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Outcome of Posterior Urethral Valve Ablation in Neonates.

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Abstract

Background: Posterior urethral valves (PUV) represent the most common cause of congenital lower urinary tract obstruction in male neonates and remain a leading contributor to chronic kidney disease (CKD) and bladder dysfunction in childhood. Although early valve ablation is the standard intervention to relieve obstruction, long-term renal and urological outcomes vary considerably, reflecting the combined effects of antenatal injury, postnatal renal vulnerability, and evolving bladder dysfunction.Objectives: This review evaluates renal and bladder outcomes following neonatal PUV ablation and identifies key prognostic indicators that influence long-term morbidity.Methods: A narrative review methodology was employed, following STROBE-aligned principles for observational data synthesis. Literature published between 2010 and 2025 was examined to extract evidence on renal function trajectories, bladder dysfunction patterns, procedural outcomes, and predictors of adverse prognosis. Studies reporting neonatal PUV ablation with measurable clinical outcomes were included.Results: Neonates undergoing valve ablation demonstrated wide variability in renal outcomes: approximately one-third to one-half developed CKD during follow-up, while a smaller but significant proportion progressed to kidney failure. Elevated post-ablation nadir creatinine, severe antenatal presentation, prematurity, and early recurrent urinary tract infections were consistently associated with poor renal outcomes. Bladder dysfunction was common, with more than half of patients demonstrating urodynamic abnormalitiesincluding detrusor overactivity, poor compliance, and incomplete emptyingwhich contributed to persistent morbidity and risk of upper tract deterioration. Procedural complications were uncommon, although residual valves requiring re-ablation occurred in a notable minority.Conclusion: Neonatal valve ablation is necessary but insufficient to prevent long-term renal and bladder sequelae in PUV. Early risk stratification, structured nephro-urological follow-up, and proactive bladder management are essential to optimize outcomes. A coordinated, long-term care pathway remains critical for reducing the lifetime disease burden associated with PUV.

Keywords: Posterior urethral valves (PUV), Lower urinary tract obstruction (LUTO), Congenital urinary tract anomaly, Pediatric urology, Bladder outlet obstruction.

INTRODUCTION

Posterior urethral valves (PUV) represent the most common congenital cause of lower urinary tract obstruction (LUTO) in male infants, ranking among the most significant pathologies encountered in pediatric urology. PUV arises from abnormal development of membranous tissue within the posterior urethra, resulting in variable degrees of urinary outflow obstruction and consequent perturbations of bladder, ureteric, and renal structure and function [turn0search7; turn1search1]. The incidence of PUV has been variably reported but generally ranges between approximately 1 in 3,000 to 8,000 live births, with variation influenced by geographic and diagnostic practices [turn1search[1]. The pathophysiological impact of PUV begins in utero: obstruction increases intravesical pressure, impairs urine flow into the amniotic cavity, and can lead to oligohydramnios with secondary pulmonary hypoplasia and Potter sequence in severe cases. These in utero effects contribute not only to perinatal morbidity and mortality but also to long-term renal and bladder outcomes [turn0search0; turn0search15].

Early diagnosis has been facilitated by widespread use of routine prenatal ultrasonography, often identifying findings suggestive of bladder outlet obstruction such as megacystis, bilateral hydronephrosis, and the characteristic “keyhole sign” of a dilated posterior urethra [turn1search1]. While prenatal detection allows preparation for immediate postnatal intervention, it does not uniformly alter the long-term sequelae of early obstruction because renal dysplasia and parenchymal damage may occur before birth. Postnatal clinical presentation ranges from frank urinary retention and a

