Original Article

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Factors Affecting Outcome of Posterior Urethral Valve in Children Underwent Valve Ablation

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Abstract

Background: Posterior Urethral Valve (PUV) is a congenital anomaly and the leading cause of chronic renal disease in boys. Several factors, such as age at presentation, high nadir serum creatinine, severe Vesicoureteric Reflux (VUR) recurrent UTIs, renal dysplasia, hypertension, albuminuria, growth failure, and primary therapy choice, are associated with poor long-term outcomes. However, studies on PUV in Bangladesh are limited. This study aimed to find out the factors affecting outcome of Posterior Urethral Valves (PUV) in children.

Materials and methods: This prospective observational study was conducted at the Department of Pediatric Surgery, Chittagong Medical College Hospital (CMCH) Chattogram, Bangladesh, from April 2023 to September 2024. A total of 27 Children aged between 1 day to 12 years having posterior urethral valve were included. Age, type of valve, type of surgery, operating time, symptoms, presence of VUR, UTIs, Serum creatinine, anterior and posterior urethral ratio in micturating cystourethrogram were recorded and risk factors for adverse outcome and mortality were analysed.

Results: The mean age of participants was 33.65±36.30 months, with 63% being children, 29.6% infants and 7.4% newborns. Type I posterior urethral valves were found in 88.9%, while 11.1% had Type III. Surgery types included valve fulguration (55.6%) and resection (44.4%) with a median operation duration of 22 minutes. Post-operative improvements were significant: dribbling of urine reduced from 85.2% to 20.8% ($p < 0.001$) recurrent UTIs from 59.3% to 12.5% ($p = 0.001$), and VUR from 51.9% to 11.1% ($p = 0.008$). Serum creatinine decreased from 0.9 mg/dL to 0.5 mg/dL ($p < 0.001$), and the posterior-to-anterior urethral ratio improved from 2.50 to 2.0 ($p < 0.001$). Overall, 88.9% of patients showed improvement, though 11.1% (n=3) died, with no significant factors associated with mortality. There were no significant differences in outcomes between the two surgical approaches ($p>0.05$).

Conclusion: Surgical intervention in posterior urethral valves resulted in significant improvements in urinary symptoms and renal function, with no single factor linked to poor outcomes, highlighting the need for comprehensive management.

Key words: Children; Posterior urethral valve; Valve ablation.

Introduction

Posterior Urethral Valve (PUV) is a congenital anomaly of proximal urethral development that is characterized by abnormal urethral membranes leading to obstruction in the outflow of urine with varying degrees of urinary tract dysfunction. PUV is the most common cause of chronic renal disease in boys.[1] Studies from various parts of the world have shown that several factors, including age at presentation, nadir serum creatinine greater than 1.0 mg/dl, Vesicoureteric Reflux (VUR) grade 3 or higher at diagnosis, recurrent febrile UTIs, renal dysplasia, bladder dysfunction, hypertension, albuminuria, growth failure and primary therapy choice, are linked to a long-term poor prognosis.[2,3,4]

It is of great importance to manage PUV meticulously as it commonly causes Chronic Kidney Disease (CKD) which is a significant burden for individuals, health care systems and societies; since it is associated with increased hospitalization, a high-cost treatment, productivity loss, morbidity and early mortality. There is often a delayed diagnosis of PUV due to lack of suspicion from the primary physician which make the outcome worse. Hence, regardless of measures available, some cases do not respond and progress to end-stage renal failure eventually. Long-term studies in children with PUV clearly show that delay in diagnosis and therefore the relief of obstruction lead to poorer renal and overall outcomes.

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With the potential for the high incidence and significant morbidity and reduced quality of life in children with PUV, it is essential to manage PUV with interventions that are indeed effective. Data are still inconclusive even with multiple interventional study in Bangladesh regarding the factors affecting outcome of PUV in children. For this reason, this study was conducted to find out the factors affecting outcome of Posterior Urethral Valves (PUV) in children.

