Efficacy and safety of subureteric injection in the management of vesicoureteral reflux in pediatric renal transplant recipients: A systematic review and meta-analysis

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ABSTRACT

Introduction: Post-transplant vesicoureteral reflux (VUR) is a recognized complication in pediatric kidney transplant recipients. While subureteric injection is widely used as a minimally invasive treatment for primary VUR, its efficacy and safety in transplant-associated reflux remain unclear. We aimed to evaluate the effectiveness and safety of subureteric injection as first-line therapy for post-transplant VUR in pediatric renal transplant recipients through a systematic review and meta-analysis.
Methods: A comprehensive search of PubMed was conducted in January 2026 for studies published from 2000 onward. Eligible studies included pediatric patients (<18 years) with post-transplant VUR treated with subureteric injection as the initial therapy. Primary outcome was radiologic success (complete resolution or ≥1-grade improvement), and secondary outcomes included clinical success (resolution of febrile urinary tract infection [UTI]/pyelonephritis), ureteral obstruction, and need for redo ureteroneocystostomy (UNC). Pooled proportions were calculated using a random-effects model, and heterogeneity was assessed using I^2 statistics.
Results: Seven retrospective studies involving 69 pediatric patients (70 renal units) met the inclusion criteria. The pooled radiologic success rate was 36.3% (95% confidence interval [CI] 17.9–54.8), while clinical success reported in five studies was 51.0% (95% CI 8.1–94.0).

Ureteral obstruction occurred in 3.8% of cases (95% CI -3.5–11.2). Rates of redo UNC varied widely across cohorts. Substantial heterogeneity was observed for both radiologic and clinical outcomes.
Conclusions: Subureteric injection may offer clinical benefit with a low complication profile in selected children with post-transplant VUR. Standardized, prospective multicenter studies are needed to clarify its role, identify optimal candidates, and guide escalation strategies.

INTRODUCTION

Kidney transplantation is the gold standard treatment for pediatric patients with end-stage renal disease, markedly improving both survival and quality of life.[1] However, various postoperative complications can arise and require careful management. Vesicoureteral reflux (VUR) into the transplanted kidney is one such complication, generally asymptomatic, with reported incidences ranging from rare symptomatic cases to high rates in routine imaging series, reaching up to 58% in some reports.

The clinical importance of VUR lies in its potential to become symptomatic, leading to recurrent urinary tract infections, pyelonephritis, and ultimately chronic kidney disease, or even graft loss.[2] In the surgical management of post-transplant VUR, subureteric injection is generally considered the first-line treatment due to its minimally invasive nature, repeatability, and favorable safety profile. Redo ureteroneocystostomy (UNC) is reserved for cases unresponsive to endoscopic therapy, as this procedure is associated with higher morbidity, prolonged hospitalization, increased risk of surgical complications, and the formation of extensive scar tissue.[3,4] Although subureteric injection has been extensively evaluated in the treatment of primary VUR, evidence regarding its use in pediatric renal transplant recipients remains limited. The current literature is restricted to small and heterogeneous cohorts with variable follow-up, producing highly inconsistent success rates.

To date, no meta-analysis has specifically examined this group, underscoring the necessity of a systematic review to synthesize the existing data and establish more reliable conclusions. In this context, this systematic review and meta-analysis aim to evaluate the efficacy of subureteric injection in the management of VUR among pediatric kidney transplant recipients, while also examining the variability of reported outcomes and the limitations of the current literature.

METHODS

This systematic review and meta-analysis was designed and reported in accordance with the PRISMA 2020 statement[5] (Supplementary Figure 1). Prior to selecting studies, all authors jointly agreed on the search strategy, eligibility criteria, and predefined outcomes.
In January 2026, we conducted a comprehensive literature search in PubMed using both keywords and relevant MeSH terms, including “kidney transplant,” “pediatric,” “vesicoureteral reflux,” and “subureteric injection.” No filters were applied for study design or publication type. Only full-text articles published in English from 2000 onward were considered eligible.

Studies were included if they focused on pediatric kidney transplant recipients (defined as <18 years) who developed post-transplant VUR involving the transplanted ureter and/or renal allograft. To qualify, studies had to report outcomes of subureteric injection as the first-line endoscopic treatment after VUR diagnosis and provide extractable data for at least one predefined outcome (e.g., radiologic success or clinical success). Post-transplant VUR was considered clinically relevant when imaging confirmed reflux into the transplanted ureter/allograft and it was associated with symptoms or graft related concerns, most commonly recurrent febrile UTI/pyelonephritis and/or moderate-to-severe reflux (where grading was reported). Studies focusing primarily on asymptomatic, low-grade VUR without infectious or functional consequences were generally not eligible.

Exclusion criteria included single-patient case reports and very small case series (<5 patients), narrative reviews, and studies in which VUR was only a minor component of broader urological outcomes such that subureteric injection-specific data were unclear or not extractable. Studies focusing solely on repeat procedures (without clearly reporting first-line subureteric injection outcomes) or alternative initial treatments were also excluded. Very small case series were excluded to reduce unstable effect estimates and the disproportionate influence of extreme proportions.[6]

A total of 55 articles were identified through the PubMed search. After screening titles and abstracts, 37 were excluded. The remaining 18 full-text articles were independently assessed by two reviewers (M.Y.S. and O.C.O.) using predefined eligibility criteria. Based on this assessment, 11 studies were excluded: 2 case reports, 7 lacking extractable data, 1 review article, and 1 case series with fewer than five patients. Ultimately, 7 studies met the inclusion criteria and were included in the systematic review and meta-analysis (Figure 1).
From each included study, we collected data on study design, sample size, and the number of ureters/renal units analyzed, as well as available patient characteristics. Additional variables included the underlying cause of end-stage renal disease (classified as urological, nephrological, neurological, or mixed), type of UNC, injection material, follow-up duration, and reported outcomes.