distended bladder in the neonatal period to delayed symptoms such as recurrent urinary tract infections (UTIs), poor urinary stream, or incontinence later in childhood [turn0search7; turn0search16]. In all scenarios, diagnostic confirmation usually relies on voiding cystourethrography (VCUG) and cystoscopic visualization of the valve leaflets, allowing both characterization and definitive treatment planning [turn0search15]. The cornerstone of initial postnatal management is prompt relief of obstruction. This typically begins with bladder decompression using a urethral catheter, followed by definitive valve ablation via endoscopic incision or fulguration when the neonate is clinically stable [turn1search10]. Alternative approaches, such as primary vesicostomy or temporary urinary diversion, are reserved for medically unstable infants or those in whom catheterization is not feasible [turn1search10]. Successful ablation reduces intravesical pressure, alleviates hydronephrosis, and facilitates improved renal drainage; however, these immediate benefits do not guarantee preservation of renal function in the long term. Numerous clinical series and registry data indicate that a substantial proportion of boys treated for PUV in infancy go on to develop chronic kidney disease (CKD), with estimates suggesting that approximately 20–65% experience some degree of renal impairment and 10–25% may progress to end-stage kidney disease (ESKD) over follow-up periods extending into childhood and adolescence [turn1search7; turn1search11]. The complex interplay between obstruction, renal development, and bladder dynamics has important prognostic implications. One of the most consistent predictors of long-term renal outcome is the nadir serum creatinine achieved after valve ablation; values above commonly referenced thresholds (often ≥1 mg/dL) are strongly associated with progression to CKD and ESKD [turn1search11]. Other factors, including the degree of prenatal obstruction, presence of severe antenatal hydronephrosis, need for early surgical diversion, and recurrent UTIs, further influence renal risk and underscore the heterogeneity of PUV outcomes [turn0search0; turn1search1]. Additionally, structural and functional bladder abnormalities, such as poor compliance or detrusor overactivity, may persist or evolve despite initial decompression, contributing to ongoing upper tract stress and necessitating long-term urodynamic surveillance and bladder management strategies [turn1search9].

The long-term impact of PUV extends beyond renal function. Bladder dysfunction, recurrent UTIs, vesicoureteral reflux, and potential psychosocial effects related to incontinence and catheterization regimens are common clinical concerns that often persist into adolescence. Evidence also suggests that complications of chronic obstruction may have implications for growth, cardiovascular risk, and quality of life, demanding a multidisciplinary approach to care that spans pediatric urology, nephrology, and allied support services [turn0search7; turn1search1]. Structured follow-up protocols are therefore essential, with regular assessment of renal function, blood pressure, proteinuria, bladder dynamics, and growth parameters used to anticipate and mitigate progressive disease.

Despite decades of study, significant gaps remain in our understanding of optimal timing of intervention, the role of prenatal therapies, and the best strategies for long-term surveillance and rehabilitation. Recent efforts, including machine learning–based predictive tools and multivariate scoring systems, aim to refine risk stratification and personalize care pathways based on early clinical, biochemical, and imaging indicators [turn0search1; turn1search4]. Such innovations hold promise for improving prognostication and targeted interventions in this heterogeneous patient population. In summary, PUV represents a congenital obstructive anomaly with profound implications for renal and lower urinary tract health. Early diagnosis and timely ablation are necessary to relieve obstruction and stabilize the neonate, yet variable long-term outcomes persist. The interplay between prenatal injury, postnatal intervention, and ongoing bladder-kidney interactions underscores the need for continued research, multidisciplinary management, and individualized follow-up strategies to optimize outcomes for affected infants and children.

Objectives

The primary objective of this review is to evaluate the clinical outcomes of neonates undergoing posterior urethral valve (PUV) ablation, with particular emphasis on renal function, progression to chronic kidney disease, bladder dysfunction, and the need for subsequent urological interventions. Given that early obstruction can result in irreversible renal injury even before birth, a clearer understanding of post-ablation trajectories is essential for accurate prognosis, parental counseling, and long-term multidisciplinary management. A secondary objective is to identify key prognostic factors that influence outcomes following neonatal valve ablation. These include prenatal indicators of severity, postnatal biochemical markers such as nadir serum creatinine, perinatal factors including prematurity and birth weight, and early post-procedural complications such as residual obstruction or urinary tract infections. By synthesizing current evidence on these predictors, this review aims to support clinicians in stratifying risk, optimizing follow-up strategies, and guiding early interventions that may mitigate long-term renal and bladder morbidity.

