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Endosurgical treatment of newborns and young children with posterior urethral valves.

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Abstract

Objective: Posterior urethral valves are a rare but the most common cause of lower urinary tract obstruction in male newborns and infants. Patients are at high risk of recurrent urinary tract infections, acute kidney injury and chronic kidney disease. The aim of this study was to present our experience of transurethral incision of posterior urethral valves in newborns as a gold standard of treatment.

Materials and methods: We conducted a case-series of patients with posterior urethral valves who underwent transurethral incision during 2017–2021. We analyzed clinical characteristics of patients, recurrence, and complications during a follow-up of 3-12 months.

Results: Of 26 patients who underwent transurethral incision of posterior urethra valves 14 had concomitant vesicoureteral reflux of II-V degrees and 12 – obstructive megaureter. Eight children received endoscopic injections (7 ureters) and ureteral stenting (5 ureters). Six infants (9 ureters) had Cohen's operation of which 4 patients had ureteric reimplantation using laparoscopic pneumovesicum and 2 patients underwent open procedure. In 4 cases we performed laparoscopic nephroureterectomy. In 12 children a spontaneous regression of VUR and megaureter within 3 months after TUI were observed. Four children developed chronic kidney disease of 1-2 stages.

Conclusions: Early diagnosis and surgery treatment of posterior urethra valves in newborns and infants provide excellent outcomes in most patients. Cystourethroscopy with the transurethral incision is highly recommended to be performed in the neonatal period as the spontaneous recovery of concomitant vesicoureteral reflux and megaureter are quite often.

The Level of Evidence: IV.

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Introduction

Congenital anomalies of the kidney and urinary tract (CAKUT) occur in up to 20% of newborns with a detection rate of 5-8 per 1000 live births. Fetal lower urinary tract obstruction (LUTO) has a frequency of up to 21% and includes a number of disorders when urine outflow gets blocked. Posterior urethral valves (PUVs) and urethral atresia (UA) are the most common causes of LUTO in male newborns and infants (1-5). PUVs are observed more often as fetuses with UA mostly die in utero. When a developing baby's bladder voiding is blocked, the amount of amniotic fluid is reduced, the size of the bladder increases, and can cause many other severe complications such as acute kidney injury (AKI) and chronic kidney disease (CKD). Early diagnosis of this condition is extremely a must as up to 35-40% of infants with LUTO are at high risk of CKD and overactive or underactive bladder symptoms in the long run (3,6-10).

PUV is a condition that can be suspected during pregnancy and allows newborns to receive the necessary treatment immediately after birth. Antenatal symptoms of PUVs are lack or absence of amniotic fluid, large bladder which does not empty during ultrasound examination, posterior urethra dilation, dilation of ureters, and renal collecting system. Oligoamnios diagnosed earlier than at 21-22 weeks of gestation is an unfavorable sign indicating a high risk of renal failure or pulmonary hypoplasia of the fetus (11). Postnatal symptoms include dysuria or anuria within 24 hours after birth and an urinary catheter is to be inserted to empty the bladder. Also, there is a high risk of urinary tract infections (UTIs), common in newborns with PUVs.

Obstructive membranes that developed in the urethra were first described by the famous Italian surgeon and anatomist Morgagni in 1717. Velpeau was the first to suggest the term of posterior urethral valve similar to heart valves in 1832. And in 1919 Young described three anatomical types of PUVs: type I – valves representing folds extending inferiorly from the verumontanum to the membranous urethra; type II – bicuspid valves as leaflets radiating from the verumontanum proximally to the bladder neck; type III – valves as concentric diaphragms within the prostatic urethra, either above or below the verumontanum (**Figure 1**). Nowadays, many authors agree that the most common type of PUV is type I (95%), type III is less often (5%), and type II is not actually an obstacle to normal urine flow.