Radiologic success, assessed per ureter or renal unit, was selected as the primary outcome since all included studies reported radiologic endpoints. Most studies assessed radiologic outcomes using postoperative voiding cystourethrography (VCUG), while a subset additionally employed diuretic renography in cases of suspected obstruction.
Due to differences in how radiologic success was defined across studies, outcomes were standardized for the pooled analysis as either complete resolution of reflux or an improvement of at least one grade. While a more stringent sensitivity analysis focusing exclusively on complete resolution was planned, it could not be reliably carried out due to the inconsistent availability of extractable data across several studies.

Secondary outcomes focused on clinical success per patient, typically defined as the absence of recurrent febrile urinary tract infections or pyelonephritis. When available, other indicators such as stable graft function (e.g., eGFR) and avoidance of further procedures, including repeat subureteric injection or redo UNC, were also considered part of clinical success.

Statistical analyses were conducted in Jamovi (version 2.7.6). Radiologic success (per ureter/renal unit) and clinical success (per patient) were pooled as proportions. Summary estimates were generated using a random-effects model and are presented with 95% confidence intervals (CIs). Between-study heterogeneity was evaluated using the I^2 statistic (and τ^2 where applicable). Studies lacking extractable data for a given outcome were omitted only from that specific analysis. When required (e.g., zero-event studies), a continuity correction was applied. Statistical significance was defined as a two-sided $p < 0.05$. Because fewer than 10 studies were available, formal assessment of small-study effects (e.g., funnel plot inspection and Egger's regression test) was not performed, as these approaches are underpowered and may be unreliable with small numbers of studies.[7]

Two authors (MYS, OCO) independently assessed the risk of bias using the 2020 Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Series in systematic reviews.[8] Disagreements were resolved by consensus. Each study was evaluated across 10 checklist items and rated as "Yes (Y)," "No (N)," "Unclear (U)," or "Not applicable (NA)." Based on these ratings, the overall risk of bias was classified as low, moderate, or high, with justification provided for each final assessment.

RESULTS

A total of 55 records were identified through the PubMed search. After screening titles and abstracts, 37 were excluded. The remaining 18 articles underwent full-text review for eligibility, resulting in the exclusion of 11 studies—2 case reports, 7 without extractable outcome data, 1 review article, and 1 case series with fewer than five patients. In the end, 7 studies met the criteria and were included in the systematic review and meta-analysis (Figure 1).

All included studies[3,4,9-13] were retrospective; six were single-center, and one was multicenter.[12] Key study characteristics are summarized in Table 1. Diagnosis and radiologic follow-up of post-transplant VUR were primarily performed using voiding cystourethrography (VCUG), while diuretic renography (DRS) was additionally used in one study[10] when obstruction was clinically suspected.

In total, the meta-analysis comprised 69 pediatric transplant recipients and 70 renal units. The distribution of patients and renal units by study was as follows: Williams 2008 (8 patients/9 units), Vemulakonda 2010 (11/11), Castagnetti 2014 (11/11), Sheth 2018 (11/11), Wu 2018 (9/9), Uçar 2021 (12/12), and Obata 2024 (7/7). In the Williams 2008 study, the number of renal units exceeded the number of patients because one child had undergone re-transplantation and had reflux involving both grafts, resulting in two affected ureters.[3] Deflux was used as the bulking agent in all included studies.[3,4,9-13]

Procedural technique was identified as HIT in Williams (2008)[3], Double HIT in Wu (2018)[9], and STING in Uçar (2021)[4] and Obata (2024)[11], whereas the remaining studies[10,12,13] did not specify the procedure in detail. Reported injection volumes ranged from 0.3 to 6 mL overall: 1–2 mL in Williams (2008)[3], 0.5–1.5 mL in Vemulakonda (2010)[12], a median of 1.3 mL (range 0.6–2) in Castagnetti (2014)[10], 3 mL per ureter (range 1–6) in Wu (2018)[9], approximately 1–2 mL in Uçar (2021)[4], and 0.3–1.6 mL in Obata (2024)[11]. Injection-volume data could not be extracted from Sheth (2018)[13](Table 2). Transplant laterality was evaluated

during study extraction; however, none of the included studies reported the true graft side (right or left iliac fossa) (Table 2).

Only the study by Williams (2008) used a refluxing ureterovesical implantation technique.[3] In contrast, all other cohorts adopted anti-reflux methods, with the Lich–Gregoir approach along with its modified versions being the most common.[4,9-13] Wu (2018) also reported using the Lich-2 and Politano–Leadbetter techniques.[9]

The duration of follow-up was inconsistently reported across the included studies. Williams et al. (2008) reported a mean follow-up of 17 months.[3] Castagnetti et al. (2014) provided an estimated follow-up of 64 months[10], while Obata et al. (2024) reported approximately 42 months of follow-up.[11] In contrast, the remaining studies did not report extractable post-injection follow-up durations[4,9,12,13] (Table 1).

