Original Article

Primary obstructive megaureter in children; 10 years' experience from a tertiary care center

Raashid Hamid, Nisar A. Bhat, Ajaz A. Baba, Gowhar Nazir Mufti, Khursheed A. Sheikh, Mohd Idrees Bashir

Department of Paediatric and Neonatal Surgery, Sheri-Kashmir Institute of Medical science, Srinagar, Jammu and Kashmir, India

Abstract

Introduction: Primary obstructive megaureter (POM) is a congenital dilatation of the ureter due to an adynamic segment of vesicoureteric junction obstruction. Surgical intervention is needed if nuclear scan shows obstructive curve. We analyzed our data and outcome of conservative and surgical treatment in such cases at our tertiary care hospital.

Materials and Methods: We evaluated all cases of POMs during the study period. Investigations included ultrasonography (USG), voiding cystourethrogram, diethylene pentacetic acid (DTPA) scan, and dimercaptosuccinyle acid scan. In antenatal cases, any pelvic dilatation ≥12 mm after 6 weeks were subjected to reonography. Patients with anterior-posterior pelvic diameter (APPD) ≥12 mm had to undergo DTPA scan to look for DRF and drainage. Follow-up USG was done in all cases of mild-to-moderate hydroureteronephrosis, with APPD <12 at 3 months interval.

Results: A total of 270 megaureters were registered and treated during the study period (2008–2019). The total number of patients included was 50 (64 ureters). The mean age of presentation in these 30 children was 21.78 ± 18.1 months (range 1–72 months) and the mean weeks of gestation in antenatal cases at presentation as megaureter was 24 ± 7 weeks (range 13–37 weeks). The mean weight of babies was 2.72 ± 0.7 g. The duration of follow-up ranged from 16 to 1W12 months. The mean APPD on the affected side was 19.99 ± 10.3 mm (range 11–43 mm). The mean ureteric diameter was 1.67 ± 0.33 mm (range 0.78–2.66 cm). The mean split function of patients with POM was 34.88% ± 11.5% on the affected side. Twenty patients (40%) had spontaneous resolution over a mean time period of 24.1 ± 11.1 months. Thirty patients underwent surgical procedures. In three children, HTN was observed over a mean follow-up period of 3 years.

Conclusion: The babies with POM need a close follow-up. Surgery is indicated in prolonged $t_{½}/T_{max}$ on renal scan, function <40% at the initial scan, or >5% split function deterioration in the subsequent renal scan.

Keywords: British Association of Psediatric Urologists, differential renal function, glomerular filtration rate, hydroureteronephrosis, primary obstructive megaureters, ultrasonography, vesicoureteric reflux

Address for correspondence: Dr. Raashid Hamid, Department of Paediatric and Neonatal Surgery, Sheri-Kashmir Institute of Medical Science, Srinagar - 190 011, Jammu and Kashmir, India.
E-mail: drraashidhamid@gmail.com

Received: 16.05.2020, **Accepted:** 01.12.2020, **Published:** 18.07.2022

Access this article online	
Quick Response Code:	Website: www.urologyannals.com
	DOI: 10.4103/UA.UA_77_20

How to cite this article: Hamid R, Bhat NA, Baba AA, Mufti GN, Sheikh KA, Bashir MI. Primary obstructive megaureter in children; 10 years' experience from a tertiary care center. Urol Ann 2022;14:252-8.

INTRODUCTION

Primary obstructive megaureter (POM) is a congenital dilatation of the ureter in the absence of reflux at vesicoureteric junction (VUJ). Most of the cases are now diagnosed antenatally owing to increased use of antenatal ultrasonography (USG). In developed world, 40% of the POMs are diagnosed prenatally. However, in developing countries, it is not unusual to see cases of UVJ obstruction presenting as abdominal pain, hematuria, and urolithiasis. At times, POM may present as chronic renal insufficiency of varying severity. Management ranges from conservative mood of treatment to ureteral stenting and surgical reimplantation with or without remodeling of the dilated ureters. British Association of Paediatric Urologists (BAPU) recommended initial conservative management. Surgical intervention is needed if differential renal function (DRF) on the nuclear scan is <40%, obstructive washout curve or deteriorating DRF on serial scans. In developing world, POM patients present with UTI and decreasing renal function or obstructive curve on scans. We retrospectively evaluated and analyzed our data of cases of POMs. We further analyzed the outcome of conservative and surgical treatment in such cases.