Materials and methods

We performed a case-series study approved by our institutional review board and ethics committee (Protocol №26, dated 10.01.2017) in patients with posterior urethral valves. We performed the procedure in one hospital – The National Medical Research Center of Children's Health (Moscow, Russia). All patients underwent cystoscopy with transurethral incision of posterior urethral valves between 2017 and 2021. We performed endoscopic dextranomer/hyaluronic acid or collagen injection in infants with vesicoureteral reflux using subureteral transurethral injection (STING) and hydrodistension implantation technique (HIT). Patients with megaureters underwent endoscopic ureteral stenting, and intravesical ureteric reimplantation (Cohen's operation) using laparoscopic pneumovesicum and laparoscopic nephroureterectomy. Since PUV in newborns is a rare but severe condition that requires endoscopic transurethral incision all endoscopic procedures were performed by senior surgeons. So the recovery rates are not to be affected by a lack of surgical experience. Preoperative workup included urinary catheter insertion, micturating cystourethrogram, kidney and bladder ultrasonography with Doppler, intravenous urography, contrast-enhanced multi-slice computed

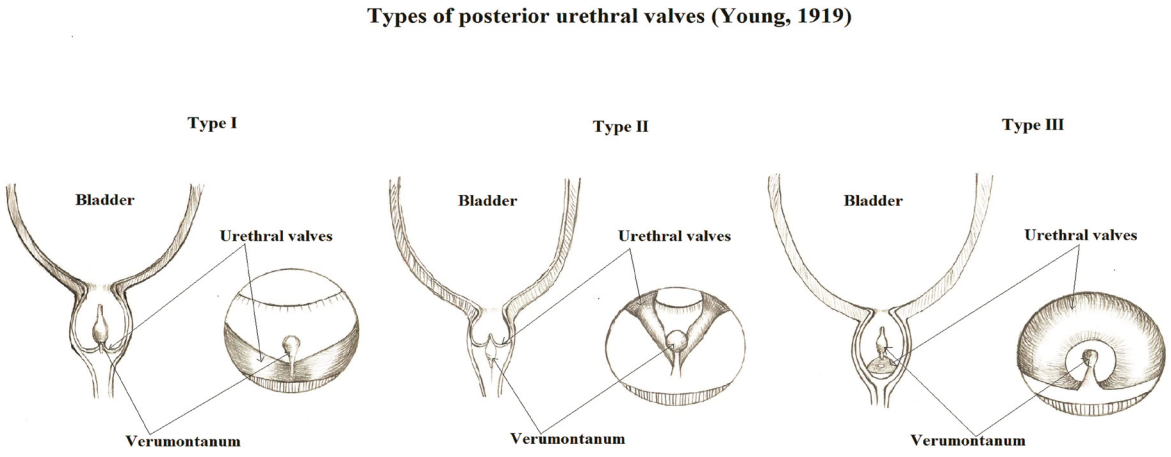

Figure 1: Types of posterior urethral valves (Young, 1919)

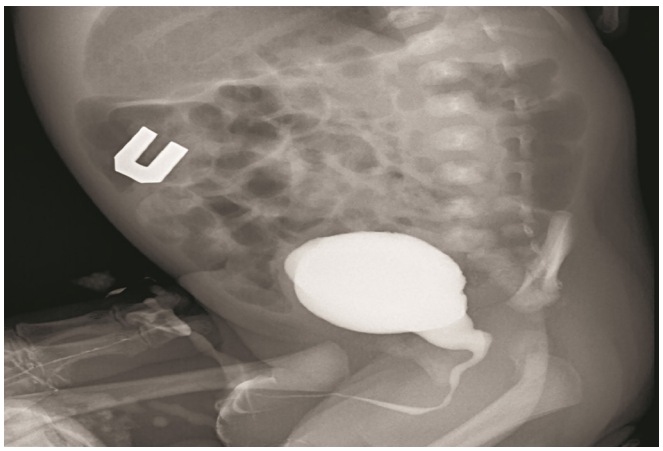

Figure 2: Micturating cystourethrography in a patient with posterior urethral valves