Materials and methods

This was a prospective observational study conducted at the Department of Paediatric Surgery, Chittagong Medical College Hospital (CMCH) Chattogram, Bangladesh, from April 2023 to September 2024. A total of 27 Children aged between 1 day to 12 years having posterior urethral valve were included. A convenient sampling method was applied. Patients who had previous valve ablation, who underwent cutaneous vesicostomy before enrolment in the study and who had other major significant congenital anomaly (Major cardiac, renal, spinal and anorectal anomalies) were excluded. Independent variables were age of presentation, antenatal diagnosis, body mass index, H/O culture positive urinary tract infection, proteinuria, Haemoglobin percentage, S. creatinine at admission, grade of VUR, Posterior and anterior urethra ratio on MCU and type of surgery. Dependent variables were overall outcome: improved, not improved, deteriorated, death, complications such as sepsis, stricture, UTI and persistence of symptoms of PUV.

Clinical evaluation of age at presentation, history of poor urine flow, dribbling of urine, recurrent UTI, height, weight and blood pressure. Initial management involved continuous per urethral catheter drainage of the bladder using a Foley's catheter or feeding tube under strict aseptic conditions. Hemoglobin percentages, serum creatinine, urine microscopy, culture and sensitivity tests were performed. Radiological investigation such as Micturating Cystourethrogram (MCU) was carried out. MCU findings showing a dilated, elongated, or tortuous posterior urethra were considered confirmatory for diagnosis. After diagnosis, patients underwent primary fulguration or resection, with the specific procedure chosen by the surgeon.

Follow-up assessments were conducted over the next six months, with clinical, biochemical and radiological improvements recorded at 2 weeks, 3 months, and 6 months post-surgery. At the 2-week follow-up, urinary dribbling, evidence of UTI, blood pressure, and serum creatinine levels were checked. After 3 months, urinary dribbling, UTI evidence, blood pressure, serum creatinine, and urine culture sensitivity were evaluated. After 6 months, urinary dribbling, UTI evidence, blood pressure, serum creatinine, urine culture sensitivity and an MCU were rechecked. Outcome was considered "Improved" if any of following two occurs-reduction in Serum creatinine level and reduction in dilatation of posterior urethra in MCU.

After collection of all the required data, these were checked, verified for consistency and tabulated using the SPSS version 26 (IBM Corp., Armonk, NY). Frequencies and percentages were calculated as summary measures for the qualitative variables.Arithmetic mean, standard deviation, median and inter-quartile range were used to describe the quantitative variables. Comparison between during enrolment and after 6 months of surgery were done by Wilcoxon Signed Rank test for continuous variables, and by McNemar's chi-square test for categorical variables.Binomial logistic regression to detect risk factors for adverse outcome. A 'p' value <0.05 was considered as statistically significant.

The study was approved by the ethical review committee of Chittagong Medical College (Memo no: 59.27.0000.013.19.PG.009.2023/1000).

Results

The mean age of the participants was 33.65±36.30 months (Median 18 months) ranging from 28 days-11 years. Maximum participants were children (63%) while 29.6% were infant and 7.4% were newborn. Only 3.7% were premature, with 96.3% being full-term. Regarding birth weight, 22.2% were classified as Low Birth Weight (LBW) and 77.8% had normal birth weight. Antenatal diagnosis of posterior urethral valves was present in 7.4% of cases, while 92.6% had no antenatal diagnosis. Delayed referral (59.3%) was the most common cause of delayed hospitalization.

88.9% had Type I posterior urethral valves, while 11.1% had Type III, with no cases of Type II. In

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terms of surgery type, 55.6% underwent valve fulguration, and 44.4% underwent resection. The median duration of operation was 22 minutes, with an Interquartile Range (IQR) of 20 to 25 minutes.

The pre- and post-operative assessment of clinical manifestations in the 27 children revealed marked improvement after surgery (Table I). Dribbling of urine decreased significantly from 85.2% at enrolment to 20.8% after 6 months ($p < 0.001$), while poor urine flow, initially seen in 74.1% of patients, completely resolved post-operatively. Recurrent urinary tract infections decreased from 59.3% to 12.5% after surgery ($p = 0.001$).

