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Original Article

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Re-ablation of the residual posterior urethral valve: a single center retrospective study

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Abstract

Objective: *Residual posterior urethral valves (RPUV) after primary ablation can be responsible for the persistence of urinary symptoms and worsening of renal function in children. This study aims to determine the impact of repeat cystoscopy and subsequent re-ablation of residual posterior urethral valves using changes in serum creatinine, uroflowmetry and ultrasonography.*

Materials and Methods: *From April 2022 to August 2023, the study was conducted at the Pediatric Urology Division, Department of Urology, BSMMU, Dhaka. A retrospective review of 74 patients with posterior urethral valves (PUV) was conducted. Of these, 28 patients (37.83%) had symptoms at 03 months like a weak stream (39.3%), straining (10.7%), dribbling (25%) and recurrent attack of fever (3.6%). Among them, 22 patients had no obstructive remnant leaflets and 6 patients (21.4%) had obstructive remnant leaflets in follow-up cystoscopy. Serial serum creatinine measurements (mg/dL), Qmax (ml/s) and ultrasonographic measurements were retrieved and recorded on separate, dated occasions against the date of surgery as follows: before primary valve ablation and at 03-month follow-up. The changing trends in both the serum creatinine, uroflowmetry and the USG changes were analysed for significance against time. The statistical analysis was conducted using SPSS version 26 statistical software. Median with interquartile range for continuous variables and frequency distributions for categorical variables used to describe the characteristics of the total sample. Associations of continuous data were assessed using the Mann-Whitney-U test while associations of qualitative data were assessed by the Fisher Exact test. In both cases, p-value < 0.05 was considered significant. Institutional ethical committee clearance was taken before the commencement of the study.*

Results: *The median age at primary valve ablation was seven years (median [interquartile range] 7.0 [2.0, 10.7]). Repeat cystoscopy was performed in 37.83% of patients, detecting a 21.4% prevalence of residual valves. The initial mean creatinine before the primary ablation was 0.69 mg/dL, with 75% of patients having elevated creatinine levels before surgery. The serum creatinine showed a significant improvement after primary ablation (mean: 0.69 mg/dL to 0.6 mg/dL, p = 0.0001) but minimal improvement after re-ablation (0.6 mg/dL to 0.57 mg/dL, p = 0.68). Preoperatively the median Qmax and PVR were 7.7 and 31.0; which were 11.2 and 25.0 at 03-month follow-up respectively.*

Keywords: Posterior urethral valves; Preoperative findings; Residual valve; Valve ablation.

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There was more dilatation in the left renal units (mean: 13.4 mm, 10.9 mm, 8.3 mm) compared to the right (mean: 11.9 mm, 9.7 mm, 8.5 mm). The left renal unit showed significant improvement after both primary ablation (p = 0.04) and re-ablation (p = 0.04). Similarly, the right renal unit showed improvement on both occasions, albeit not statistically significant (p = 0.14 and p = 0.29, respectively). Summarily, a persisting postoperative raised serum creatinine, low Qmax, PVR and hydroureteronephrosis had a significant relationship with residual valves, the sooner the obstruction is resolved entirely, the better the outcome.

Conclusions: *The prevalence of residual posterior urethral valves after primary ablation was 21.4%, with an improvement in the trend of hydronephrosis and serum creatinine after re-ablation of residual valves. Repeat cystoscopy is therefore effective in the detection of residual valves and has the added benefit of being both diagnostic and therapeutic.*

Introduction

PUV is the most common cause of lower urinary tract obstruction (LUTO) in newborn males, affecting one in every 5,000-8,000 births and accounting for roughly 60% of all LUTO cases.[1] Endoscopic valve ablation is the definitive treatment for PUV, failure of which can result in severe urological sequelae affecting both the upper and lower urinary tract.[1] The recommended follow-up measures after valve ablation include clinical evaluation using urinalysis and renal function tests, radiological evaluation using repeat kidney-ureter-bladder (KUB) ultrasonography and voiding cystourethrogram (VCUG), and cystoscopic evaluation.[2,3] Routine follow-up is paramount to detecting voiding dysfunction, preventing progression to end-stage renal disease (ESRD), and managing the presence of urinary tract infections (UTIs).[4]