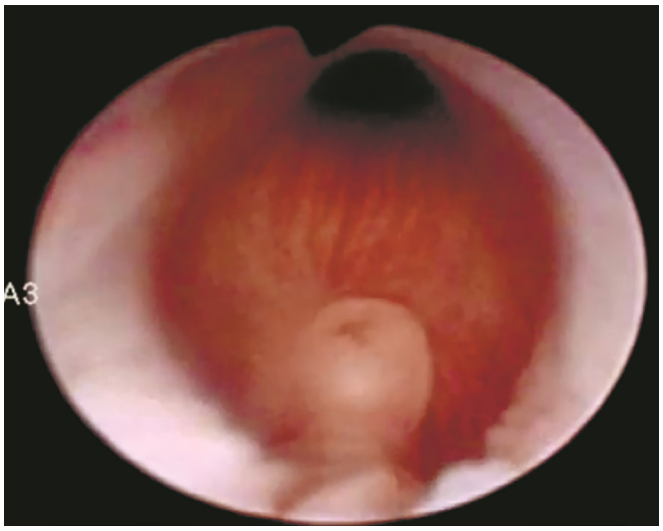

Figure 3: Cystourethroscopy in a patient with posterior urethral valves, Type 1

tomography, and static renal scintigraphy with 99mTc-DMSA. We performed MCUG using water-soluble contrast dye and normal saline diluted 1:1 in a volume of 40 ml which corresponded to the normal bladder volume of a newborn. A comprehensive chemistry panel and urinalysis were done, and renal function was monitored by glomerular filtration rate (eGFR per Schwartz). After surgery, a two-day bladder diary and ultrasound checks of residual urine were recorded. We analyzed age, time of operation, complications, concomitant urinary system disorders, recurrence, renal function, and bladder function. We also evaluated articles from PubMed centered on newborns and infants who underwent surgical treatment for PUVs published for the period of the last five years to determine the frequency of acute kidney injury and complications.

Results

Our cohort included 26 male newborns with suspected PUVs delivered to the National Medical Research Center of Children's Health, Surgical Department of Newborns and Infants from September 2017 to December 2021. The age at admission ranged from 10 to 60 days (mean 16,9±7) and two children were admitted at the age of 70 and 107 days after birth. The mean week of gestation was 38±1 and the mean body weight was 3452,7±541 g. In 20 patients, the diagnosis was suspected by antenatal ultrasound at 25-34 weeks of gestation, and 6 children had postnatal symptoms such as anuria within 24 hours after birth, ultrasound findings of unilateral or bilateral hydronephrosis, and megaureters. PUV was confirmed by MCUG (dilation of posterior urethra, **Figure 2**). All patients underwent renal and bladder ultrasonography (US) with Doppler, intravenous urography or contrast-enhanced MSCT. Static renal scintigraphy with 99mTc-DMSA was performed after 21 days of age if required. A large retroperitoneal cyst was diagnosed in one infant after birth, which required percutaneous puncture (under ultrasound control), and drainage for 5 days and was treated as urinoma with no further recurrence. In our study, 6 patients had their eGFR per Schwartz extremely low and suffered from acute kidney injury with blood urea >15mM/L, creatinine >200μM/L, nephrogenic hypertension, and metabolic acidosis. These patients received AKI therapies before MCUG and further transurethral incisions were performed in order to improve renal function, and diuresis and achieve target rates of blood urea and creatinine.

