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Research Article

Comparative Outcomes Of Early Versus Delayed Surgery In Posterior Urethral Valves In Infants

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ABSTRACT

Posterior urethral valves (PUV) is the commonest cause of congenital lower urinary tract obstruction in male infants and a major contributor to childhood chronic kidney disease (CKD). The optimal timing of definitive surgical intervention—early (neonatal/within days–weeks of life) versus delayed (after stabilization, weeks–months later)—remains debated. Early relief of obstruction theoretically limits ongoing renal and bladder damage, but neonatal physiology, comorbidities, and anesthesia risks sometimes motivate a delayed approach with interim urinary drainage (catheterization or vesicostomy). We performed a focused narrative synthesis of recent evidence (guidelines, cohort studies, and reviews, 2018–2024) on renal, bladder, growth, and perioperative outcomes comparing early and delayed definitive surgery in infants with PUV. Early endoscopic ablation or timely definitive decompression is associated with more rapid improvement in urinary drainage, lower early post-obstructive complications, and improved trends in bladder dynamics; however, long-term renal outcomes (eGFR, progression to CKD/ESKD) are more strongly predicted by disease severity at presentation (nadir serum creatinine, oligohydramnios, extent of renal dysplasia) than by timing alone. Multiple large cohorts and contemporary guideline summaries emphasize that while early intervention is desirable when the infant is hemodynamically stable, prognostication must incorporate antenatal findings and early renal biomarkers (including nadir creatinine and validated risk scores). Practical, risk-stratified clinical pathway was proposed: immediate decompression for unstable infants, early definitive ablation where feasible, and focused longitudinal surveillance of renal function and bladder dynamics. Research gaps include randomized comparisons (not ethically feasible in many settings), standardized definitions of “early” and “delayed”, and multicenter prospective datasets with harmonized outcome measures. Early surgery offers clear immediate benefits; long-term renal preservation depends principally on initial disease severity and comprehensive post-operative care.

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INTRODUCTION

Posterior urethral valves (PUVs) represent a congenital obstruction of the posterior urethra exclusively affecting male infants, often diagnosed antenatally or within the first year of life. The obstruction results in progressive bladder outlet obstruction with subsequent urinary tract dilation and renal impairment. Surgical intervention aims to relieve obstruction, ideally preventing irreversible renal damage and bladder dysfunction.

PUV is a leading cause of pediatric CKD and pediatric renal replacement therapy in many series. Contemporary registries estimate that 20–65% of children with PUV develop some degree of chronic kidney disease and 8–21% progress to end-stage kidney disease (ESKD) in long-term follow-up.

Timely relief of obstruction is a central therapeutic goal. Definitive management typically involves endoscopic valve ablation in infants, whereas temporary urinary diversion (vesicostomy or catheter drainage) may be used in unstable neonates or where endoscopy is not feasible. However, the optimal timing—immediate neonatal ablation versus delayed ablation after stabilization—remains controversial. Determining whether early definitive surgery alters long-term renal and bladder outcomes, or simply improves early clinical course, is crucial for counseling families and planning perinatal management.

Methods

This is a focused narrative review synthesizing current evidence, guideline recommendations, and recent cohort data (2018–2024) addressing timing of surgical management for PUV in infants. Searches were made on PubMed/Medline, Google Scholar, NCBI Bookshelf (StatPearls), and major society guideline updates (EAU/ESPU, AUA summaries) using terms: “posterior urethral

valves”, “neonatal valve ablation”, “timing of surgery”, “early versus delayed”, “renal outcomes PUV”, and “nadir creatinine PUV”. Priority was given to large cohort studies, systematic reviews, guideline statements, and recent translational research informing prognosis (PURK score, nadir creatinine). Where available, emphasis was made for studies and reviews published within the last 5 years.

Limitations: This narrative approach is not a formal meta-analysis. Heterogeneity in defining “early” vs “delayed”, variable follow-up durations, and differing outcome measures across studies limit quantitative pooling.

Epidemiology And Natural History

PUV incidence is approximately 1:3,000–1:8,000 male births. The clinical spectrum ranges from severe fetal lower urinary tract obstruction (often detected by antenatal ultrasound and oligohydramnios) to milder forms presenting later with UTIs or voiding dysfunction. Antenatal detection—hydrops, oligohydramnios, bilateral hydronephrosis—frequently predicts more severe renal dysplasia and worse outcomes. Longitudinal cohorts confirm the high lifetime risk of CKD, and many children require prolonged multidisciplinary follow-up into adulthood.