MATERIALS AND METHODS

We evaluated the case records collected from medical records department and outdoor registry of all cases of POMs managed in our department. All the patients of megaureters, other than POM, were excluded by voiding cystourethrogram (VCUG), diethylene pentacetic acid (Tc-DTPA) scan, and dimercaptosuccinyle acid scan whenever indicated. USG of the abdomen was done in all cases with special emphasis on anterior-posterior pelvic diameter (APPD), ureteric diameter, and cortical thickness. In antenatal cases, detailed fetal USG was performed to look for kidney, bladder, ureters, posterior urethra, and any other fetal abnormality. Fetus was screened for the progression of hydronephrosis (HDN) or ureteral dilation and amount of liquor by two scans in the third trimester. These babies were examined after birth for any other associated abnormalities. Postnatally, USG was done on day 7 and day 28 of life for APPD and ureteric size. All the findings were noted down. All the patients of POM underwent VCUG to rule out vesicoureteric reflux (VUR). All these patients were kept on antibiotic prophylaxis. Amoxicillin 50 mg/kg was the drug used. Prophylaxis was started at a mean age of 1.5 ± 1.63 years.

In antenatal cases, any pelvic dilatation ≥12 mm after 6 weeks were subjected to nuclear renography. The reonography showed $t_{½}$, time to reach to $t_{½}$, drainage curves, and DRF. DRF was considered reduced when <40%. The obstructive nature of the disease at UVJ was confirmed by DTPA scan washout/drainage curve. In addition to the nuclear scan, IUV was also performed in 16 cases. Furthermore, in 15 patients, magnetic resonance urography (MRU) was performed to delineate the anatomy and function of the obstructed ureters. The obstruction was defined either unilateral fall in function <40% or obstructive washout curve with $t_{½}$>15 min or 5% fall in renal function on a subsequent renal scan. In bilateral cases, DRF together with global glomerular filtration rate (GFR) was taken as a parameter for indication of surgery.

After confirmation of the obstructive nature of pathology at VUJ, 30 patients underwent surgical procedure. A transvesical approach was utilized. The ureter was dissected and reimplanted in a transtrigonal fashion after excision of adynamic or stenosed segment of the UVJ. Remodeling of the ureter was performed by excisional tapering in 8 instances. The ureters were tapered to achieve 5:1 ureteral diameter to tunnel length ratio. The excised segment of VUJ underwent detailed histopathological examination by an experienced pathologist to look for several different abnormalities, including pattern of muscular fibers and bundles.

Regression of POM was defined by decrease in HDN and improvement in drainage curve or DRF on subsequent nuclear renograms. Follow-up USG was done in all cases of mild-to-moderate hydroureteronephrosis (HUN), with APPD <12 at 3-month interval. Patients with APPD ≥12 mm had to undergo DTPA scan to look for DRF and drainage. Patients were followed with USG 3 monthly and subsequent renal scans 6–8 monthly in case the drainage curves were nonobstructive and/or DRF ≥40. Renal dysplasia and decreased global renal function on scans were indicators of adverse clinical outcomes. Other patient characteristics such as age, sex, birth weight, antenatal USG, serum creatinine, urea, urine examination, and culture sensitivity were all noted down.

Data were analyzed statistically using SPSS system. Continuous variables were compared using Student's *t*-test, and categorical variables were compared using Chi-square test. Statistical significance was assumed when $P < 0.05$. Kaplan–Meier product-limit method was used for survival analysis.

RESULTS

A total of 270 megaureters were registered and treated

during the study period (2008–2019). The total number of patients having POM was 50 (64 ureters) [Figures 1-4]. POM constituted 18.5% of all cases of megaureters managed in our department during this study period. Fourteen cases (28%) had bilateral disease. There were 40 males and 10 female patients. Twenty patients (12 males and 8 females) presented antenatally, and in 30 patients, POM was diagnosed postnatally. All the antenatal cases presented as HDN on fetal USG. Megaureter was diagnosed in the second trimester in eight patients and in the third trimester in 12 patients [Table 1].