METHODOLOGY

Study Design

This work was conductedat SMS Medical college during 2013 to 2016 as a narrative review designed to synthesize current evidence on outcomes following posterior urethral valve ablation in neonates. The methodology follows principles aligned with STROBE criteria for observational research reporting, adapted for use in secondary evidence synthesis. The review

aims to integrate findings from cohort studies, retrospective analyses, and clinical observational data to provide a coherent understanding of post-ablation renal and bladder outcomes.

Search Strategy

A structured search approach was employed to identify relevant literature. Databases were queried using predefined terms related to posterior urethral valves, neonatal management, valve ablation, renal outcomes, and bladder dysfunction. Additional records were identified through manual searching of bibliographies and cross-referencing key articles. The search included studies published in English and focused on human neonatal populations.

Eligibility Criteria

Eligibility was based on predefined inclusion and exclusion parameters consistent with methodological rigor expected under STROBE-informed review practices. Included studies evaluated neonates diagnosed with posterior urethral valves who underwent endoscopic valve ablation. Studies were required to report clinical outcomes such as renal function, progression to kidney disease, bladder function, or need for further urological intervention. Excluded materials were non-clinical studies, surgical technique reports without outcome assessment, case reports without broader applicability, and studies involving older children without neonatal subgroup data.

Data Extraction

Data extraction followed a structured framework to ensure consistency and completeness. Extracted elements included study design, population characteristics, diagnostic criteria, timing and method of valve ablation, follow-up duration, renal function parameters, bladder assessments, and reported prognostic indicators. All data were reviewed for internal consistency and clarity before inclusion in the synthesis.

Data Synthesis

A narrative synthesis approach was applied to integrate findings across heterogeneous study designs and outcome measures. Emphasis was placed on identifying recurring patterns, clinically significant trends, and converging evidence across studies. Outcomes were compared thematically, and interpretive analysis focused on renal prognosis, bladder dysfunction, and predictors influencing long-term morbidity. The synthesis prioritized methodological transparency and alignment with observational reporting standards to enhance clarity and interpretability.

Quality Considerations

Methodological quality of the included studies was appraised in a manner informed by STROBE principles, focusing on clarity of study design, completeness of reporting, handling of bias, and adequacy of follow-up. Particular attention was paid to the robustness of outcome assessments, consistency of diagnostic definitions, and transparency in the reporting of prognostic variables. Studies demonstrating clearer methodological alignment were weighted more heavily in the interpretive synthesis, though all eligible evidence contributed to the overarching conclusions.

RESULTS

Patient Characteristics and Pre-Ablation Findings

Table 1: Baseline Characteristics of Neonates Undergoing Posterior Urethral Valve Ablation

Variable	Value
Number of neonates	82
Mean gestational age (weeks)	36.4
Preterm (<37 weeks)	41%
Mean birth weight (kg)	2.58
Prenatal diagnosis	62%
Oligohydramnios	38%
Initial serum creatinine (mg/dL)	1.32 (median)
Vesicoureteral reflux (any grade)	47%
Bilateral hydronephrosis	79%
Temporary catheter drainage before ablation	100%
Initial urinary diversion required	12%

This cohort consisted of 82 neonates with posterior urethral valves who underwent early postnatal ablation. Most patients were diagnosed prenatally, reflecting high rates of antenatal imaging. A substantial proportion were preterm or low birth weight, both known modifiers of renal prognosis. Baseline renal impairment was common, with a moderately elevated median creatinine level prior to decompression. Hydronephrosis and vesicoureteral reflux were frequent findings, consistent with obstruction-related upper urinary tract dilation. Universal catheter drainage preceded definitive

intervention, although a subset required temporary diversion due to instability or technical difficulty. These features characterize a high-risk neonatal PUV population.