Pathophysiology and rationale for early intervention

Chronic outflow obstruction in utero or early postnatal life leads to bladder wall remodeling, detrusor hypertrophy, reduced compliance, and progressive renal parenchymal injury due to increased intrarenal pressure and impaired nephrogenesis. Early relief of obstruction aims to halt or mitigate these processes, restore cyclic bladder dynamics, reduce recurrent infections and prevent further nephron loss. Animal models and clinical observations support the concept that



earlier decompression should limit progressive injury; however, irreversible renal dysplasia present at birth may limit the benefit of any postnatal intervention.

Definitions used in the literature

Studies vary in how they define “early” versus “delayed” surgery:

- Early/neonatal ablation: valve ablation within the first days to 28 days of life (commonly within 48–72 hours for neonates who are clinically stable). BioMed
- Delayed ablation: valve ablation after initial stabilization, which may range from weeks to months of age; often preceded by temporary drainage (catheter or vesicostomy).

This variability complicates direct comparisons and meta-analyses.

Evidence: short-term outcomes (immediate postoperative course, complications)

Multiple contemporary case series and institutional cohorts report that early endoscopic ablation, when feasible in a stable neonate, leads to rapid decompression, improved drainage, quicker reduction in bladder outlet obstruction signs, and shorter hospital stay compared with prolonged preoperative drainage strategies. Early ablation may reduce episodes of urinary tract infection and the need for prolonged catheterization or diversion. However, neonatal anesthesia and perioperative management must be carefully optimized to minimize immediate risks.

A 2023–2024 body of observational data suggests early ablation lowers short-term morbidity (e.g., sepsis from retained urine, electrolyte derangements) compared with delayed definitive surgery that defers ablation after weeks of catheter or vesicostomy care. Nevertheless, some neonates

with severe pulmonary hypoplasia or unstable cardiorespiratory status at birth require initial diversion until clinically fit for endoscopic ablation.

Evidence: bladder function outcomes

Bladder dysfunction (poor compliance, reduced capacity, detrusor hyperactivity leading to incontinence) is frequent after PUV ablation—the so-called “valve-bladder syndrome”—and may persist despite early treatment. Several studies show trends toward improved bladder dynamics when relief of obstruction is achieved early, but many infants still exhibit persistent dysfunction requiring prolonged urodynamic surveillance and interventions (anticholinergics, CIC, augmentation in severe cases). Thus, early ablation reduces ongoing obstructive remodeling but does not always prevent myogenic failure if significant prenatal bladder injury already occurred.

Evidence: Renal Outcomes

Key Prognostic Modifiers

Across multiple cohorts and recent reviews, disease severity at presentation—rather than timing of surgery alone—emerges as the dominant predictor of long-term renal outcome. Strong prognostic factors include:

- Nadir serum creatinine in the first year of life (lower nadir strongly predicts better long-term eGFR). *Frontiers*
- Antenatal oligohydramnios and severe bilateral hydronephrosis, which predict significant renal dysplasia. *Nature*
- Degree of renal dysplasia on imaging and early need for renal replacement therapy. *PubMed*

Comparative Findings:



Observational studies suggest that early ablation may reduce further renal insult from ongoing obstruction but that long-term preservation of renal function is variably affected. For many infants with severe antenatal injury, even prompt neonatal ablation cannot fully prevent CKD progression. Several recent cohort analyses and reviews (2019–2024) show similar long-term eGFR trajectories in patients who underwent early versus delayed ablation once baseline disease severity is accounted for; in other words, the apparent benefit of early surgery in unadjusted analyses often attenuates after adjusting for severity markers.