Mean age, expressed in months, was reported in three studies (Williams 2008: 139 months; Vemulakonda 2010: 96 months; Obata 2024: 91 months).[3,11,12] Age was not extractable in several studies[9,10,13]; additionally, Uçar 2021 reported age at transplantation rather than age at injection.[4]

Mean time from transplantation to VUR diagnosis varied across studies—52 months in Castagnetti (2014, estimated), 16 months in Sheth (2018), and 12 months in Wu (2018).[9,10,13] No extractable timing data were available from the other cohorts to calculate an overall average.[3,4,11,12]

Among patients with known etiology, the cause of ESRD was most often nephrological, found in just over half the cases (33 out of 61, or 54.1%), followed by urological reasons (24 out of 61, or 39.3%). Neurological causes were very rare—only two patients in total—and were observed only in the Vemulakonda (2010) and Uçar (2021) studies.[4,12] A small number of cases could not be clearly categorized or involved multiple factors (2 out of 61, or 3.3%). Williams (2008) did not specify the causes.[3]
When treatment outcomes were stratified by disease background in the individual studies, they were generally reported as upper versus lower tract pathology rather than according to the broader nephrological, urological, neurological, or mixed categories used for descriptive synthesis.[10,12]

Information on prior bladder surgery was generally absent, except that Wu (2018)[9] excluded patients with augmentation cystoplasty, vesicostomy, and clean intermittent catheterization before transplantation (Table 2).

Baseline voiding dysfunction was clearly reported in only two studies: it was absent in Williams (2008)[3] and present in 3 of 12 patients in Uçar (2021)[4]. In the remaining studies[9-13], although some patients had lower urinary tract or other urological causes of ESRD, baseline voiding dysfunction was not reported in a standardized or extractable manner (Table 2).
Use of clean intermittent catheterization was reported as absent in Williams (2008)[3] and Wu (2018)[9], present in 1 of 12 patients in Uçar (2021)[4], and not reported in the remaining studies[10-13] (Table 2).

Radiologic success was defined variably across studies. In some cases, success was based solely on complete resolution on VCUG[12], while others required both complete VCUG resolution and the absence of febrile urinary tract infections or pyelonephritis.[3,13] Some definitions considered complete VCUG resolution along with no febrile UTIs sufficient[9,10],

whereas others accepted improvement in VCUG findings to grade 0–1 combined with the absence of febrile UTIs as successful.[4,11] In one of these, preservation of eGFR was also included as part of the clinical success definition.[11]

Owing to the fact that many cohorts reported radiologic outcomes as composite endpoints such as resolution and/or improvement without providing separate counts for complete resolution, outcomes were standardized for analysis as either complete resolution or improvement by at least one grade. A sensitivity analysis focusing strictly on "complete resolution only" was considered but could not be reliably performed due to data limitations. Radiologic success data were available from all seven included studies, encompassing a total of 70 renal units. Among these, 26 units demonstrated radiologic success following subureteric injection. The overall pooled radiologic success rate was 36.3% (95% CI: 17.9–54.8), as calculated using a random-effects model. Heterogeneity across cohorts was substantial **(**$I^2 = 75.5\%$; $\tau^2 = 0.046$**)** (Figure 2).

Radiologic success rates varied substantially between studies. The highest rate was observed in Castagnetti et al. (2014), with 63.6% success (7 out of 11 renal units), while the lowest was reported by Sheth et al. (2018), with 0% success (0 out of 11 units).[10,13] These results, along with other study-level estimates, are summarized in Table 1.

Clinical success data at the patient level were extractable from five studies: Williams (2008), Sheth (2018), Wu (2018), Uçar (2021), and Obata (2024).[3,4,9,11,13] In contrast, Vemulakonda (2010) and Castagnetti (2014) did not provide data suitable for patient-level analysis.[10,12] Based on a random-effects model, the pooled clinical success rate was 51.0% (95% CI: 8.1–94.0), but heterogeneity was substantial ($I^2 = 94.9\%$; $\tau^2 = 0.228$) (Figure 3). There was marked variation in clinical success rates across individual studies, ranging from 100% in both Williams (2008)[3] and Obata (2024)[11], to 0% in Sheth (2018)[13], 22.2% in Wu (2018)[9], and 33.3% in Uçar (2021).[4]

Ureteral obstruction was selected as the primary complication of interest. Among the studies analyzed, obstruction was observed in only two cohorts: 33.3% (3/9) in one study [7] and 8.3% (1/12) in another [4], while the remaining studies reported no cases [3,8–11]. In the pooled random-effects analysis, the overall incidence of obstruction was 3.8% (95% CI: –3.5–11.2) with minimal heterogeneity ($I^2 \approx 0\%$) (Figure 4).

The need for redo UNC was inconsistently reported across studies, ranging from no cases in some cohorts[3,12] to as many as six in others.[4,13] Specifically, one study documented redo procedures in five patients[9], another in one patient[11], while one did not provide extractable data regarding this outcome.[10]

Risk of bias

According to the JBI Critical Appraisal Checklist for Case Series, six studies[3,4,10-13] were judged to have a low overall risk of bias, while one study[9] demonstrated a moderate risk of bias. Justifications for the overall risk-of-bias assessments were primarily based on the completeness of participant inclusion, the clarity of eligibility criteria, and the consistency of diagnostic procedures and outcome reporting across studies (Table 3).

DISCUSSION

This systematic review and meta-analysis synthesized the limited available evidence on subureteric injection for post-transplant VUR in pediatric kidney transplant recipients. In seven retrospective studies (69 patients, 70 renal units), pooled radiologic success was 36.3% (95% CI: 17.9–54.8), while pooled clinical success (five studies) was 51.0% (95% CI: 8.1–94.0). Between-study heterogeneity was substantial, likely reflecting differences in success definitions, follow-up duration, and surgical technique. Ureteral obstruction, the most clinically important complication given its potential impact on graft function was uncommon (pooled incidence 3.8%), although precision was limited by the small number of events. Rates of redo UNC varied widely, underscoring ongoing uncertainty regarding durability and the need for subsequent interventions.

In this meta-analysis, pooled radiologic success after first-line subureteric injection was modest (36.3%), whereas pooled clinical success was higher (51.0%). This discrepancy highlights a potential disconnect between imaging-based outcomes and patient-centered clinical improvement. Notably, some studies—such as Williams (2008)[3] and Obata (2024)[11]—reported complete clinical success despite limited or absent radiologic resolution, suggesting that the primary therapeutic goal of subureteric injection may be the prevention of febrile urinary tract infections rather than the complete elimination of VUR. Because clinical success definitions and follow-up reporting were inconsistent across cohorts, this observation should be interpreted cautiously and underscores the importance of standardized, clinically meaningful outcomes alongside radiographic endpoints.