The mean age of presentation in these 30 children was 21.78 ± 18.1 months (range 1–72 months). In patients who were suspected antenatally and confirmed postnatally with nuclear scans, the mean weeks of gestation at presentation as megaureter was 24 ± 7.1 weeks (13–37 weeks). The mean weight of babies was 2.72 g. Twenty patients presented with UTI, and 10 patients presented with abdominal pain. Twenty patients who presented with UTI included eight patients diagnosed prenatally [Tables 2, 3 and Figure 5]. The average time for the first UTI was 13 ± 7.2 months. POM was associated with other anomalies in nine instances. Three patients had cryptorchidism, two patients had renal agenesis on the affected side, two patients had distal hypospadias, and two had inguinal hernia.

All the babies were normotensive at presentation. The rate of UTI was more in children above 1 year of age. UTI was diagnosed in 30%, 40%, 58% in children <1 year of age, 1–3 years of age, >3 years of age, respectively. UTI in children who presented antenatally did not suffer more UTIs, but UTI in this group of patients occurred at earlier months of life.

The mean duration of follow-up was 6.78 ± 7.1 years (16–112 months). Initially, babies with POM were followed with USG, which documented APPD in millimeters (mm). The mean APPD on the affected side was 19.99 ± 10.3 mm (range 11–43 mm). The mean ureteric diameter of the diseased ureters was 1.67 ± 0.33 mm (range 0.78–2.66 cm). Grade of HDN was mild (Grade I) in 18 patients, moderate (Grade II and III) in 20 patients, and severe (Grade IV) in 12 patients. Obstruction at UVJ was confirmed in all cases by the nuclear renogram. The degree of ureteric dilatation did not correlate with the degree of HDN. The average split function of patients with POM was 34.88% ± 11.5% on the affected side. 54% of patients had function ≥40%, while four patients had function <30%. The remaining patients had a function between 30% and 40%. Initially, 19 patients revealed complete obstruction on DTPA scan and partial obstruction in six patients [Bar Chart 1 and Tables 4-6].

Thirty patients underwent surgical treatment. There were 12 patients from the antenatal group and 18 patients from the postnatal group who underwent surgery. In 8 cases, remodeling of the dilated ureters was performed by excisional tapering. These patients underwent

Table 1: Distribution of type of megaureters

Type of megaureter	Frequency (%)
Refluxing	156 (57.77)
obstructive	50 (18.5)
Refluxing and obstructive	30 (11.11)
Nonrefluxing and nonobstructive	34 (12.5)
Total	270 (100)

Table 2: Age distribution of the patients

Age of the patients in months	Frequency (%)
<3	7 (14)
4-6	7 (14)
7-12	9 (18)
13-36	17 (34)
34-72	10 (20)
Total	50 (100)

Table 3: Distribution of the ureteral diameter in millimeters

Ureteric diameter in mm	Frequency (%)
5-10	9 (18)
11-15	4 (8)
16-20	24 (48)
21-25	7 (14)
26-30	6 (12)
Total	50 (100)

Table 4: Presentation of the patients with primary obstructive megaureters

Presentation	Frequency (%)
Pain abdomen	10 (20)
UTI	25 (50)
Urosepsis/azotemia	4 (8)
Asymptomatic	11 (22)
Total	50 (100)

UTI: Urinary tract infection

Table 5: Split function of the affected kidneys

Percentage function	Frequency (%)
<25	1 (2)
26-30	3 (6)
31-35	7 (14)
36-40	14 (28)
>41	26 (52)
Total	50 (100)

Table 6: Distribution of global glomerular filtration rate

Global GFR ml/min	Frequency (%)
<70	5 (10)
71-80	6 (12)
81-90	10 (20)
91-100	11 (22)
101-115	15 (30)
Total	50 (100)