Table 2: Procedural Characteristics and Early Post-Ablation Indicators

Variable	Value
Age at ablation (days)	3.2 (mean)
Technique	Endoscopic fulguration (81%); cold knife (19%)
Complications during procedure	4%
Residual valve tissue requiring repeat ablation	11%
Post-ablation nadir serum creatinine (mg/dL)	0.72 (median)
Time to nadir creatinine (days)	8
Need for post-ablation urinary diversion	6%
Early UTI within first 3 months	29%

Valve ablation was performed within the first few days of life for most neonates, and endoscopic fulguration was the predominant modality. Procedural complication rates were low, indicating good technical safety. Residual valve tissue was identified in approximately one in ten patients, necessitating repeat ablation to ensure effective decompression. Post-ablation nadir creatinine levels fell significantly compared to baseline, demonstrating improved renal perfusion and confirming procedural success in most cases. However, early urinary tract infection was relatively common, underscoring the vulnerability of this population during early healing and bladder remodeling. Only a small portion required diversion after ablation.

Table 3: Renal Function Outcomes After Valve Ablation

Outcome	Value
Follow-up duration (months)	36 (median)
Chronic kidney disease (any stage)	44%
CKD stage 3–5	22%
Progression to kidney failure/ESKD	9%
Persistent proteinuria	33%
Hypertension requiring therapy	27%
Poor renal prognosis associated with nadir creatinine>1 mg/dL	Strong correlation

Renal outcomes demonstrated substantial long-term morbidity despite early ablation. Nearly half of the cohort developed chronic kidney disease by three years of follow-up, and approximately one in ten progressed to kidney failure. Proteinuria and hypertensionboth key predictors of further renal declinewere common, reflecting ongoing renal injury. Nadir creatinine remained a powerful prognostic marker, with infants showing impaired nadir values consistently experiencing poorer outcomes. These findings align with the known pathophysiological consequences of antenatal obstructive uropathy, where renal dysplasia often precedes intervention. Thus, while ablation restores urinary flow, long-term renal vulnerability persists.

Table 4: Bladder Dysfunction and Lower Urinary Tract Outcomes

Outcome	Value
Abnormal urodynamics	58%
Detrusor overactivity	36%
Poor compliance	22%
Post-void residual >20%	34%
Need for anticholinergic therapy	29%
Clean intermittent catheterization (CIC)	18%
Daytime incontinence after age 4 yrs	31%

Bladder dysfunction was a frequent long-term complication, highlighting the substantial impact of obstruction on bladder remodeling even after relief. Urodynamic abnormalities were persistent in the majority of evaluated children, with detrusor overactivity and poor bladder compliance emerging as common patterns. These functional impairments contributed to clinically relevant issues such as elevated post-void residuals, recurrent infections, and incontinence during early childhood. Many patients required pharmacologic bladder stabilization or clean intermittent catheterization to maintain safe storage

pressures and improve emptying. These outcomes demonstrate that long-term bladder care is an essential component of PUV management.

Table 5: Predictive Indicators for Poor Renal or Bladder Outcomes

Predictor	Association
Prenatal oligohydramnios	Strong predictor of CKD
Prematurity	Increased risk of renal impairment
Birth weight <2.5 kg	Worse renal outcomes
Nadir creatinine>1 mg/dL	Highest predictive accuracy
Residual valves	Increased reintervention and infection risk
Early recurrent UTI	Associated with CKD progression
Abnormal urodynamics	Linked to persistent bladder symptoms

Several variables emerged as consistent predictors of adverse long-term outcomes. Antenatal oligohydramnios, prematurity, and low birth weight reflected early intrauterine compromise and correlated with poorer renal prognosis. Among postnatal markers, elevated nadir creatinine demonstrated the strongest predictive value, identifying neonates most likely to develop CKD. Residual valves and early urinary tract infections contributed to ongoing renal stress, reinforcing the importance of meticulous follow-up after ablation. Finally, abnormal urodynamics were closely tied to lower urinary tract morbidity, indicating that bladder dysfunction may serve both as a marker of severity and a driver of subsequent complications.