The relatively low radiologic success could be due to several contributing factors. Transplant-associated reflux occurs at a reconstructed junction, where scar tissue and altered anatomy could make the injected material less stable.[3,14] Radiologic outcomes were assessed using varying definitions across studies; some defined success as complete resolution of reflux, while others accepted partial improvement, such as a reduction by at least one grade. Additionally, imaging protocols varied considerably between studies. While two studies[3,11] explicitly reported performing postoperative VCUG at 3 months, most others[4,9,10,12,13] did not specify the timing of imaging. This lack of uniformity likely contributed to inconsistencies in the assessment and comparability of radiologic success across studies.

These findings are consistent with previous reviews of endoscopic treatment for post-transplant VUR, which also reported variable and often modest radiographic resolution and highlighted obstruction as the key safety concern. Our pooled radiologic success rate of 36.3% is consistent with findings from Rebullar et al. (2021), who reported a similar rate of 36.8% in a cohort of 67 pediatric kidney transplant recipients.[14] This parallel supports the observation that radiographic resolution following endoscopic injection in this context tends to be modest and varies across cases.[14] In the same study, the overall complication rate defined as ureteral obstruction was reported at 10.4%, highlighting that while such complications are not common, ureteral obstruction remains the most important safety concern in this patient group.[14] Although Deflux was used in all included cohorts, ureteral obstruction, while infrequent overall, remains clinically meaningful because even rare events may threaten graft function and sometimes necessitate stenting or surgical revision.[15] Therefore, even when the pooled obstruction rate appears low, a structured post-procedure

surveillance strategy (early ultrasonography and renal function assessment, followed by standardized imaging when feasible) remains essential in transplant recipients.[15]

Clinical success estimates should be interpreted with caution. The pooled patient-level clinical success showed substantial heterogeneity and a wide confidence interval, likely reflecting non-uniform (and sometimes incompletely reported) outcome definitions as well as variability in follow-up and reporting. Differences in background management particularly antimicrobial prophylaxis and center-specific thresholds for diagnosing and documenting UTIs may further influence clinical endpoints. Standardized, patient-centered definitions and transparent reporting of prophylaxis and follow-up are needed to improve comparability and reliability. Although VCUG is not a flawless modality and some observer variability exists, it remains a quantitatively measurable and relatively standardized method for grading VUR, with good interobserver agreement reported in the literature (intraclass correlation coefficients commonly in the 0.8–0.9 range).[16] In contrast, clinical success often defined as the absence of recurrent febrile UTI/pyelonephritis is inherently more subjective and may vary with local urine collection/culture practices, prophylaxis protocols, and diagnostic thresholds. Accordingly, radiologic success was chosen as the primary endpoint in this meta-analysis to maximize comparability across heterogeneous studies, whereas clinical outcomes were analyzed as secondary endpoints.

Overall, the mismatch between radiologic and clinical outcomes implies that subureteric injection may still provide meaningful clinical benefit in selected patients, even when imaging shows persistent reflux. In practice, subureteric injection may be most reasonable for symptomatic transplant recipients with recurrent febrile UTI/pyelonephritis attributable to VUR, particularly those with low-to-moderate reflux grades, stable graft function, and no evidence of ureteral obstruction or high-pressure bladder dysfunction where a minimally invasive, repeatable option is preferred before undertaking redo UNC.[12] Within this symptom-driven approach, the primary goal becomes infection control and graft preservation, rather than achieving complete radiographic resolution which may be limited and should not be the sole determinant of success or the need for escalation to definitive reconstruction.[11]

The underlying etiology may also play an important role in treatment success in transplant-associated VUR. In the included literature, most studies that addressed this question divided patients into those with upper and lower tract pathologies rather than using broader categories such as nephrological, urological, neurological, or mixed disease backgrounds.[10,12] These broader categories were used in the present review because they could be applied more consistently across the included studies, several of which reported only the primary cause of ESRD rather than a uniform upper-versus-lower tract classification. In general, lower tract pathology was associated with less favorable outcomes after endoscopic treatment.[10,12] Vemulakonda (2010) reported radiologic success in 4 of 6 patients with upper tract pathology, compared with 1 of 3 patients with lower tract pathology.[12] Similarly, Castagnetti (2014) reported endoscopic success in 6 of 6 patients without lower urinary tract pathology, compared with only 1 of 5 patients with lower urinary tract pathology.[10] However, because of inconsistent classification, limited data, and variable outcome reporting across studies, the influence of underlying etiology could not be formally assessed in this meta-analysis.

The wide range of redo UNC rates across cohorts likely reflect a combination of variation in patient populations and how each center approaches treatment decisions.[13] Factors such as initial symptom severity, how failure is defined, whether a second injection is routinely offered before surgery, and inconsistent follow-up durations all contribute to this variability.[13,17] Taken together, these factors make it difficult to assess the long-term effectiveness of a single injection.[12] Still, they support the use of a stepwise management plan, where subureteric injection is considered an appropriate first-line option and further intervention is based on response either through repeat injection in selected cases or surgical revision when necessary.[3,12]

This study has several limitations related to the type and quality of the available evidence. All included studies were retrospective case series with small participant numbers, varying reasons for intervention, inconsistent outcome definitions, and gaps in how follow-up and imaging protocols were reported. These inconsistencies likely introduced substantial heterogeneity, weakening the strength and generalizability of the pooled outcomes. Furthermore, due to the small number of studies, it wasn't possible to assess the impact of small-study bias. As a result, the combined findings should be considered preliminary and more useful for informing future research than for providing definitive conclusions. Subgroup analysis by implantation technique was not feasible due to limited and inconsistently reported data, together with the small number of studies.