GFR: Glomerular filtration rate

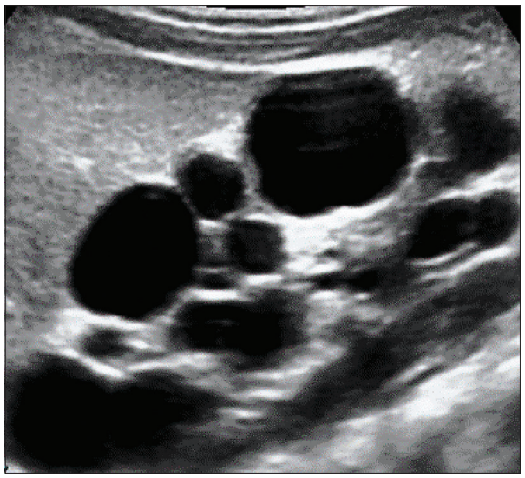


Figure 1: Fetal antenatal hydronephrosis at 23 weeks of gestation

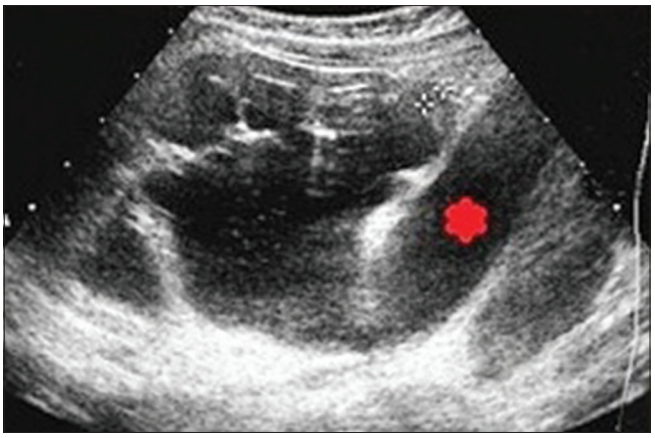


Figure 2: Fetal ultrasonography shows dilated distal ureter

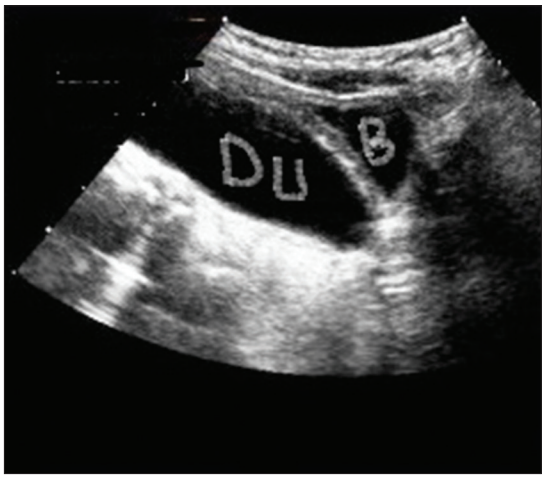


Figure 3: Adilated distal ureter with tapering near vesicoureteric junction

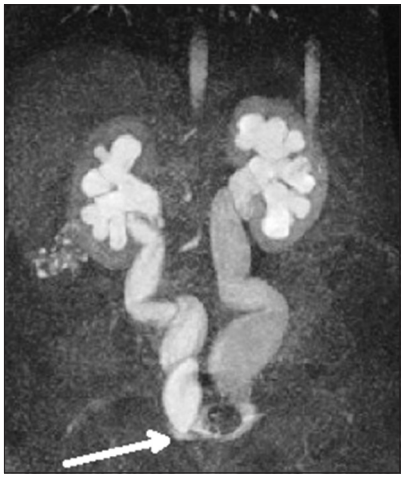


Figure 4: Magnetic resonance urography showing narrowed vesicoureteric junction with bilateral dilated obstructed ureters