RPUVs are defined as persistent PUV leaflets after the primary endoscopic ablation of valves. These RPUVs are responsible for the persistence of symptoms and the progression of disease after PUV ablation.[5,6] The incidence of RPUV in the literature varies from 12% to 78%.[5-7] The diagnosis of such RPUV can be suspected based on clinical and radiological findings; however, detection can only be confirmed by cystoscopy.[8-9] Whereas cystoscopy is considered a standard procedure after ablation, a significant proportion of centers would only offer repeat cystoscopy when there were clinical or radiological signs of persistent obstruction.[2-10]

This study aims to assess the magnitude of RPUV in children and the impact of repeat cystoscopy and subsequent re-ablation as a standard routine procedure in the management of PUV based on the changing trends of serum creatinine, uroflowmetry and ultrasonographic measurements.

MATERIALS AND METHODS

A total, of 74 patients were diagnosed with PUV between April 2022 and August 2023. This was a retrospective review of patients with PUV who underwent primary valve ablation at the Pediatric Urology Division, Department of Urology, BSMMU. The protocol for PUV ablation at the Department of Urology was the importance of re-look urethro-cystoscopy after the fulguration of the posterior urethral valve. Thereafter, routine repeat cystoscopy was scheduled three months after primary urethral valve ablation.

During repeat cystoscopy, if RPUV were detected, re-ablation was carried out using the same endoscopic technique. At the end of both endoscopic interventions, an on-table Credé manoeuvre was performed as a measure of adequate resolution of obstruction. Routinely, serum creatinine, uroflowmetry and renal sonography were performed as part of the posterior urethral valve pre-operative workup and follow-up protocol. Serum creatinine measurements (mg/dL), Qmax (ml/s) and ultrasonographic measurements were retrieved and recorded on separate, dated occasions against the date of surgery as follows:

- before primary valve ablation (initial creatinine level);
- before repeat cystoscopy (≥three months after primary valve ablation).
- after repeat cystoscopy (≥three months after repeat cystoscopy).

The values of serum creatinine, Qmax and the renal pelvic diameter on both the left and right kidneys were plotted against the occasions listed above. The changing trends in both the serum creatinine, Qmax and the ultrasonographic changes were analysed for significance against time.

Informed consent was obtained from all guardians before undergoing the procedures under review. Institutional approval was sought before the study was conducted, and ethical clearance was given by the BSMMU Ethics Committee (Ref: IRB: BSMMU/2022/3390, Date: 07.04.2022).

Statistical analyses were conducted by using SPSS Version 26 and P-values of less than 0.05 were considered significant.

RESULTS

A total of 74 patients underwent posterior urethral valve ablation. 28 patients had symptoms at 03 months like a weak stream (39.3%), straining (10.7%), dribbling (25%) and recurrent attack of fever (3.6%). Among them, 6 patients (21.4%) had obstructive remnant leaflets in follow-up cystoscopy. Serial serum creatinine measurements (mg/dL), Qmax (ml/s), and ultrasonographic measurements (mm) were retrieved and recorded on separate, dated occasions against the date of surgery as follows: before primary valve ablation; and at 03 month follow-up. The changing trends in the serum creatinine, Qmax and the USG changes were analysed for significance against time. Mean patient age, obstructive voiding symptoms, post void residual urine (PVR in milliliters), serum creatinine measurements (mg/dL), presence of residual valve, condition of bladder neck and changes in urinary bladder were considered as study variables. The serum creatinine showed a significant improvement after primary ablation (mean: 0.69 mg/dL to 0.6 mg/dL, $p = 0.0001$) but minimal improvement after re-ablation (0.6 mg/dL to 0.57 mg/dL, $p = 0.68$). Preoperatively the median Qmax and PVR were 7.7 and 31.0; which were 11.2 and 25.0 at 03-month follow-up respectively. There was more dilatation in the left renal units (mean: 13.4 mm, 10.9 mm, 8.3 mm) compared to the right (mean: 11.9 mm, 9.7 mm, 8.5 mm). The left renal unit showed significant improvement after both primary ablation ($p = 0.04$) and re-ablation ($p = 0.04$). Similarly, the right renal unit showed improvement on both occasions, albeit not statistically significant ($p = 0.14$ and $p = 0.29$, respectively).