All children in our study underwent cystourethroscopy with transurethral incision (TUI) of posterior urethral valves. We used a pediatric cysto-urethroscope and resectoscope 9 Fr. (KARL STORZ, Germany). Straightforward telescope 0º and unipolar cutting loop were a must. The posterior urethra was examined and the cutting loop helped to detect and coagulate valves at 4-5 and 7-8 o'clock positions (**Figure 3 and 4**). We found type 1 PUV in 24 patients, and type 3 in 2 children. All patients with type 3 PUV suffered from acute kidney injury in their early neonatal period. No intraoperative complications were observed. The mean operation time was 18,2±7 min. Postoperatively the bladder was drained by Foley catheter Ch/Fr: 8 left in for 5-7 days. After the Foley catheter was removed a two-day bladder diary was recorded. Parameters of our interest included urination frequency (UF), maximum and average volumes of urine (MVV and AVV), and fluid intake. Also, three ultrasound scans to check residual urine were performed after voiding (during 4-6 hours). This procedure helped to diagnose severe bladder exertion disorders. None of such was found in our study: AVV was 20-30 ml, UF was every 30-40 min, and residual urine ≥5-7 ml. All patients were discharged with no postoperative complications. Rehabilitation therapy and physiotherapy were

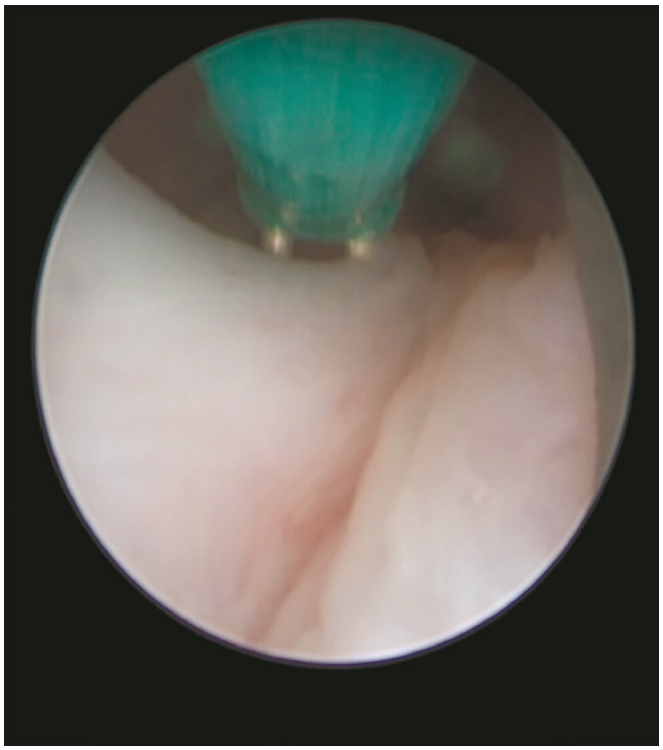

Figure 4: Transurethral incision in a patient with posterior urethral valves

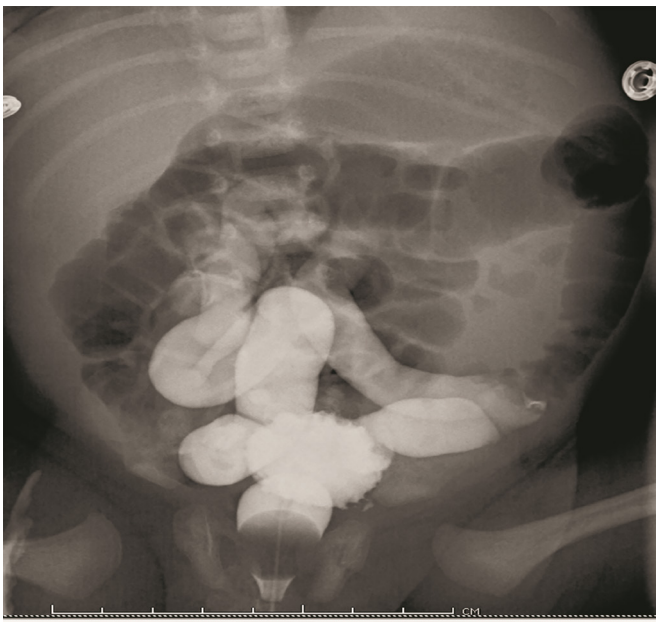

Figure 5: Micturating cystourethrography in a patient with posterior urethral valves and bilateral vesicoureteral reflux

recommended in order to improve urodynamics and reduce possible renal scarring.