Of note, one study[3] contributed two renal units from a single patient; however, given the overall sample size, any impact of within-patient correlation on renal-unit level pooling is likely minimal.

There is a clear need for future prospective, multicenter studies to enhance the evidence base and minimize variability across studies. These investigations should adopt uniform treatment criteria, standardized imaging follow-up protocols (including consistent timing for VCUG), and a shared, patient-centered definition of clinical success alongside radiologic outcomes. Detailed reporting should include reflux severity, surgical implantation techniques, trends in graft function, and use of prophylactic antibiotics. In addition, clear criteria should be defined ahead of time for when to escalate from injection to surgery. Well-designed subgroup analyses based on reflux severity and implantation method would help clarify which patients are most likely to benefit from subureteric injection and who might ultimately require surgical reconstruction. The included studies reported transplant laterality, injection technique and volume, prior bladder surgery, baseline voiding dysfunction, and CIC use inconsistently; more standardized reporting of these variables would improve comparability across studies and strengthen future evidence synthesis.

To summarize, subureteric injection as an initial treatment for post-transplant VUR in children offers limited and inconsistent radiologic outcomes. However, some patients still benefit clinically, even when imaging shows persistent reflux. Although ureteral obstruction is infrequent, it remains the most important safety issue, necessitating ongoing surveillance. To better guide patient selection and establish more reliable, meaningful results, higher-quality and standardized studies are essential.

CONCLUSIONS

Subureteric injection demonstrated a pooled radiologic success rate of 36.3% and may serve as a practical, minimally invasive first-line treatment for selected pediatric kidney transplant patients with post-transplant VUR. Although uncommon, ureteral obstruction is a serious complication in this population and warrants close follow-up due to its potential impact on graft function. Prospective multicenter studies are needed to standardize treatment protocols, define long-term outcomes, and clarify when to move from injection to surgical revision in nonresponders.

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FIGURES AND TABLES

Figure 1. PRISMA 2020 flow diagram of the study.

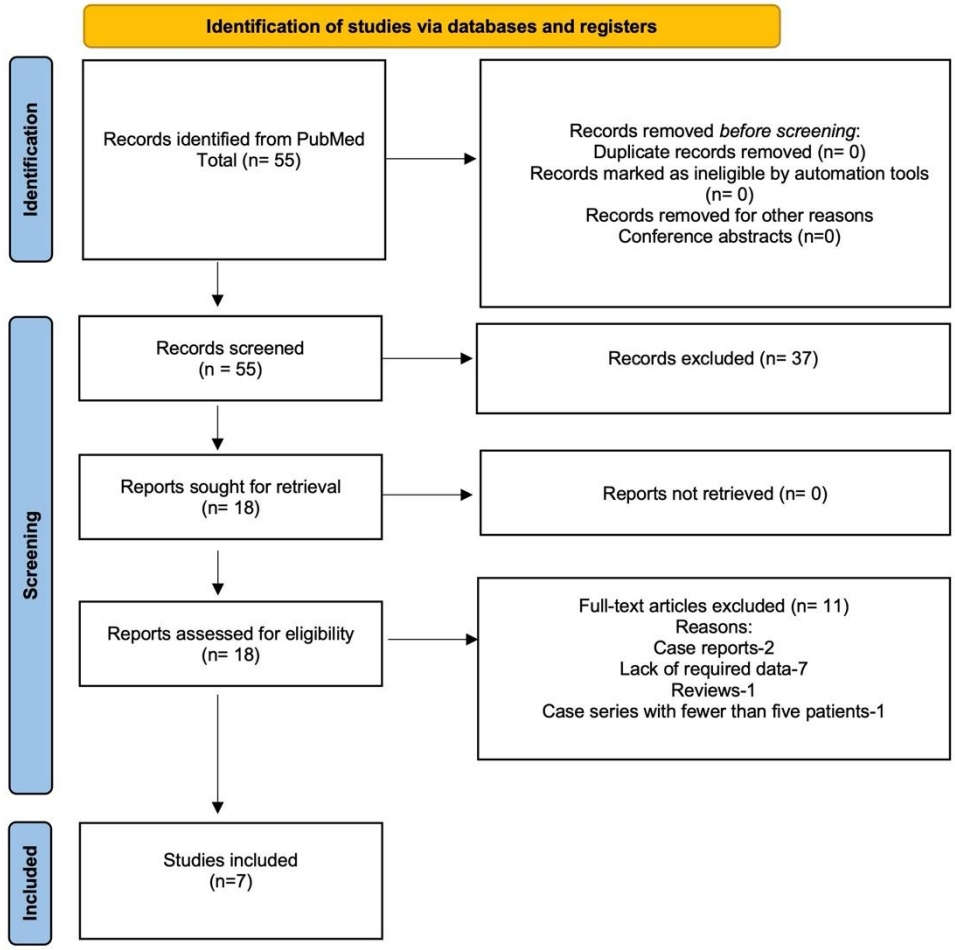

Figure 2. Forest plot of radiologic success rate.