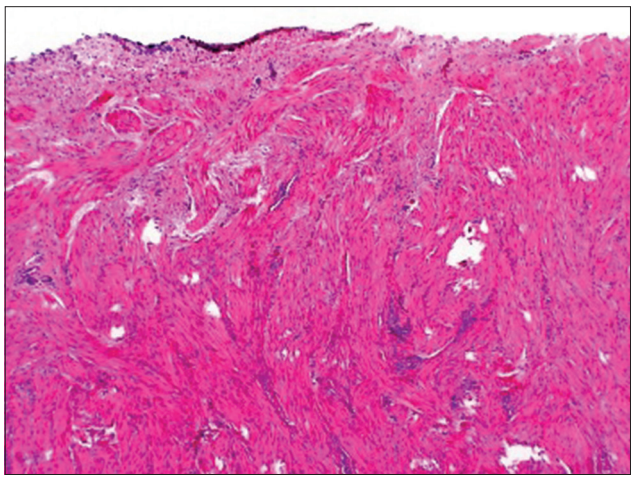


Figure 5: HPE of the excised vesicoureteric junction segment showing smooth muscle hyperplasia

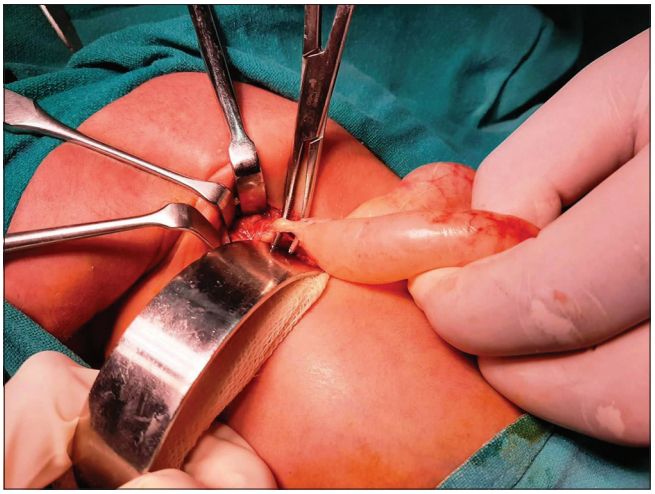


Figure 6: Intraoperative picture showing distal stenosing segment

ureteroneocystostomy with tapering of distal ureteral segment needed in eight cases. Postoperative ureteral obstruction occurred in two patients. These were managed by temporary ureterostomies. There was no difference in the incidence of operation between initially obstructive and partially obstructive POM. The histopathological examination showed hypertrophy of circular muscle fibers with localized deficiency of muscle fibers. In our histological

specimen, the patients with severe obstruction have more severe hypertrophy of muscle fibers. Postoperatively, renal moieties showed good growth with no significant difference between the healthy and contralateral side. Only one child developed a reduction in global GFR due to contralateral VUR. In three children, HTN was observed over a mean follow-up period of 3.7 years. Six children had a decrease in renal function from 47% to 42% [Figures 6 and 7].

Twenty patients (40%) had a spontaneous resolution. The spontaneous resolution could not be predicted on the degree of HDN and diameter of the ureter. The average time for resolution was 24.1 ± 11.1 months (10–36 months). Eight percent (nine) of patients, with initial ureteral diameter <15 mm, showed spontaneous resolution at a mean follow-up of 21 months. The remaining 11 patients resolved over an average follow-up of 28 months. These findings confirmed no significant difference between the two groups in terms of spontaneous regression or need for surgical intervention. In two patients with severe UTI and azotemia, PCN was inserted for stabilization of renal function before definitive surgery. Two patients who failed to respond to DJ stent underwent ureterostomy to stabilize urosepsis before the definitive reconstruction at UVJ during the infantile period. Out of 30 patients who underwent surgical procedures, 21 patients had DRF between 30% and 40%. Renal function improved on subsequent renal scans in four patients, while it remained the same in 21 patients [Bar Chart 2].