In our study, all patients had PUVs combined with other congenital malformations of the urinary system (**Figure 5**). Fourteen patients had vesicoureteral reflux (VUR) of II-V degrees (22 ureters), of which 5 children (7 ureters) underwent endoscopic dextranomer/

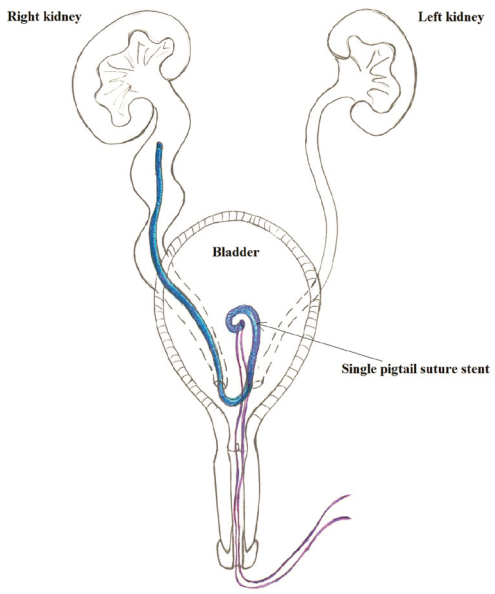

Figure 6: Position of a single pigtail suture stent in the bladder

hyaluronic acid or collagen injections. We used STING and HIT procedures. Meanwhile, 6 children (11 ureters) had spontaneous regression of VUR after TUI. Obstructive megaureter was found in 12 children (18 ureters), of which 3 children (5 ureters) underwent endoscopic ureteral stenting. We used a single pigtail suture stent Ch/Fr: 5, 6 cm (MIT, Russia) left in for 35-47 days (**Figure 6**). Excellent and good outcomes such as reduced dilation of the renal collecting system and ureters were registered after stents were removed. Ultrasound follow-up and stent removal were performed on an outpatient basis. No stent-related symptoms were observed in this group.

Intravesical ureteral reimplantation (Cohen's operation) was performed in 6 children (9 ureters) aged 4-6 months. Four of them were operated on using laparoscopic pneumovesicum and two patients required open procedure due to severe VUR and one functioning kidney. Recurrent UTIs, VUR of 5 degrees, ureter obstruction confirmed by IVU, as well as failure to stent ureters because of a severe stenosis were indications for surgery. Three infants with UVR were operated on due to ureteral diverticulum which gave no way to make endoscopic correction of UVR. Bilateral Cohen's operation was performed in 1 patient. We started with a cystoscopy checking bladder mucosa, detrusor, and ureteral orifices. Severe inflammation was a contraindication for surgery, but we found none of such in our study. The bladder was filled up with normal saline and the first trocar was placed, then the bladder was fixed to the abdominal wall with one suture using Tuohy epidural needle 18G (a procedure similar to video-assisted percutaneous inguinal hernia

repair). It was essential to place the camera trocar into the bladder dome along the midline as cranial as possible not to damage the peritoneum. We used 3mm trocars both for the camera and manipulators, which allowed us to reduce bladder injury and possible postoperative urine leakage. Also, it helped to change the camera position more easily during the operation if needed. Sufficient bladder visualization was provided by CO2 insufflation at 8 mm Hg. Intravesical ureteral reimplantation using laparoscopic pneumovesicum was similar to conventional open Cohen's operation regardless of the bladder volume. In the case of the ureteral diverticulum, it was resected en bloc together with the distal part of the ureter using a unipolar L-shaped hook. Then a submucosal tunnel was created and ureteric reimplantation was performed with 5-0 monofilament absorbable sutures. Silicone catheter Ch/Fr: 5 was placed in the ureter with its outflow through the port incision. We had no intraoperative complications and no conversion. The mean operation time was 100,2±38 min for unilateral and 160±26 min for bilateral reimplantation. Moderate hematuria was observed for up to 2 days in all patients. On 5-7 postoperative days ureteral catheters were removed. The bladder was drained with a Foley catheter Ch/Fr: 8 for 6-10 days postoperatively. Patients were followed up with a clinical assessment and renal ultrasonography and discharged home.