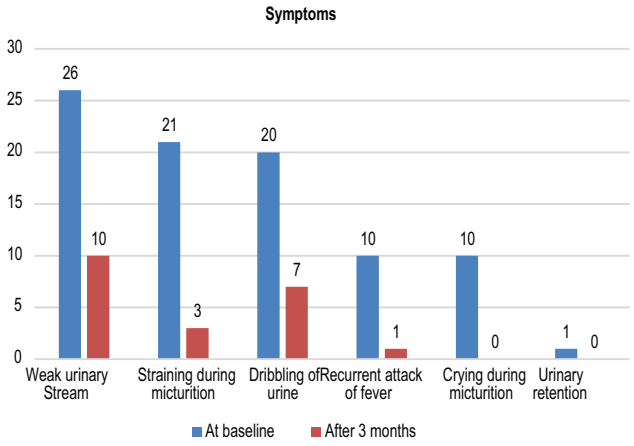

Figure I: *Multiple Bar diagram showing distribution of patients by symptoms (n=28)*

Table-I. *Postoperative outcomes*

Characteristic	Preoperative	Postoperative		p-value
		03 month (before ablation)	03 month (after ablation)	
Mean Change of creatinine (mg/dl) (Mean±S.D)	0.69±0.07			0.0001
	0.60±0.03	0.57±0.05		
Left renal pelvic diameter (in mm) (Mean±S.D)	13.4±0.14	10.9±0.96	8.3±0.66	0.04
Right renal pelvic diameter (in mm) (Mean±S.D)	11.9±0.03	9.7±0.47	8.5±0.87	0.14

Values are presented as mean ±SD.

Discussion

Residual valves are defined as persistent PUV leaflets after primary endoscopic ablation of valves. These leaflets can be responsible for recurrent UTIs and the rapid progression to bladder dysfunction, chronic kidney disease, and end-stage renal failure.[2,5] The diagnosis of such residual valves can be suspected clinically and radiologically; however, detection can only be confirmed by cystoscopy.[7,8]

This study sought to determine the magnitude of RPUV and the impact of repeat cystoscopy and subsequent re-ablation as a standard routine procedure in the management of PUV-based on the changing trends of serum creatinine and sonographic measurements of the renal pelvis. Significantly, the prevalence of residual valves was 21.4%, with an improvement in both serum creatinine and RPD after ablative and re-ablative procedures. Serum creatinine showed a statistically significant improvement after the primary ablation of valves, while the left RPD showed a statistically significant improvement after both the primary ablation of PUV and the re-ablation of RPUV. The median age at surgery in our study was seven years, which is similar also reported in other studies. In a systematic review, the age range at surgery for PUV was 0-180 months, with the largest study in the review recording a mean age of 30 months.[11] Early intervention is a direct result of early diagnosis, which is now well established with the advent of antenatal diagnosis.[2,3]

The protocol at BSMMU was to offer repeat cystoscopy after three

months of primary ablation. This was performed in 37.83% of patients,

detecting a 21.4% prevalence of residual valves. This finding compares well with the incidence of RPUV in the literature, which varies from 12% to 78%.[5-7] In a systematic review, repeat cystoscopy was found to be described as a standard procedure independent of clinical course in some studies, while in other studies, the decision to repeat cystoscopy was based on VCUG results.[11]