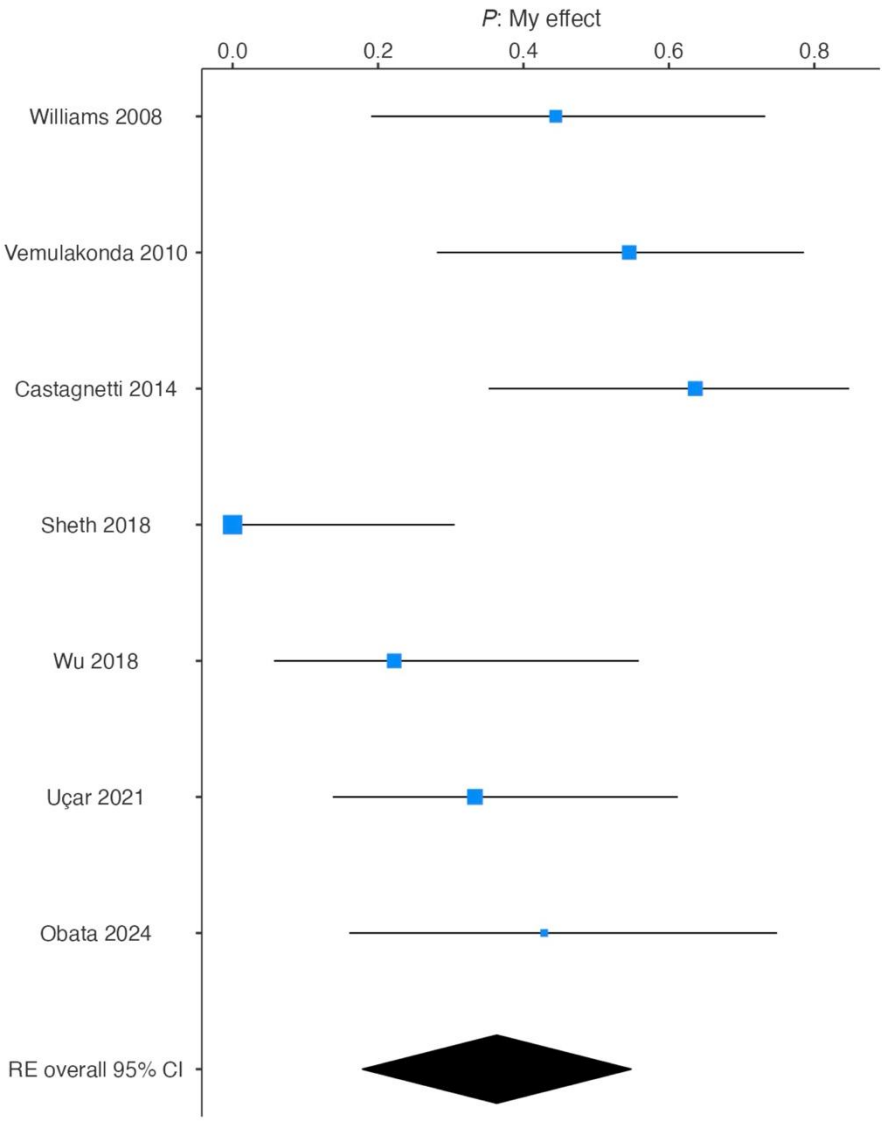

Figure 3. Forest plot of clinical success.