CKD with unilateral loss of kidney function was observed in 4 children (4 kidneys). This condition was confirmed by static renal scintigraphy (99mTc-DMSA) with further laparoscopic nephroureterectomy performed at the age of 4-6 months. In this group, renal failure was diagnosed after birth together with VUR, megaureter, and reflux nephropathy. Recurrent UTIs with no effect of conservative antibiotic treatment were indications for surgery. We performed laparoscopic nephroureterectomy using transperitoneal access and 3 mm trocars for camera and manipulators, CO2 pneumoperitoneum at 10 mm Hg. The kidney and ureter were removed through a circumbilical incision. The mean operation time was 67,4±23 min. Neither intraoperative complications nor conversion was observed.

In our study, the follow-up period was 1 year. On a secondary admission in three months after surgery renal and bladder ultrasound, MCUG, MSCT, and cystourethroscopy were performed as well as blood urea, creatinine, Ca, and phosphor rates were checked in all patients. Residual valves in the posterior urethra were found in one patient with no dysuria symptoms, he underwent a redo TUI. One infant with bilateral non-refluxing megaureter had recurrent UTIs after laparoscopic Cohen's operation so he underwent repeated open procedures at the age of 6 months. Four patients had CKD: 3 of them had stage 1 with eGFR >90mL/min and 1 infant – Stage 2 with eGFR 60-89 mL/min. Twelve patients had no recurrent symptoms of lower urinary tract obstruction, VUR, or UTIs proved by MCUG and renal US with Doppler in 1 year after surgical correction. One infant with urinoma, PUV, and bilateral VUR also had no recurrence.

Discussion

Posterior urethra valves are known to cause up to 17% of chronic kidney disease in children (12), although neither the incidence (~1/4000) nor the proportion antenatally diagnosed (~1/3) of boys with PUV appears to have changed in the past 30 years (2-4,13). PUVs in newborns (up to 1 month of age) are diagnosed only in 35-40% (4,14). When PUVs are found postnatally after 1 year of age children are subject to severe complications and UTIs leading to possible CKD and further kidney failure treatments such as dialysis or transplant (3,14-16). Our findings correlated with that described in the literature: 77% of PUVs were proved by prenatal diagnostics and 23% after birth.

CKD is the most severe complication of PUVs and can occur in up to 35% of patients (6,7,9). Most authors agree that PUVs are a risk factor of further kidney failure (8,17-19). The standard treatment of PUV is urethral catheterization followed by TUI, but even done early it could not guarantee the preservation of normal kidney function (1-3,13,20). In our cohort, 23% of patients had acute renal injury after birth and 15% of infants developed CKD, stages 1-2. Some authors estimated that there was no significant difference between antenatal vs. postnatal diagnosis of PUVs with regard to long-term clinical outcomes (9,14). Some authors reported about significantly lower prevalence of CKD in patients with extravasation resulting in prenatal ascites or urinoma which acted as a pop-of mechanism (21). Nevertheless, early diagnostics and treatment are essential (13,18,20). Patients with PVUs often require further surgery due to VUR or megaureters complicated by recurrent urinary tract infections which are common in this group (6). In our study these subgroups appeared to be almost equal – we observed 46% of patients with obstructive megaureters and 54% with VUR. Finally, almost half of them (46%) had spontaneous regression of VUR and megaureters proved by MCUG after 3 months of TUI of posterior urethra valves. In this respect, one should not underestimate the role of conservative treatment, rehabilitation, and physiotherapy after PUV repair. Still, 23% of our patients required Cohen's operation and in 15% of infants, laparoscopic nephroureterectomy was

performed. So, a multidisciplinary team approach is required paying attention to both the lower and upper urinary tract, as well as kidney function (2).