Table I Pre- and post-operative assessment of clinical manifestations (n=27)

Symptoms	During enrollment (n=27) n (%)	After 6 months of surgery (n=24) n (%)	p-value$^{\alpha}$
Dribbling of urine	23 (85.2%)	5 (20.8%)	<0.001
Poor Flow	20 (74.1%)	0 (0.0%)	-
Fever	25 (92.6%)	3 (12.5%)	<0.001
Difficulty in micturition	23 (85.2%)	1 (4.2%)	<0.001
Abdominal or flank pain	11 (40.7%)	0 (0.0%)	-
Respiratory distress	2 (7.4%)	0 (0.0%)	-
Failure to thrive	11 (40.7%)	1 (4.2%)	0.004
Recurrent UTI	16 (59.3%)	3 (12.5%)	0.001

p-value was determined by $^{\alpha}$McNemar's chi-square test.

The median BMI improved from 14.65 kg/m2 to 16.40 kg/m^2 ($p < 0.001$). Haemoglobin levels also increased significantly from 10.80 g/dL to 11.15 g/dL ($p = 0.001$). Serum creatinine levels dropped significantly from a median of 0.9 mg/dL (IQR 0.6-1.9) to 0.5 mg/dL (IQR 0.4-0.6) ($p < 0.001$). Proteinuria decreased from 59.3% at enrolment to 29.2% post-operatively ($p = 0.031$) and positive urine culture findings (bacterial growth) reduced from 44.4% to 20.8%, although this change was not statistically significant ($p = 0.180$).

The pre- and post-operative assessment of MCU (Micturating Cystourethrogram) and VUR (Vesicoureteral Reflux) in the 27 children shows significant improvement after surgery. The median posterior to anterior urethra ratio decreased from 2.50 (IQR 2.0-3.0) at enrolment to 2.0 (IQR 1.75-2.15) after 6 months of surgery ($p < 0.001$). VUR was present in 51.9% of children before surgery, but this dropped significantly to 11.1% post-operatively ($p = 0.008$). Conversely, the absence of VUR increased from 48.1% at enrolment to 77.8% after surgery. Overall, the results show a marked improvement in both MCU measurements and VUR status following the surgical intervention.

The overall outcomes for the 27 study participants showed that 88.9% (n=24) experienced improvement after surgery. Among them, 66.67% (n=18) showed a decrease in both creatinine levels and MCU ratio. In 14.81% (n=4), only creatinine levels decreased, while in 7.41% (n=2) only the MCU ratio decreased. However, 11.1% (n=3) of the participants died during the study period.

There were no significant differences in outcomes between fulguration (n=15) and resection (n=12) procedures for treating posterior urethral valves, six months post-surgery (Table II).

Table II. Outcome (after 6 months of surgery) comparison between fulguration and resection of posterior valve urethra (n=27)

	Fulguration (n=15) n (%)/Median (IQR)	Resection (n=12) n (%)/Median (IQR)	p-value
S. creatinine			
Before surgery	0.86 (0.6-1.5)	1.25 (0.6-2.46)	0.256*
After 6 months	0.50 (0.4-0.6)	0.5 (0.3-0.6)	0.820*
P-A ratio			
Before surgery	2.66 (2.0-3.5)	2.37 (2.0-2.88)	0.323*
After 6 months	2.0 (2.0-2.23)	1.8 (1.6-2.0)	0.150*
Dribbling of urine			
Before surgery	13 (86.7)	10 (83.3)	1.0**
After 6 months	1 (6.7)	4 (33.3)	0.142**
Fever			
Before surgery	14 (93.3)	11 (91.7)	1.0**
After 6 months	3 (20.0)	0 (0.0)	0.223**
Difficulty in micturition			
Before surgery	13 (86.7)	10 (83.3)	1.0**
After 6 months	1 (6.7)	0 (0.0)	1.0**
Recurrent UTI			
Before surgery	9 (60.0)	7 (58.3)	1.0**
After 6 months	2 (13.3)	1 (8.3)	1.0**
Growth in culture			
Before surgery	8 (53.3)	4 (33.3)	0.441**
After 6 months	3 (20.0)	2 (16.7)	1.0**
In-hospital outcome			1.0**
Improved	13 (86.7)	11 (91.7)	
Death	2 (13.3)	1 (8.3)	

p-value was determined by *Mann-Whitney U test and **Fisher's exact test.

