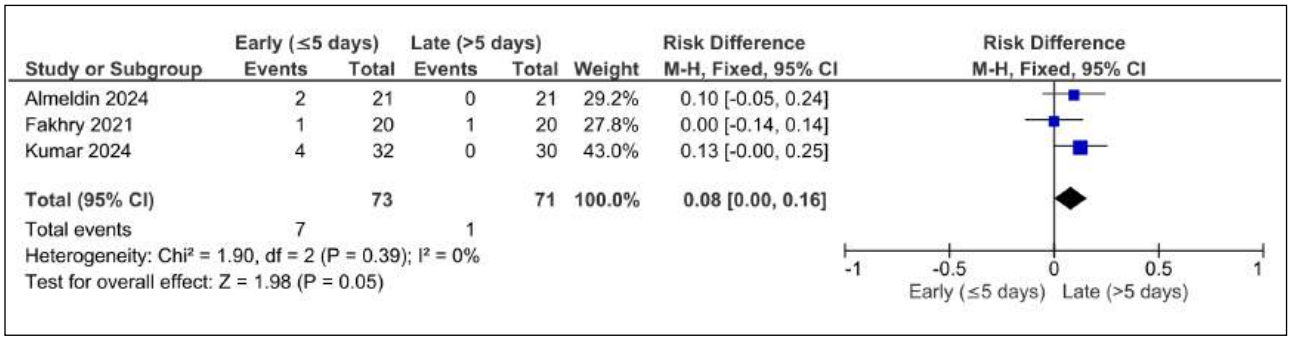
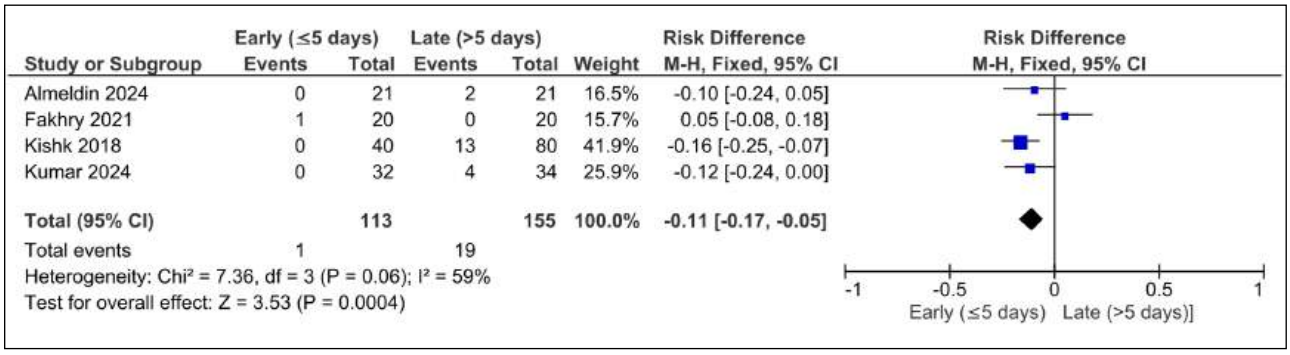


Figure 6.
Forest plot for bladder spasm.



Discussion

Across nine comparative studies of TIP, early catheter removal at or before postoperative day 5 was not associated with a significant difference in urethrocutaneous fistula, meatal stenosis, wound dehiscence, or urinary retention. The inclusion of the recent studies of *Aslam (2026)* (16) and *Qadir (2025)* (17) increased the available sample for fistula and wound-related outcomes without materially changing the overall interpretation. The pooled fistula estimate remained imprecise and heterogeneity remained substantial, whereas wound dehiscence and urinary retention estimates showed no detectable heterogeneity.

A shorter indwelling duration may reduce detrusor irritation and trigonal stimulation, which are recognized contributors to bladder spasm in catheterized children. The bladder-spasm analysis favored early removal, although moderate heterogeneity reduces confidence in the exact magnitude of benefit. Urinary retention was numerically more frequent after early removal, but the pooled absolute difference was small, crossed the null, and was based on few events. Transient edema of the meatus or neourethra after catheter removal remains a plausible mechanism for these events, which generally occur during the immediate post-removal period and may respond to temporary recatheterization (14).

Prior single-center cohorts and small randomized comparisons have reported mixed findings on catheter timing, often combining different repair techniques or using inconsistent definitions of early removal (15). By restricting eligibility to primary TIP repair and a prespecified 5-day threshold, this review addresses a more clinically homogeneous question. The two newly included randomized trials expanded the evidence base, but neither demonstrated that earlier removal increased structural complications. Nevertheless, substantial heterogeneity for fistula and meatal stenosis indicates that operative technique, patient selection, and follow-up remain important sources of variation.

For children undergoing TIP, catheter removal at or before postoperative day 5 can be considered in appropriately selected cases because the updated analyses did not show significantly higher risks of fistula, meatal stenosis, wound dehiscence, or urinary retention. A short, protocolized observation period after removal remains prudent, including documentation of voiding and predefined criteria for recatheterization when the child fails to void or develop suprapubic distention. Caregivers should receive clear instructions regarding transient dysuria, reduced voided volumes, and indications for reassessment. Because the bladder-spasm finding is based on sparse events and moderate heterogeneity, reduction in catheter-related discomfort should be regarded as a potential benefit rather than a definitive effect.