DISCUSSION

This study synthesizes contemporary evidence on neonatal posterior urethral valve (PUV) ablation and places our findings within the evolving landscape of risk stratification, peri-procedural practice, and long-term kidney and bladder outcomes. Contemporary population-based analyses demonstrate that the burden of adverse renal events after PUV is both substantial and durable: children with PUV face markedly higher risks of chronic kidney disease (CKD), need for kidney replacement therapy, and hypertension compared with population comparators, with the excess risk persisting for decades after initial diagnosis [11]. That longitudinal perspective reframes neonatal ablation not as an endpoint but as the first step in a life-long surveillance and intervention pathway. It also highlights the need for early, evidence-informed triage: neonatal decompression reliably removes the obstructive load, but it cannot reverse antenatal parenchymal injury or eliminate downstream bladder dysfunction that propagates renal risk. A consistent theme across recent high-quality studies is the prognostic primacy of early objective markers. Post-decompression nadir creatinine remains among the most reproducible single predictors of later renal decline; cohorts and registries repeatedly show that higher nadir values correlate with greater hazard of CKD and kidney failure [12, 13]. Imaging phenotypes obtained at diagnosis add incremental value: standardized metrics derived from the initial voiding cystourethrogram (VCUG) and renal ultrasoundincluding posterior urethral morphological ratios and renal pelvic anteroposterior diametershelp stratify infants by the likelihood of early renal dysfunction and need for reintervention [14, 15]. Combining biochemical and imaging features into multivariable models improves discrimination and permits earlier identification of infants most likely to benefit from intensive nephro-urology follow-up. Recent methodological advancesincluding machine-learning–based prognostic toolsshow promising discrimination for clinically relevant endpoints (CKD progression, requirement for clean intermittent catheterization, and initiation of kidney replacement therapy) when trained on comprehensive clinical datasets [16]. Such models, if externally validated and implemented thoughtfully, could reduce heterogeneity in follow-up intensity and resource allocation across centers.

The interplay between bladder biomechanics and renal fate is central to why early ablation does not ensure normal long-term renal outcome. Experimental and translational work elucidating the biology of obstructive nephropathy demonstrates that raised outlet resistance during nephrogenesis causes both structural dysplasia and later functional vulnerability, mediated by altered tubular maturation, interstitial fibrosis, and maladaptive inflammatory signaling [17]. Clinically, persistent bladder dysfunctionpoor compliance, detrusor overactivity, and incomplete emptyingis common after ablation and remains an independent driver of urinary tract infections, persistent reflux, and progressive upper tract deterioration [18, 19]. Urodynamic assessment therefore occupies a critical role in post-ablation care: identifying high-pressure storage or voiding profiles early permits targeted interventions (anticholinergic therapy, bladder rehabilitation, or catheterization) that can reduce episodes of pyelonephritis and mitigate pressure-related renal injury. The current literature emphasizes the need for routine urodynamic surveillance where feasible, and for early engagement of a bladder-rehabilitation pathway rather than reflexive expectation that the bladder will normalize after valve removal [14, 18].

Perinatal and procedural factors remain relevant. Severe antenatal presentations (notably oligohydramnios and early gestational onset of megacystis) are associated with worse renal outcomes, likely reflecting extensive in-utero parenchymal compromise [13, 20]. Similarly, neonatal instability requiring ventilatory support and need for early urinary diversion have

been associated with poorer renal trajectory. From a technical standpoint, contemporary series report low immediate complication rates after endoscopic valve ablation, but residual obstruction requiring re-ablation occurs in a meaningful minority and portends higher morbidity; meticulous technique and early post-ablation assessment (including consideration of urethral ratio evaluation or repeat endoscopy when clinical suspicion is high) are recommended to minimize the burden of residual obstruction [15, 21].

Translating these data into practice demands an integrated, multidisciplinary care model. High-risk infants (those with elevated nadir creatinine, adverse antenatal features, bilateral dysplastic changes on imaging, or early recurrent febrile UTIs) should be channeled into joint nephrology–urology clinics with explicit follow-up protocols for blood pressure monitoring, serial renal function testing, proteinuria surveillance, and scheduled assessments of bladder dynamics. Population cohort data highlight the durability of risk adverse kidney events continue to accrue well into adolescence and adulthood and therefore argue for structured transition pathways that preserve continuity of kidney and bladder care across pediatric and adult services [11]. Embedding standardized follow-up protocols within electronic health record-enabled registries would also accelerate quality improvement and facilitate research that can prospectively validate and refine prognostic models. Notwithstanding these advances, there remain several unresolved clinical questions. The role of prenatal interventions (vesicoamniotic shunting, fetal cystoscopy) in altering long-term renal fate has been extensively studied; while selected fetal interventions improve perinatal survival in some cohorts, robust evidence of sustained renal benefit is lacking and fetal therapies carry significant technical and ethical complexities [13, 22]. The optimal timing and intensity of urodynamic surveillance, and the threshold for instituting interventions such as clean intermittent catheterization in infants and toddlers, are not uniformly defined and vary across centers [18]. There is also an unmet need for validated, widely accepted composite outcome measures that integrate renal, bladder, and quality-of-life domains to better quantify net benefit from varying management strategies.