A consensus statement from India recommends the performance of check cystoscopy and/or VCUG for patients who have persistent symptoms. In their statement, routine cystoscopy and/or VCUG are labeled as optional.[2] Conversely, another author found that repeat VCUG alone is not effective in detecting residual valves and recommended check cystoscopy for all patients.[10] Consequently, the modality that should be used to detect RPUV is debated, as is highlighted in the literature, with no clear consensus.[6,7]

In a retrospective study, demonstrate that a combination of clinical, radiological, and endoscopic modalities is required to evaluate the presence of residual valves or strictures.[5] Another go further to justify the use of check cystoscopy on all patients by stating that routine cystoscopy can identify more cases of residual valves as opposed to the performance of cystoscopy only after clinical or radiological suspicion.[7]

Since the protocol at BSMMU was re-look cystoscopy for symptomatic patients at 03 month, our study could not demonstrate a comparison between VCUG versus re-look cystoscopy. However, a 21.4% RPUV prevalence in our study supports the practice of routine repeat cystoscopy after primary ablation. In a quest to find an authoritative answer to the debate herein cited, the European Association of Urology (EAU) Paediatric Urology Guidelines, updated in 2023, recommend that the effectiveness of primary valve ablation should be demonstrated within three months, either by clinical improvement (sonogram and renal function), control VCUG, or a re-look cystoscopy, depending on the clinical course.[3]

Renal function is the most significant and reported outcome of PUV. The proportion of patients with elevated creatinine before ablation ranges from 17% to 57%, with a mean between 88 umol/L and 141 umol/L.[12] Our study had a mean creatinine level of 0.69 mg/dL before primary ablation, with 75.5% of patients having an elevated creatinine level before surgery. Nadir creatinine is defined as the lowest creatinine level during the first year following diagnosis.[13] A serum nadir creatinine above 88.4 umol/L (1.0 mg/dL) is shown to be the most significant and independent risk factor for poor renal outcomes. A local study by RCWMCH confirmed this finding, with moderate to severe renal impairment occurring in patients with a serum nadir creatinine above 89 umol/L.

Serial serum creatinine measurements, usually within three months after ablation, are a significant component of follow-up for patients with PUV and have been used to monitor renal function post-PUV ablation.[3] Additionally, a rise in serum creatinine and/or persistence of high serum creatinine is seen in

residual valves, necessitating the need for a re-look cystoscopy.[14] In our study, a significant improvement was noted in the serum creatinine trend after primary ablation, with a drop in the mean creatinine value. However, there was minimal change in serum creatinine before and after repeat ablation in patients with RPUV. There was also no statistical difference in the mean serum creatinine of patients with residual valves and those without after primary ablation. These findings underscore the clinical significance of initial bladder drainage and primary ablation in the treatment of PUV.[2,3]

Ultrasonography is recommended within three months after ablation and is particularly favourable as it is readily available, affordable, non-invasive, and lacks radiation exposure.[2,3,15] The anteroposterior RPD is an objective ultrasonographic parameter of the renal pelvis that is used to grade the degree of hydronephrosis.[16] Persistent hydronephrosis should warrant evaluation of the lower urinary tract for dysfunction or obstruction.[17] Conversely, resolution of hydronephrosis is seen within three months after valve ablation in the absence of vesicoureteral reflux and residual LUTO.[18,19]

Our study determined a significant resolution in the degree of hydronephrosis across the follow-up period. Both left and right RPDs showed an improvement trend after ablation and after re-ablative procedures within an average of 10 weeks to 14.7 weeks, respectively. These findings compare well with a prospective study by others where significant resolution of hydronephrosis was demonstrated on two ultrasonographic assessments taken three months apart in patients after PUV ablation. [20]

Notably, there was more dilatation in the left renal units compared to the right. Likewise, the resolution of hydronephrosis across time was statistically significant for the left RPD compared to the right RPD. In a large prospective cohort showed, left hydronephrosis was 1.3 times more common than right hydronephrosis in patients with antenatally detected hydronephrosis, inclusive of those with PUV. [21] Similarly, in those with transient hydronephrosis, the left renal units showed higher resolution rates than the right.[21]