It is essential to keep in mind that when urine flow is unblocked it does not lead to a complete recovery (7). After primary examination and if PUVs is suspected the patient must be delivered to the surgical department. The gold standard for PUVs is micturating cystourethrogram, which allows us to find out the dilation of the posterior urethra. In case of UTI or other severity due to acute kidney injury, we delayed MCUG and restore urine flow using a urinary catheter. In some cases, cystostomy might be necessary (7,22), but we didn't require any in our study.

Special attention is to be paid to Potter and Prune Belly syndromes which often include LUTO (23,24). Newborns with Potter syndrome are of a specific phenotype: low-set ears, wide-set eyes, retrognathia, limb contractures, clubfoot, and severe pulmonary hypoplasia, and CAKUT. Oligoamnios together with Potter syndrome often leads to fetal death in utero. Prune Belly syndrome includes weak or absent abdominal wall muscles, bilateral cryptorchidism, and CAKUT. These patients usually require many surgeries and need life-long follow-up care depending on the condition's severity. So it might be an indication of pregnancy termination at the request of parents. We had one patient with PUV and Prune Belly syndrome (was excluded from our study).

Analysis of long-term results of endoscopic treatment shows that early diagnosis and treatment of the posterior urethral valve already in the neonatal period allows to restore the urodynamics of the urinary system, normalize the function of the bladder and avoid the formation of chronic kidney disease and chronic renal failure.

Conclusions

Early diagnosis and appropriate surgery treatment of PUVs in newborns and infants provides excellent and good outcomes in the majority of patients. It helps to restore both urodynamics and bladder function. The gold standard of PUVs' repair is cystourethroscopy with transurethral incision. It is highly recommended to perform the procedure in the neonatal period due to severe complications that are common in this group of patients: acute kidney injury, chronic kidney disease, and recurrent urinary tract infections. Most patients with concomitant VUR and megaureters require further surgery, but conservative treatment (rehabilitation and physiotherapy) is necessary as the spontaneous recovery of VUR after TUI is also possible. All patients should have regular medical checkups every 3 months and followed up by a pediatric nephrologist and urologist on a regular basis.

Conflict of interest

The authors report no conflict of interest.

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Contributions

Research concept and design: **AF, SZ, AG, AGur, SK**
Data analysis and interpretation: **AG, AGur, RB, EE, ON**
Collection and/or assembly of data: **RB, IK, DA, MS, AL**
Writing the article: **AG, AGur, EE, IK, RB**
Critical revision of the article: **AF, SZ, AG, AGur, SK, ML, LM**
Final approval of the article: **AF, SZ, AG, AGur, SK, ML, LM**

References

1. Wu CQ, Traore EJ, Patil D. Role of a preoperative catheter regimen in achieving early primary endoscopic valve ablation in neonates with posterior urethral valves.J Urol. 2021;205(6):1792-7.
2. Tambo FF, Tolefac PN, Ngowe M. Posterior urethral valves: 10 years audit of epidemiologic, diagnostic and therapeutic aspects in Yaoundé gynaeco-obstetric and paediatric hospital. BMC Urol. 2018;18(1):46.
3. Chan MT, Chan EE, Ng YH. Outcome of boys with posterior urethral valves from a single tertiary hospital in Singapore. ANZ J Surg. 2022;92(5):1159-64.
4. Brownlee E, Wragg R, Robb A. Current epidemiology and antenatal presentation of posterior urethral valves: Outcome of BAPS CASS National Audit. J Pediatr Surg. 2019;54(2):318-21
5. Talati AN, Webster CM, Vora NL. Prenatal genetic considerations of congenital anomalies of the kidney and urinary tract (CAKUT). Prenat Diagn. 2019;39(9):679-92.