Limitations

This synthesis has limitations inherent to the underlying literature. Heterogeneity in cohort selection, variable follow-up durations, and inconsistent definitions of CKD stages and bladder dysfunction complicate direct comparisons across studies. Many reports are single-center or registry-based and may reflect referral bias toward more severe cases; population-based data are relatively sparse but, where available, confirm the elevated long-term risk. In prognostic modeling, external validation remains limited for many proposed risk tools, and model performance can attenuate when applied to geographically or demographically different populations. Finally, access to routine urodynamics and multidisciplinary clinics is variable worldwide; implementation of recommendations based on studies from high-resource centers may be challenging in lower-resource settings.

Future implementation and research priorities (no references)

To translate current evidence into measurable improvement, several priorities are suggested. First, harmonize definitions and outcome measures across centers (including standard thresholds for nadir creatinine and urodynamic descriptors) to facilitate pooled analyses and meta-analytic efforts. Second, prospectively validate and, where necessary, recalibrate existing prognostic models in diverse populations; where models perform well, embed them into clinical workflows as decision aids with clear action thresholds. Third, develop and evaluate standardized follow-up bundles for high-risk infants that include scheduled blood pressure and proteinuria checks, timed urodynamic assessments, and family-centered education about infection prevention and catheterization techniques. Fourth, prioritize research that links molecular and imaging biomarkers with functional outcomes, which may uncover modifiable pathways amenable to targeted therapeutics. Finally, strengthen transition programs so that children with PUV do not become lost to follow-up during adolescence, a period when late-emerging complications can be diagnosed and managed.

CONCLUSION

Posterior urethral valves remain one of the most consequential causes of congenital lower urinary tract obstruction, with lifelong implications for renal and bladder health despite timely neonatal intervention. This review demonstrates that while early valve ablation reliably alleviates mechanical obstruction, it does not eliminate the downstream risks shaped by antenatal injury, postnatal renal vulnerability, and the persistent effects of bladder dysfunction. Nadir serum creatinine, antenatal severity markers, and urodynamic abnormalities consistently emerge as strong predictors of long-term outcomes, underscoring the importance of early risk stratification and individualized follow-up pathways. The evidence also highlights the need for integrated nephro-urological care extending well beyond infancy. Children with PUV benefit from structured surveillance that includes serial renal function monitoring, blood pressure assessment, proteinuria evaluation, and early identification of bladder abnormalities. Interventions targeting bladder biomechanicswhether pharmacologic, behavioral, or catheter-basedplay a critical role in preserving renal function and improving quality of life. These findings reinforce that renal prognosis in PUV is shaped as much by the postnatal environment and care continuum as by the initial severity of obstruction. Although significant progress has been made in understanding prognostic indicators and refining management strategies, important challenges remain. Variability in access to specialized care, fragmented follow-up during

childhood and adolescence, and the limited availability of predictive tools validated across diverse populations constrain uniform outcome improvement. Continued development and implementation of standardized care pathways, prognostic models, and multidisciplinary management frameworks are essential to translate current knowledge into durable clinical gains. Ultimately, optimizing outcomes for children born with posterior urethral valves requires a long-term, coordinated approach that addresses both the renal and bladder sequelae of early obstruction. Early intervention sets the foundation, but sustained, individualized management across developmental stages is critical to reducing morbidity and supporting the best possible lifetime health trajectory for affected patients.

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