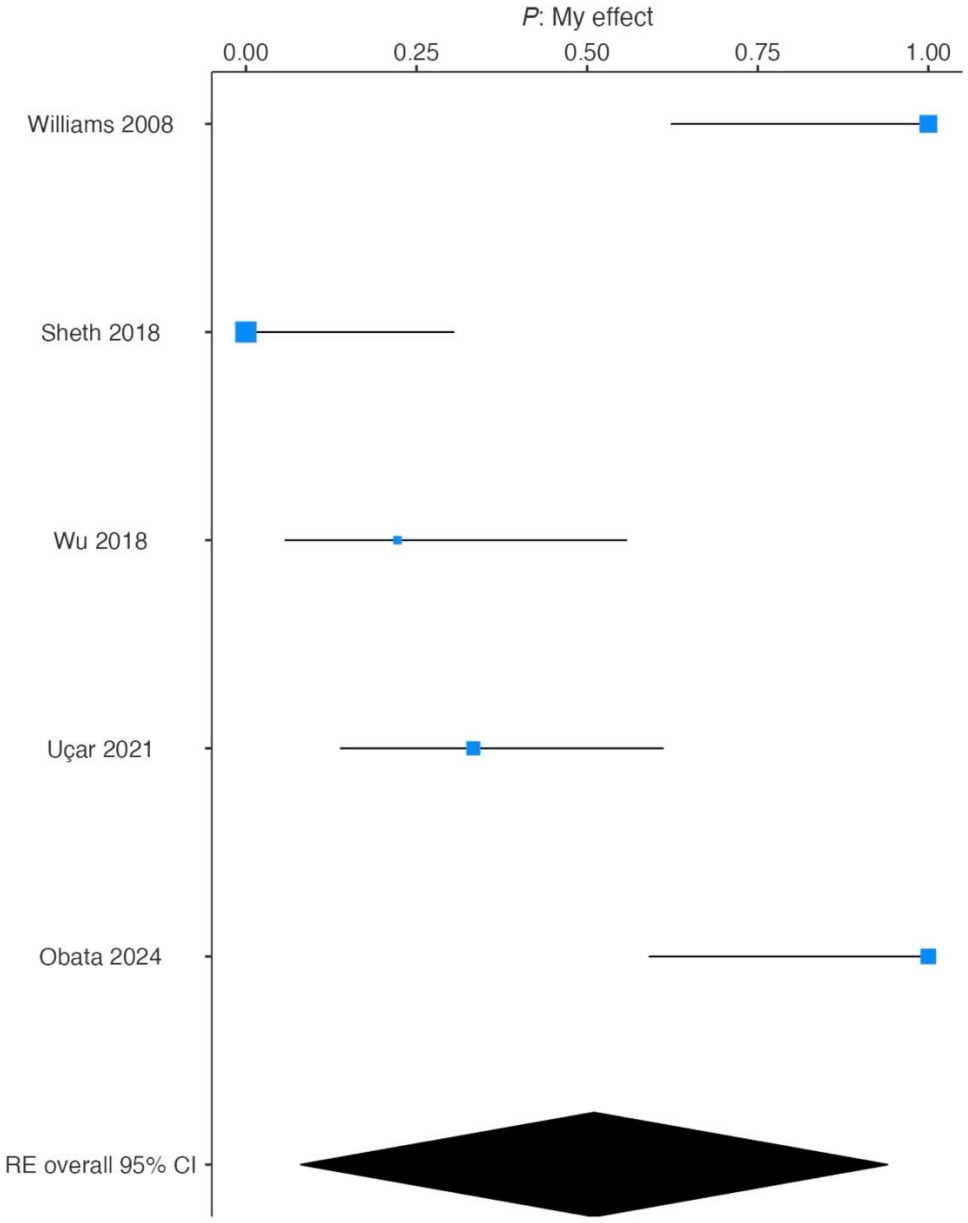

Figure 4. Forest plot of complication (ureteral obstruction).

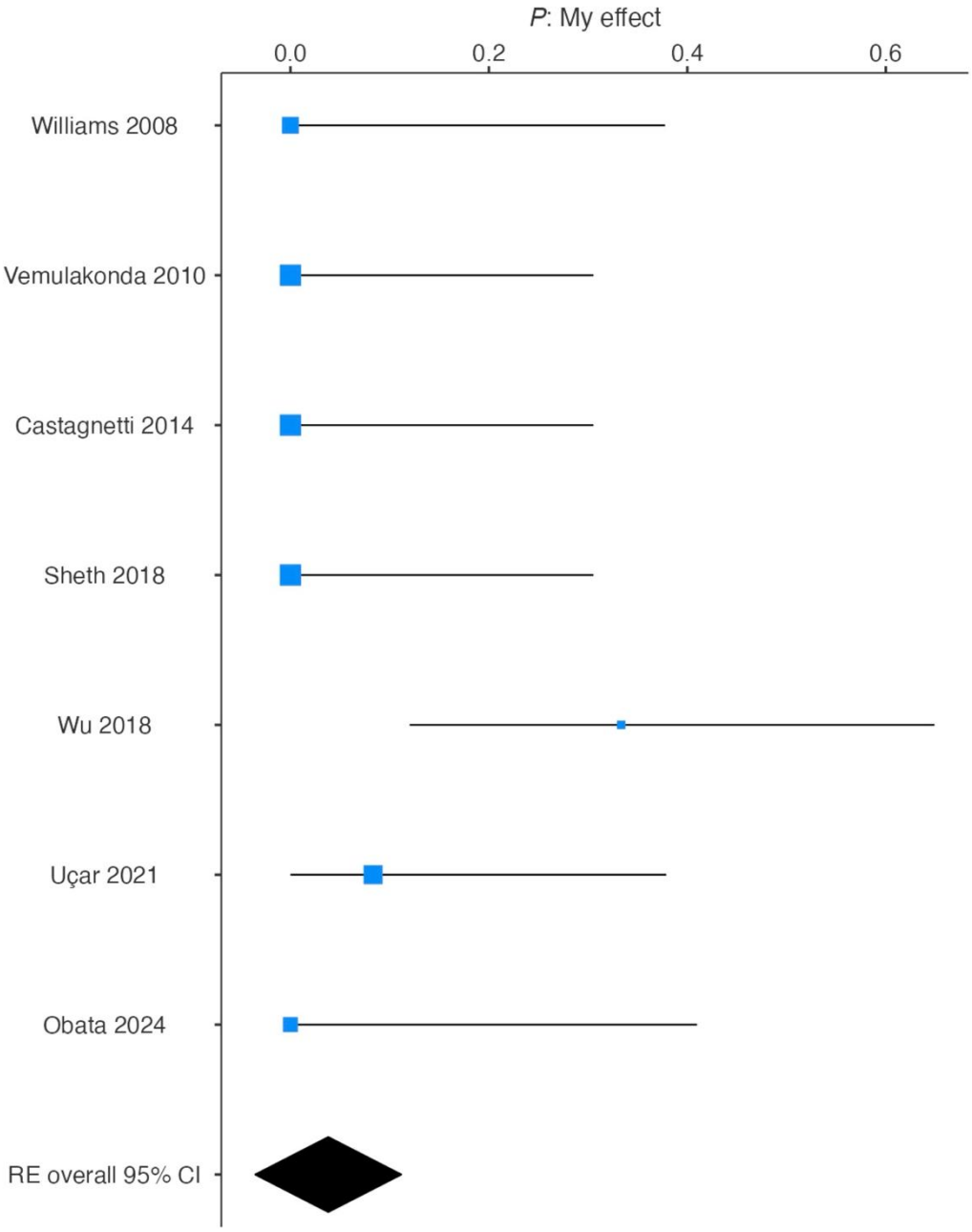

Table 1. Study characteristics and extracted variables of included cohorts

Study (year)	Design	Center type	Diagnostic Modality	Pts, n	Renal units, n	Radio-logic success (renal units, n)	Clinical success per patient, n	Overall (radio-logic) success (%)	ESRD etiology–urologic, n	ESRD etiology–nephro-logic, n
Williams 2008[3]	Retrospective	Single-center	VCUG	8	9	4	8	44	NR	NR
Vemulakonda 2010[12]	Retrospective	Multicenter	VCUG	11	11	6	NR	54.5	2	6
Castagnetti 2014[10]	Retrospective	Single-center	VCUG, DRS when obstruction suspected	11	11	7	NR	63.6	5	6
Sheth 2018[13]	Retrospective	Single-center	VCUG	11	11	0	0	0	4	7
Wu 2018[9]	Retrospective	Single-center	VCUG	9	9	2	2	22	5	4
Uçar 2021[4]	Retrospective	Single-center	VCUG	12	12	4	4	33.3	4	7