6. Çelakil EM, Ekinci Z, Yücel BB. Outcome of posterior urethral valve in 64 children: a single center's 22-year experience Minerva. Urol Nefrol. 2019;71(6):651-6.
7. Chua ME, Ming JM, Carter S. Impact of adjuvant urinary diversion versus valve ablation alone on progression from chronic to end stage renal disease in posterior urethral valves: a single institution 15-year time-to-event analysis. J Urol. 2018;199(3):824-30.
8. Berte N, Vrillon I, Larmure O, Gomola V, Ayav C, Mazeaud C, et al. Long-term renal outcome in infants with congenital lower urinary tract obstruction. Prog Urol. 2018;28(12):596-602.
9. Coquillette M, Lee RS, Pagni SE. Renal outcomes of neonates with early presentation of posterior urethral valves: a 10-year single center experience. J Perinatol. 2020;40(1):112-7.
10. Demirkan H, Yeşildal C. Serum creatinine levels in cases of posterior urethral valve: 29 years experience of a pediatric urology reference center. Low Urin Tract Symptoms. 2020;12(3):274-7.
11. Harper L, Waubant A, Vignes J. Can quantity of amniotic fluid reliably predict postnatal renal function in boys with posterior urethral valves: a decision curve analysis. Prenat Diagn. 2017;37(9):931-4.
12. Buffin-Meyer B, Tkaczyk M, Stańczyk M. A single-center study to evaluate the efficacy of a fetal urine peptide signature predicting postnatal renal outcome in fetuses with posterior urethral valves. Pediatr Nephrol. 2020;35(3):469-75.
13. Brown BP, Simoneaux SF, Dillman JR, ACR Appropriateness Criteria® Antenatal Hydronephrosis-Infant. J Am Coll Radiol. 2020;17(11S):S367-9.
14. Vasconcelos MA, Simões E Silva AC, Dias CS, Gomes IR, Carvalho RA, Figueiredo SV, et al. Posterior urethral valves: comparison of clinical outcomes between postnatal and antenatal cohorts. J Pediatr Urol. 2019;15(2):167.
15. Vieira EL, Rocha NP, Bastos FM. Posterior urethral valve in fetuses: evidence for the role of inflammatory molecules Pediatr Nephrol. 2017;32(8):1391-400.
16. Herbst KW, Tomlinson P, Lockwood G. Survival and kidney outcomes of children with an early diagnosis of posterior urethral valves. Clin J Am Soc Nephrol. 2019;14(11):1572-80.
17. Rocha NP, Bastos FM, Vieira EL. The protective arm of the renin-angiotensin system may counteract the intense inflammatory process in fetuses with posterior urethral valves. J Pediatr (Rio J). 2019;95(3):328-33.
18. Long CJ, Bowen DK. Predicting and modifying risk for development of renal failure in boys with posterior urethral valves. Curr Urol Rep. 2018;19(7):55.
19. Wragg R, Brownlee E, Robb A. Tubular and glomerular biomarkers of renal tissue function in the urine of fetuses with posterior urethral valves. J Pediatr Urol. 2022;S1477-5131(22)00116-4.
20. Sarhan OM, Wadie B, Al-Kawai F. Bladder function in children with posterior urethral valves: impact of antenatal versus postnatal diagnosis. Int Braz J Urol. 2022;48(1):78-86.
21. Lundar L, Aksnes G, Morkrid L. Prenatal extravasation of urine seems to preserve renal function in boys with posterior urethral valves. J Pediatr Urol. 2019;15(3):241.e1-e7.
22. Chandran H, Knight M, McCarthy L. The postnatal management of boys in a national cohort of bladder outlet obstruction. J Pediatr Surg. 2019;54(2):313-7.
23. Farrugia MK. Fetal bladder outflow obstruction: Interventions, outcomes and management uncertainties. Early Hum Dev. 2020;150:105189.
24. Sen S, Arunachalam P, Sam CJ. Non-obstructive, non-refluxing uretero-colonic anastomosis by colonic sero-muscular excision and extra mural peri-ureteric wrap - A new technique in 17 children. J Pediatr Urol. 2021;17(1):99.e1-e7.