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The analysis of factors associated with outcomes in 27 children revealed no statistically significant associations (Table III). Patients who improved had a median age of 5.5 months and a median pre-operative BMI of 14.69 kg/m^2, compared to 0.67 months and 12.44 kg/m^2 in those who died. All deaths occurred in patients with Type I valves, and pre-operative serum creatinine and haemoglobin were higher in those who died, though these differences were not significant. Vesicoureteral reflux and proteinuria were present in all patients who died, but no factor showed a significant association with outcome.

Table III Factors associated with outcome (n=27)

	Improved (n=24) n (%)/Median (IQR)	Died (n=3) n (%)/Median (IQR)	COR (95%CI)	p-value
Age of presentation (Month)	5.50 (1.0-25.0)	0.67 (0.23-0.67)	1.01 (0.98-1.04)	0.376
Pre-operative BMI (Kg/m^2)	14.69 (11.97-16.48)	12.44 (10.30-12.44)	0.91 (0.61-1.36)	0.655
Type of Valve				
Type I	21 (87.5)	3 (100)	-	1.0
Type III	3 (12.5)	0 (0.0)	(Ref)	
Type of surgery				
Fulguration	13 (54.2)	2 (66.7)	1.69 (0.14-21.27)	0.684
Resection	11 (45.8)	1 (33.3)	(Ref)	
Pre-operative haemoglobin	10.75 (9.32-11.47)	12.80 (8.10-12.8)	1.63 (0.90-2.9)	0.106
Pre-operative s. creatinine	0.78 (0.6-1.5)	2.1 (1.9-2.1)	1.48 (0.89-2.45)	0.131
Pre-operative proteinuria	13 (54.2)	3 (100)	-	1.0
Pre-operative P-A ratio	2.5 (2.0-3.0)	2.25 (2.0-2.25)	0.84 (0.25-2.81)	0.774
Pre-operative VUR				
Reflux	11 (45.8)	3 (100)	-	1.0
No reflux	13 (54.2)	0 (0.0)	(Ref)	

p-value was determined by *Binomial logistic regression.

Discussion

The cohort was predominantly composed of children (63%) with 29.6% classified as infants and 7.4% as newborns. The mean age of the participants was 33.65±36.30 months, suggests that patients with this condition present late in our circumstances. A previous Bangladeshi study by Biswas and Chakraborty found that 50% of the patients were aged between 1 month to 1 year, followed by 36% were more than 1 years old and 14% were less than 1 month old.[5] Another Bangladeshi study by Karim et al. observed that the median age of patients was 2 years.[6] Similar findings were also noted in previous studies in Africa in which maximum of patients were presented after the age of 1 year.[7,8] In-contrast, a Pakistani study by Yamin et al. found that the majority of patients (73.3%) were below six months of age, between six to 12 months were 16.6% and 10% were above one year.[9] Several authors have discussed that late presentation is common among the patients of PUV in developing countries. The cause is not only negligence but also partly due to continuous use of diapers not allowing parents to notice the symptoms of PUV early.[5,10,11]

While the diagnosis of PUV can be made prenatally, only 7.4% of the study patients were diagnosed prenatally.[12,13] Negative attitude, long distances to service providers, considerably heavy financial cost are major barriers to prenatal ultrasound.[8] Voiding dysfunction was the most common reason for presentation. This is in keeping with findings from many other studies in the literature.[14,15] In this study, serum creatinine levels decreased from 0.9 mg/dL to 0.5 mg/dL (IQR, showing improved renal function and reduced blockage, crucial for preventing long-term kidney damage. This is in accordance with the other studies.[6,15]

Recurrent UTIs decreased from 59.3% to 12.5% ($p = 0.001$) supporting the hypothesis that correcting the obstructive pathology of PUV can significantly reduce infection risk. Although the drop in positive urine cultures in my study (From 44.4% to 20.8%) was not statistically significant ($p = 0.180$) this trend indicates a potential decrease in urinary tract infections, which aligns with the observed clinical improvements. Like my study findings, Karim et al. also noticed that recurrent UTI before surgery 52.0% had urinary tract infections and during follow up it decreased to 24.0% at the end of 6 months.[6]