Resolution of upper tract dilatation and improvement of renal function may be considered indirect signs of urinary tract decompression.[5] However, the persistence of renal dysfunction and hydronephrosis in the absence of mechanical blockage is a well-considered sequelae of PUV and has been linked to renal polyuria, vesicoureteral reflux, and bladder dysfunction. This underscores the likelihood of persistent upper tract dilatation and elevated serum creatinine in patients without residual valves.[22]

Conclusions

The study shows a significant prevalence of residual posterior urethral valve of 21.4%, with a significant improvement in the trend of hydronephrosis and serum creatinine in the follow-up period. Notably, a significant improvement in the left renal pelvic diameter was found after the re-ablation of residual valves. Therefore, repeat cystoscopy is effective in the detection of residual valves and has the added benefit of being both diagnostic and therapeutic. Protocol-based vigilance after primary ablation is key to promoting early detection and re-ablation of residual posterior urethral valve.

References

1. Ansari, M.S., Gulia, A., Srivastava, A. and Kapoor, R., 2010. Risk factors for progression to end-stage renal disease in children with posterior urethral valves. *Journal of pediatric urology*, *6*(3), pp.261-264.
2. Babu, R. and Kumar, R., 2013. Early outcome following diathermy versus cold knife ablation of posterior urethral valves. *Journal of pediatric urology*, 9(1), pp.7-10.
3. Basu, A.K., Banerjee, S., Haque, J., Chakravarty, A., Chatterjee, U.S., Ghosh, A., Mitra, D., Bhowmik, K., Basak, D. and Chatterjee, S.K., 2023. Posterior urethral values: report of a single private clinic in Kolkata. *Journal of Indian Association of Pediatric Surgeons,* 8(3), p.144.
4. Bajpai, M., Dave, S. and Gupta, D.K., 2001. Factors affecting outcome in the management of posterior urethral valves. *Pediatric surgery international*, *17*, pp.11-15.
5. Burmeister, D., AbouShwareb, T., D'Agostino Jr, R., Andersson, K.E. and Christ, G.J., 2012. Impact of partial urethral obstruction on bladder function: time-dependent changes and functional correlates of altered expression of Ca2+ signaling regulators. *American Journal of Physiology-Renal Physiology*, 302(12), pp.F1517-F1528.
6. Bilgutay, A.N., Roth, D.R., Gonzales Jr, E.T., Janzen, N., Zhang, W., Koh, C.J., Gargollo, P. and

Seth, A., 2016. Posterior urethral valves: risk factors for progression to renal failure. *Journal of pediatric urology*, *12*(3), pp.179-e1.