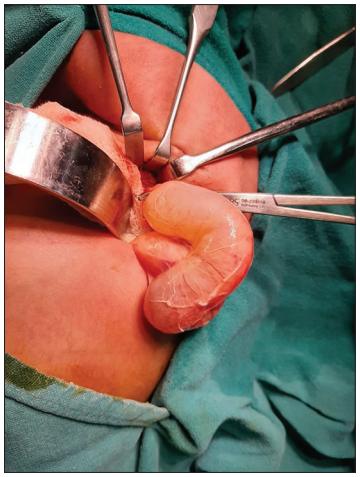
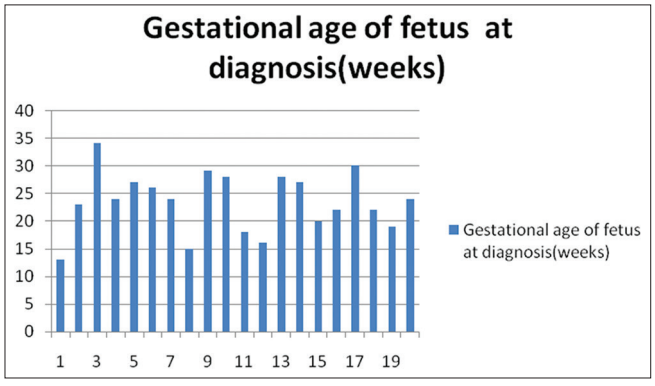


Figure 7: Intraoperative picture showing dilated tortuous ureters



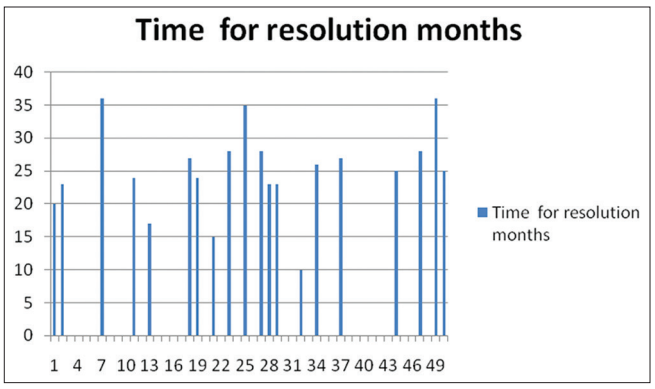
Bar Chart 1: Gestational age of 20 patients diagnosed in the antenatal period

DISCUSSION

In our study, we analyzed the clinical characteristics management and long-term outcome after conservative or operative management of POM cases. The megaureter was usually discovered during infancy or childhood prior to the introduction of prenatal USG.[1] In our study, POM constituted about 18.5% of all the megaureters. A study by Shokeir and Nijman. reported that POM constituted about 25% of all cases of obstructive uropathy.[2]

At present, this pathology accounts for 23% of fetal upper urinary tract dilatation. POM is the third most common cause of upper urinary tract dilatation after pelviureteric junction obstruction and UVR.[3] The predominance of POM on the left side in our series was corresponding with that reported by Keating *et al*.[4] The combination of renal agenesis present in two of our cases associated with POM is consistent with the CAKUT complex which postulates that genetic anomalies in.[5]

The most frequent symptom in children with the postnatal presentation was UTI in 20 patients followed by abdominal pain in eight patients. In a study by Angerri *et al*., the most frequent symptom in infants was UTI and older children had episodes of fever accompanied by abdominal pain.[1] USG is the primary modality for the assessment of HUN antenatally. Sonography plays a key role in the evaluation of megaureters. It can trace the whole ureter from PUJ to UVJ. USG helps in assessing the size, shape, and tortuosity



Bar Chart 2: The time period for resolution of megaureters

of the affected ureter and pelvis. Tortuosity of the ureter and pelvis can give an impression of an obstructive process on sonography. As in our study, USG dimensions of distal ureter were measured in millimeters. In a study by Hellström *et al*. and Smith *et al*., the ureteral size was directly measured from imaging studies and uniformly found ureter to be <6 mm and labeled ureter as megaureter if distal ureter was >8 mm.[6,7] All the cases of megaureters were put on antibiotic prophylaxis. The antibiotic prophylaxis was advised routinely soon after the delivery of the baby.[8] Although the rate of UTI in infants with POM has not yet been formally studied, many authors, including the German consensus paper, recommended antibiotic prophylaxis in infancy until an obstructive megaureter has been excluded.[8,9] BAPU consensus was that antibiotic prophylaxis is advisable for the first 6–12 months of life.[10] Prophylaxis is continued after confirming the diagnosis of the obstructive nature of the megaureter. POM was confirmed postnatally by nuclear scans in all antenatally suspected cases. In a study by Keating *et al*., POM patients were confirmed on the basis of renal scans.[4] The severity of obstruction can be evaluated by parameters, including renal uptake, excretion, time to peak activity, and $t_{½}$ following lasix washout. Technetium 99m (99mTc) DTPA and 99mTc mercaptoacetyltriglycine (MAG 3) evaluate the obstruction. DTPA is a glomerular agent and provides limited information during the 1st month of life because of a low neonatal GFR.[11]