The median ratio of the posterior to anterior urethra reduced from 2.50 (IQR 2.0-3.0) at enrolment to 2.0 (IQR 1.75-2.15) six months following surgery ($p < 0.001$). This reduction implies that urethral dimensions have returned to normal, indicating that the obstructive pathology associated with PUV was successfully surgically corrected. Prior to surgery, 51.9% of children had Vesicoureteral Reflux (VUR) which dropped considerably to 11.1% afterward ($p = 0.008$). This significant reduction indicates that the surgical intervention effectively relieved the obstruction, allowing for better bladder drainage and lowering the danger of urine reflux into the ureters. In this

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study, all patients who died had vesicoureteral reflux. However, the role of VUR in PUV is still controversial. Some groups consider that high grade bilateral VUR significantly correlates with prognosis while others have not found any such correlation.[16-18]

In this study, 88.9% of the subjects (n=24) showed clinical improvement after surgery for Posterior Urethral Valves (PUV). Among those who improved, 66.67% (n=18) had lower blood creatinine levels and a lower P-A urethral ratio, showing that renal function and urinary tract structure had improved together. Likewise, Biswas and Chakraborty reportedrenal functional improvement in 60%.[5] However, 14.81% (n=4) of my study patients demonstrated a decrease in creatinine levels alone, whereas 7.41% (n=2) observed a reduction in the P-A urethral ratio but creatinine levels were within normal limit. This variation indicates that, whereas many patients benefited from overall improvements in their clinical condition, others saw isolated improvements in renal function or morphological parameters. However, mortality rate was found to be 11.1%. The survival figure of 88.9% in this study is almost similar compared to other centres in Asia (87.5%) and western world (96.2-100%).[19,20] In current study, patients who died had a much younger median age of 0.67 months and a lower median pre-operative weight of 2.3 kg. This shows that older, larger newborns may be more resilient and capable of recovering from the surgical complications associated with Posterior Urethral Valves (PUV). However, birth weight of the study patients did not carry a significant additional risk for patients with PUVs as regard the final outcome, which was also supported by Sarhan.[21]

In this study, no individual component was found as having a substantial impact with overall results. The lack of significant factors in this study might be due to the small sample size of only three deceased patients with no other cases of deterioration, which limited the statistical power needed to detect associations through regression analysis.

Limitations

The relatively small sample size may reduce the statistical power and generalizability of the findings. Conducting the study at a single centre may introduce selection bias, limiting the applicability of results to broader populations. The six-month follow-up period is insufficient to assess long-term renal function and outcomes in PUV patients. The study did not incorporate advanced renal function markers or post-operative quality of life assessments, limiting a comprehensive evaluation of patient recovery.

Conclusion

Surgical intervention, either fulguration or resection, led to significant clinical, biochemical, and radiological improvements in most patients, reducing symptoms like urinary dribbling, recurrent UTIs, and vesicoureteral reflux. No single factor was significantly associated with poor outcomes, emphasizing the need for comprehensive management in PUV cases.

Recommendations

Surgical intervention, through either fulguration or resection, is recommended for achieving significant clinical, biochemical and radiological improvements in patients. The choice should be tailored to individual patient needs for optimal outcomes. Prenatal screening for PUV is recommended to enable early diagnosis and prompt intervention, minimizing the risk of renal damage and improving long-term outcomes. Larger multicentre studies with long-term follow up should be conducted to increase the generalizability and reliability of the findings across diverse populations. Future research should include advanced renal function markers and assessments of quality-of-life post-surgery to better evaluate overall patient recovery and well-being.

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Contribution of authors

RF-Acquisition of data, data analysis, interpretation of data, drafting & final approval.
MKAS-Conception, design, interpretation of data, critical revision & final approval.
TKC-Conception, design, critical revision & final approval.

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Disclosure

All the authors declared no conflict of interest.

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