7. Buffin-Meyer, B., Klein, J., van der Zanden, L.F., Levtchenko, E., Moulos, P., Lounis, N., Conte-Auriol, F., Hindryckx, A., Wühl, E., Persico, N. and Oepkes, D., 2020. The ANTENATAL multicentre study to predict postnatal renal outcome in fetuses with posterior urethral valves: objectives and design. *Clinical kidney journal*, *13*(3), pp.371-379.
8. Caione, P. and Nappo, S.G., 2011. Posterior urethral valves: long-term outcome. *Pediatric surgery international*, *27*, pp.1027-1035.
9. Casale, A.J., 1990. Early ureteral surgery for posterior urethral valves. *Urologic Clinics of North America*, *17*(2), pp.361-372.
10. Cho, S.Y., Bae, J., Yoo, C. and Oh, S.J., 2013. Establishment of a grading system for bladder trabeculation. *Urology, 81(3),* pp.503-507.
11. Churchill, B.M., McLorie, G.A., Khoury, A.E., Merguerian, P.A. and Houle, A.M., 1990. Emergency treatment and long-term follow-up of posterior urethral valves. *Urologic Clinics of North America*, *17*(2), pp.343-360.
12. Choudhury, S.R., Chandha, R., Puri, A., Prasad, A., Sharma, A. and Kumar, A., 2003. Clinical spectrum of posterior urethral valve obstruction in children. *Journal of Indian Association of Pediatric Surgeons*, *8*(3), p.148.
13. Chow, S.C., Shao, J., Wang, H. and Lokhnygina, Y., 2017. *Sample size calculations in clinical research*. CRC press.
14. Coleman, R., King, T., Nicoara, C.D., Bader, M., McCarthy, L., Chandran, H. and Parashar, K., 2015. Nadir creatinine in posterior urethral valves: how high is low enough?. *Journal of Pediatric Urology*, *11*(6), pp.356-e1.
15. Crooks, K.K., 1982. Urethral strictures following transurethral resection of posterior urethral valves. *The Journal of urology*, *127*(6), pp.1153-1154.
16. DeFoor, W., Clark, C., Jackson, E., Reddy, P., Minevich, E. and Sheldon, C., 2008. Risk factors for end stage renal disease in children with posterior urethral valves. *The Journal of urology*, *180*(4S), pp.1705-1708.
17. Fleiss, J.L., Levin, B. and Paik, M.C., 2013. *Statistical methods for rates and proportions*. John wiley & sons.
18. Gupta SD, Khatun AA, Islam AI, Shameem IA. Outcome of endoscopic fulguration of posterior urethral valves in children. *Mymensingh Medical Journal*. 2009 Jul; 18(2):239-44.
19. Heikkilä, J., Holmberg, C., Kyllönen, L., Rintala, R. and Taskinen, S., 2011. Long-term risk of end stage renal disease in patients with posterior urethral valves. *The Journal of urology*, 186(6), pp.2392-2396.
20. Horowitz, M., Harel, M., Combs, A.J. and Glassberg, K.I., 2009. Surveillance cystoscopy in the management of posterior urethral valves. *The Journal of Urology*, 181(4S), pp.172-172.
21. Hodges, S.J., Patel, B., McLorie, G. and Atala, A., 2009. Posterior urethral valves. *The Scientific World Journal*, *9*, pp.1119-1126.
22. Imaji, R. and Dewan, P.A., 2002. Congenital posterior urethral obstruction: re-do fulguration. *Pediatric surgery international*, 18, pp.444-446.
23. Krishnan, A., de Souza, A., Konijeti, R. and Baskin, L.S., 2006. The anatomy and embryology of posterior urethral valves. *The Journal of urology*, *175*(4), pp.1214-1220.
24. Kibar, Y., Ashley, R.A., Roth, C.C., Frimberger, D. and Kropp, B.P., 2011. Timing of posterior urethral valve diagnosis and its impact on clinical outcome. *Journal of pediatric urology*, *7*(5), pp.538-542.
25. Lal, R., Bhatnagar, V. and Mitra, D.K., 1998. Urethral strictures after fulguration of posterior urethral valves. *Journal of pediatric surgery*, *33*(3), pp.518-519.
26. Lopez Pereira, P., Espinosa, L., Martinez Urrutina, M.J., Lobato, R., Navarro, M. and Jaureguizar, E., 2003. Posterior urethral valves: prognostic factors. *BJU international*, *91*(7), pp.687-690.
27. MALIKQ, M.A., SIAL, S.H.J., IQBAL, Z. and Ahmad, M., 2005. Posterior urethral valves. *The Professional Medical Journal*, *12*(04), pp.473-478.
28. Machin, D., Campbell, M.J., Tan, S.B. and Tan, S.H., 2011. *Sample size tables for clinical studies*. John Wiley & Sons.

29. Mirshemirani, A., Khaleghnejad, A., Rouzrokh, M., Sadeghi, A., Mohajerzadeh, L. and Sharifian, M., 2013. Posterior urethral valves; a single center experience. *Iranian journal of pediatrics,* 23(5), p.531.

30. Nijman, R.J.M. and Scholtmeijer, R.J., 1991. Complications of transurethral electro incision of posterior urethral valves. *British journal of urology*, *67*(3), pp.324-326.