A practical implication is that early intervention helps prevent added, iatrogenic injury from persistent obstruction, but cannot reverse pre-existing dysplasia, which is the major determinant of eventual CKD/ESKD. [secipe.org](https://www.secipe.org)

Evidence: growth, survival and transplant outcomes

Children with PUV who progress to CKD may experience growth failure and require renal replacement therapy. Studies confirm that early decompression facilitates better nutritional and growth trajectories in many infants by improving urinary physiology and decreasing infection burden; however, growth outcomes correlate more closely with degree of renal impairment than with timing of valve ablation per se. PUV remains one of the leading congenital urologic indications for pediatric renal transplantation in several registries. [ScienceDirect](https://www.sciencedirect.com)¹

Risk Stratification Tools And Biomarkers

Recent work has focused on standardizing prognostication. The nadir creatinine during the first year is repeatedly validated as a robust predictor of CKD risk. Newer prognostic scoring systems (e.g., PURK/PURV-like scores) that

combine antenatal findings, early creatinine nadir, degree of hydronephrosis, and presence of vesicoureteral reflux have been proposed and externally validated to stratify CKD risk in infants with PUV. These tools help clinicians decide on timing/intensity of intervention and long-term surveillance.

Practical Clinical Approach (Synthesis And Recommendations)

Based on contemporary guidelines (EAU/ESPU summaries and recent reviews) and cohort evidence:

1. Immediate goals: decompress urinary tract in neonates with obstructive uropathy. If the neonate is hemodynamically stable, early endoscopic valve ablation is generally preferred. If unstable or if endoscopy is not feasible, consider temporary bladder drainage (Foley catheter) or a vesicostomy to preserve renal function until the infant is stable for definitive ablation.
2. Risk-stratified decision making: use antenatal markers (oligohydramnios, renal parenchymal appearance), initial creatinine trends, and validated risk scores to triage infants into aggressive early management pathways versus staged care with close monitoring.
3. Post-operative surveillance: rigorous follow-up of renal function (serial eGFR), bladder dynamics (urodynamics where available), and early management of reflux or persistent obstruction is essential—early ablation is only one step in a continuum of care that includes infection control, bladder rehabilitation, and nephrology collaboration.
4. Multidisciplinary care: perinatal counseling, neonatology, pediatric nephrology, and urology collaboration improves timing decisions and long-term outcomes. [SpringerLink](https://www.springerlink.com)



Controversies And Knowledge Gaps

- Heterogeneous definitions: lack of uniform definitions for “early” vs “delayed” complicate comparisons. Standardized time windows (e.g., <7 days, 7–28 days, >28 days) would facilitate future meta-analysis.
- Confounding by indication: sicker infants are more likely to undergo early interventions (or conversely may be too sick), creating selection bias in observational cohorts. Prospective, multicenter registries with standardized data collection are needed. *Nature*
- Randomized trials infeasible: ethical and logistical barriers limit randomized trials of timing; observational designs with careful adjustment and propensity matching are pragmatic alternatives. *Frontiers*
- Longitudinal adult follow-up: many series have limited adulthood follow-up. Lifespan studies are necessary because CKD and bladder dysfunction evolve over decades.

Discussion

The evidence supports early intervention as beneficial to renal preservation in PUV infants, emphasizing the critical window of neonatal surgery to mitigate renal damage. However, bladder outcomes appear multifactorial and less sensitive to timing alone, influenced by severity of obstruction and individual patient factors. The variability in reported bladder dysfunction highlights the complexity of this condition and the necessity for tailored postoperative management, including urodynamic monitoring and adjunct therapies.

Despite these findings, challenges remain including variability in patient populations, differences in surgical techniques, and follow-up duration. Future prospective multicenter studies are required to solidify these findings and refine clinical guidelines.

CONCLUSIONS

Early definitive decompression (endoscopic valve ablation) in clinically stable neonates with PUV offers clear short-term advantages—rapid relief of obstruction, reduced early infectious complications, and improved initial bladder dynamics. However, long-term renal outcomes are dominated by pre-existing disease severity (antenatal injury, nadir creatinine), and timing alone does not fully determine CKD risk. A pragmatic, risk-stratified approach—immediate decompression when indicated, early ablation when safe, and comprehensive long-term multidisciplinary follow-up—optimizes outcomes. Future research should standardize timing definitions, validate prognostic tools across populations, and develop multicenter prospective datasets to better quantify the marginal long-term benefits of early surgery.

Practical recommendations for clinicians

1. Aim for early valve ablation in neonates who are hemodynamically stable and where endoscopy is feasible. *BioMed Central*
2. Use temporary diversion (catheter/vesicostomy) when initial stabilization is necessary.
3. Employ nadir creatinine and antenatal imaging to risk-stratify infants for intensive surveillance. *Frontiers*
4. Ensure longitudinal multidisciplinary follow-up (urology + nephrology + growth/nutrition + urodynamics).

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