Obata 2024[11]	Retrospective	Single-center	VCUG	7	7	3	7	43	4	3

Table 1 (cont'd). Study characteristics and extracted variables of included cohorts												
Study (year)	**ESRD etiology–unknown/mixed, n**	**Ureterovesic anastomosis type**	**Mean FU, mos**	**Injected material**	**Mean age, mos**	**Success criteria**	**Complication rate–ureteral obstruction, %**	**Post-injection VCUG timing, mean/month**	**Redo ureteroneocystostomy required, n**	**Time from transplant to VUR Dx, mos**	**Risk of bias**	**DOI**
Williams 2008[3]	NR	Refluxing	17	Deflux	139	Complete resolution of VUR on follow-up VCUG, No febrile UTI / pyelonephritis	0	3	0	NR	Low	10.1016/j.jpurol.2008.04.003
Vemulakonda 2010[12]	2	Anti-refluxing (Lich-Gregoir)	NR	Deflux	96	Complete resolution of VUR on	0	NR	0	NR	Low	10.1111/j.1399-3046.2009.01196.x

						followup VCUG						
Castagnetti 2014[10]	0	Anti-refluxing (Lich-Gregoir)	64*	Deflux	NR	Resolution of VUR on followup VCUG, No febrile UTI	0	NR	NR	52*	Low	10.1111/petr.12207
Sheth 2018[13]	0	Anti-refluxing (modified Lich-Gregoir)	NR**	Deflux	NR**	Complete resolution of VUR on follow-up VCUG, No febrile UTI / pyelonephritis	0	NR	6	16	Low	10.1016/j.jpurol.2018.07.006

Wu 2018[9]	0	Anti-refluxing (Lich-2, Politano-Leadbetter)	NR***	Deflux	NR***	resolution of VUR on followup VCUG, No febrile UTI	33.3	NR	5	12	Moderate	10.1111/petr.13299
Uçar 2021[4]	0	Anti-refluxing (Lich-Gregoir)	NR	Deflux	NR****	resolution of VUR (gr 0−1) on follow-up VCUG, No febrile UTI	8.3	NR	6	NR	Low	10.6002/ect.2020.0367
Obata 2024[11]	0	Anti-refluxing (Lich-Gregoir)	42*	Deflux	91		0	3	1	NR	Low	10.1016/j.jpedsurg.2023.12.005

*Estimated mean calculated from the reported median and range using distribution-based methods. **Age and followup duration were not reported separately for the post-transplant VUR subgroup treated endoscopically. ***Median age (6.3) and mean followup duration (5.5) are provided relative to the time of transplant, but specific values for the period following subureteric endoscopic injection are not reported. ****Mean age at the time of transplantation

was 78.4 months, age at the time of injection was not explicitly reported. NR: not reported; VCUG: voiding cystourethrography;VUR: vesicoureteral reflux; UTI: urinary tract infection

Table 2. Study-level reporting of key procedural and patient variables						
Study	**Graft side (right or left iliac fossa)**	**Technique**	**Amount injected (mL)**	**Prior bladder surgery**	**Baseline VD**	**CIC**
Williams 2008[3]	NR	HIT	1–2 mL	NR	No	No
Vemulakonda 2010[12]	NR	NR	0.5–1.5 mL	NR	NR	NR
Castagnetti 2014[10]	NR	NR	1.3 (0.6–2) mL	NR	NR	NR
Sheth 2018[13]	NR	NR	NR	NR	NR	NR
Wu 2018[9]	NR	Double HIT	3 (1–6) mL	No	NR	No
Uçar 2021[4]	NR	STING	1–2 mL	NR	3/12	1/12
Obata 2024[11]	NR	STING	1.0 (0.3–1.6) mL	NR	NR	NR

CIC: clean intermittent catheterization; HIT: hydrodistention implantation technique; NR: not reported; STING: subureteral transurethral injection; VD: voiding dysfunction.

Table 3. Joanna Briggs Institute (JBI) checklist applied for critical appraisal of case Ssries in this systematic review												
Study	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Overall risk of bias**	**Justification**
Williams 2008	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**Low risk**	Clear inclusion criteria, standardized diagnostic methods, and complete outcomes reported
Vemulakonda 2010	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	**Low risk**	Standardized diagnostic methods and clearly reported outcomes
Castagnetti 2014	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	**Low risk**	Clear outcome definitions and standardized diagnostic methods were consistently applied.
Sheth 2018	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**Low risk**	Overall methodological rigor with well-reported outcomes
Wu 2018	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	**Moderate**	Lack of complete inclusion of eligible patients raises concern for potential selection bias
Uçar 2021	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**Low risk**	Uniform management within a single center supported study reliability
Obata 2024	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**Low risk**	Standardized management and consistent outcome assessment reported

Ratings of questions: Yes (Y) / No (N) / Unclear (U) / Not applicable (NA)
Rating for the overall risk of bias: Low / Moderate / High

Items of the checklist

Question 1. Were there clear criteria for inclusion in the case series?

Question 2. Was the condition measured in a standard, reliable way for all participants included in the case series?

Question 3. Were valid methods used for identification of the condition for all participants included in the case series?

Question 4. Did the case series have consecutive inclusion of participants?

Question 5. Did the case series have complete inclusion of participants?

Question 6. Was there clear reporting of the demographics of the participants included in the study?

Question 7. Was there clear reporting of clinical information of the participants?

Question 8. Were the outcomes or follow-up results of cases clearly reported?

Question 9. Was there clear reporting of the presenting sites'/clinics' demographic information?

Question 10. Was statistical analysis appropriate?