31. Nabil, A.E.W., Salem, A., Salah, M., Ibrahim, H., Ghany, M.A. and Emran, A., the Importance of Second Look Cystoscopy after Posterior Urethral Valve Ablation in Children: Single Center Experience. *Clinical Surgery*. 2019; 4, 2691.

32. Nasir, A.A., Ameh, E.A., Abdur-Rahman, L.O., Adeniran, J.O. and Abraham, M.K., 2011. Posterior urethral valve. *World journal of pediatrics*, *7*, pp.205-216.

33. Nawaz, G., Hussain, I., Muhammad, S., Jamil, M.I., Rehman, A.U., Iqbal, N. and Akhter, S., 2017. Justification for Re-Look cystoscopy after posterior urethral valve fulguration. *Journal of Ayub Medical College Abbottabad*, 29(1), pp.30-32.

34. Oktar, T., Salabas, E., Acar, O., Atar, A., Nane, I., Ander, H. and Ziylan, O., 2013. Residual valve and stricture after posterior urethral valve ablation: how to evaluate? *Journal of Pediatric Urology*, 9(2), pp.184-187.

35. Peters, C.A., Bolkier, M., Bauer, S.B., Hendren, W.H., Colodny, A.H., Mandell, J. and Retik, A.B., 1990. The urodynamic consequences of posterior urethral valves. *The Journal of urology*, *144*(1), pp.122-126.

36. Parkhouse, H.F., Barratt, T.M., Dillon, M.J., Duffy, P.G., Fay, J., Ransley, P.G., Woodhouse, C.R.J. and Williams, D.I., 1988. Long term outcome of boys with posterior urethral valves. *British journal of urology*, *62*(1), pp.59-62.

37. Ryan, T.P., 2013. *Sample size determination and power*. John Wiley & Sons.

38. Rittenberg, M.H., Hulbert, W.C., Snyder III, H.M. and Duckett, J.W., 1988. Protective factors in posterior urethral valves. *The Journal of urology*, *140*(5), pp.993-996.

39. Sarhan, O., El-Ghoneimi, A., Hafez, A., Dawaba, M., Ghali, A. and Ibrahiem, E.H., 2010. Surgical complications of posterior urethral valve ablation: 20 years' experience. *Journal of Pediatric surgery*, 45(11), pp.2222-2226.

40. Shirazi, M., Farsiani, M., Natami, M., Izadpanah, K., Malekahmadi, A. and Khakbaz, A., 2014. Which patients are at higher risk for residual valves after posterior urethral valve ablation? *Korean Journal of Urology*, 55(1), pp.64-68.

41. Smeulders, N., Makin, E., Desai, D., Duffy, P.G., Healy, C., Cuckow, P.M., Cherian, A., Hiorns, M.P. and Mushtaq, I., 2011. The predictive value of a repeat maturating cystourethrogram for remnant leaflets after primary endoscopic ablation of posterior urethral valves. *Journal of Pediatric Urology*, 7(2), pp.203-208.

42. Sundarsanan, B., Nasir, A.A., Puzhankara, R., Kedari, P.M., Unnithan, G.R. and Damisetti, K.R.P., 2009. Posterior urethral valves: a single center experience over 7 years. *Pediatric surgery international*, 25, pp.283-287.

43. Smith, G.H., Canning, D.A., Schulman, S.L., Snyder, H.M. and Duckett, J.W., 1996. The long-term outcome of posterior urethral valves treated with primary valve ablation and observation. *The Journal of urology*, *155*(5), pp.1730-1734.

44. Schober, J.M., Dulabon, L.M. and Woodhouse, C.R., 2004. Outcome of valve ablation in late presenting posterior urethral valves. *BJU international*, *94*(4), pp.616-619.

45. Thomas, D.F. and Gordon, A.C., 1989. Management of prenatally diagnosed uropathies. *Archives of disease in childhood*, 64(1 Spec No), p.58.

46. Yohannes, P. and Hanna, M., 2002. Current trends in the management of posterior urethral valves in the pediatric population. *Urology*, *60*(6), pp.947-95