Strengths of this review include a TIP-specific clinical question, an updated search, duplicate study processes, and inclusion of nine comparative studies, seven of which were randomized trials. The revised analysis also increased the sample available for the primary outcome. Important limitations remain. Heterogeneity was substantial for urethrocutaneous fistula and meatal stenosis, several outcomes were uncommon, and the newly included trials had some concerns regarding allocation concealment and selective reporting. Follow-up duration and outcome definitions varied across studies, and two non-randomized studies remained susceptible to residual confounding.

Future trials should be multicenter and adequately powered, with standardized definitions for UCF, meatal stenosis thresholds, wound dehiscence, and objective urinary retention criteria that include voiding success and ultrasound residuals. Follow-up should be long enough to capture late meatal stenosis, preferably at least 12 months. A core outcome set that includes patient-reported discomfort and caregiver burden would make results more comparable. Trials should stratify or predefine analyses by repair severity, age, plate quality, glans size, dressing strategy, and stent size because these factors may modify the effect of timing. Comparative work is also needed on adjuncts that could reduce spasms and retention, including anticholinergics, alpha-blockers, and regional anesthesia techniques. Cost-effectiveness and workflow outcomes should be integrated to inform day-surgery pathways. Finally, an individual patient data meta-analysis could refine risk estimates, enable harmonized outcome definitions, and support development of a simple risk score to guide catheter timing decisions in TIP.

Conclusions

After TIP repair, early catheter removal at or before postoperative day 5 was not associated with statistically significant differences in urethrocutaneous fistula, meatal stenosis, wound dehiscence, or urinary retention compared with later removal. Early removal may reduce bladder spasm, although moderate heterogeneity and sparse events limit certainty. An early-removal pathway may be considered for selected patients when combined with brief post-removal observation and clear criteria for recatheterization.

Declarations

Ethical approval and consent for participate: *Not applicable. This study is a systematic review and meta-analysis of previously published data.*

Consent for publication: *Not applicable.*

Availability of data and material: *All data generated or analyzed during this study are included in this manuscript.*

Competing interests: *The authors declare that they have no competing interests.*

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Authors' contributions: *IMA, study concept, literature search, data extraction, statistical analysis, data interpretation, and manuscript original drafting; T, study supervision, methodology, data interpretation, and critical revision of the manuscript; DPA, study design, methodology, data interpretation, and critical revision of the manuscript. All authors read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.*

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References

1. Snodgrass W. Tubularized, incised plate urethroplasty for distal hypospadias. J Urol 1994; 151:464-5.

2. European Association of Urology; European Society for Paediatric Urology. EAU/ESPU Guidelines on Paediatric Urology. Arnhem: EAU Guidelines Office; 2024. Section: Hypospadias.

3. Escolino M, Caraco MS, Mazzone V, et al. The impact of postoperative urinary diversion on surgical outcomes of hypospadias repair: a systematic review and meta-analysis of pediatric literature. Medicina (Kaunas) 2025; 61:1659.

4. Kumar A, Ram Dhayal I. A comparative study on the outcomes of hypospadias surgery following early versus late bladder catheter removal. Cureus 2022; 14:e26104.

5. Kishk TFA, Ammar MS, Taalab AA, Soror TMWEA. Comparative study to detect optimum time for removal of urinary catheter after hypospadias repair surgery. Med J Cairo Univ 2018; 86:3181-5.

6. Tatanis V, Katsakiori P, Spinos T, et al. Anterior and mid-penile hypospadias repair with tubularized incised plate technique: is it possible with 20-hour catheterization? Diseases 2024; 12:279.

7. Almeldin H, Elzohiri M, Naiem Y, et al. Comparative study

between early and delayed removal of urethral stent after tubularised incised plate urethroplasty in distal hypospadias. Med J Cairo Univ 2024; 92:857-62.

8. Fakhry T, Amer AM, Fawzy AN. Comparative study between two days versus seven days urethral stenting of distal hypospadias after tubularized incised plate urethroplasty. Int Surg J 2021; 8:1085-8.

9. Radwan M, Soliman MG, Tawfik A, et al. Does the type of urinary diversion affect the result of distal hypospadias repair? A prospective randomized trial. Ther Adv Urol 2012; 4:161-5.

10. Hashim HL, Al Adhami A, Abid AH. Does the early removal of urethral stent can reduce postoperative complications of Snodgrass urethroplasty for hypospadias repair? A prospective randomized trial. Int Surg J 2017; 4:3839-43.

11. Gabra A, Beyari BM, AlNuwaiser SJ, et al. Outcomes of hypospadias repair based on surgical techniques: a 4-year retrospective study. Res Rep Urol 2024; 16:79-87.

12. Markopoulos T, Katsimperis S, Lazarou L, et al. Catheter-related bladder discomfort: insights into pathophysiology, clinical impact, and management. Cureus 2025; 17:e81322.

13. Haider MZ, Annamaraju P. Bladder catheterization. In: StatPearls (Internet). Treasure Island: StatPearls Publishing; 2026.

14. Werneburg GT. Catheter-associated urinary tract infections: current challenges and future prospects. Res Rep Urol 2022; 14:109-33.

15. Dale J, Woodward B, Elagami H. Age-dependent early complications of hypospadias repair: a single institutional experience. Pediatr Surg Int 2023; 39:115.

16. Aslam M, Saeed M, Ali U, et al. Timing of urethral stent removal and its impact on complications after tubularized incised plate repair of distal hypospadias. Int J Pharm Res Technol. 2026; 16:1738-1742.

17. Qadir I, Arshad AW, Ali S, et al. Outcomes of the complications between early and late stent removal in hypospadias repair. Med Forum. 2025; 36:10-14.

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