As this was a retrospective study, 16 cases had IUV records, and in 15 cases, MRU was done to delineate the anatomy and function of the obstructed ureters. On a rare occasion, an excretory urogram may play a role when an anatomic definition is required. IVU is waning as a diagnostic modality in the evaluation of pediatric uropathy. Stool, bowel gas, irradiation, contrast allergy, and immaturity of the neonatal kidney limit its utility.[12] MRU has a potentially important future role in the evaluation of the megaureter. MRU with gadolinium has less nephrotoxic effects than contrast agents used for intravenous urography and conventional computed tomography imaging.[13] This imaging modality is particularly important for anatomic study if renal function is compromised. BAPU recommended that all babies with unilateral or bilateral HUN should undergo VCUG obtained to exclude bladder outlet obstruction or posterior urethral valve. BAPU Members said that ureteric dilatation >10 mm was used as a cutoff for MAG-3 scan. We used DTPA scan as MAG-3 was not available in our hospital. Babies presenting in the postnatal period either with UTI or pain were managed in a similar fashion as was the protocol followed by the authors.[13]

All the patients with initial normal scans were followed according to the guidelines set by BAPU. Forty percent of patients in our series had spontaneous resolution. In a study by Charlotte *et al*., half of their patients had spontaneous resolution; they observed entirely normal longitudinal growth of the kidneys with POM compared to healthy contralateral renal units.[14] The spontaneous improvement has been documented in the literature within first 2 years of life.[15,16]

In a study by Mackinnon *et al*., the degree of obstruction correlated with the percentage of circular muscle fibers, as demonstrated in our series.[10] Gregior and Debled found increased collagen infiltration, circular muscle hypertrophy, and varying degree of muscle dysplasia similar to our series.[17] In nine patients, the ureters with an initial ureteric diameter of <15 mm showed spontaneous resolution at a mean follow-up of 24 months. The remaining 11 patients resolved over an average follow-up of 28 months. In a study by Charlotte *et al*., half of the cases regressed over 2 years.[18] As the residual dilatation takes more time for resolution. In a study by Charlotte *et al*., sonographic dilatation of the ureters often persists for some time after relief of obstruction; hence, in their study, it was unlikely to overestimate the rate of spontaneous regression. In our study, there was no correlation between initial diameter of ureter/degree of HDN and the rate of spontaneous regression. In a study by Mclellan *et al*., the initial degree of HDN was not the predictor of spontaneous resolution, and the diameter of the ureter showed correlation with spontaneous resolution of VUJ obstruction.[18] A plausible explanation for this finding in their study could be mirrored by the direct measurement of retrovesicle ureteric distension than by assessing pelvic dilatation.

Although diureteric renogram is widely regarded as the most useful tool for assessing the degree of obstruction, there are little exact data, and the prognosis of intermediate obstruction is unclear.[19,20] We do not believe in the assumption of better prognosis of patients with intermediate obstruction. One of the best indicators for operation is >5% split function deterioration in the subsequent renal scans, as was the protocol followed in our cases. Ureteral reimplantation with or without ureteral tapering is considered the gold standard procedure for these patients, with a documented success rate between 90% and 95%. However, in small infants, reimplantation of a grossly dilated ureter could be challenging and leads to potential complications, such as secondary obstruction, vesicoureteral reflux, and bladder dysfunction.[21] For this reason, temporary urinary diversions could be indicated during the 1st month of life if the baby presents with invasive UTI/azotemia, but diversions are not exempt of complications. As two of our cases did not respond to DJ

stenting for preoperative stabilization, ureterostomy was performed in these two patients. Ureterostomies have problems such as infections, skin irritations, and stenosis.[22] Percutaneous nephrostomies could be done with external tubes but have limited durability in small as was done in two of our cases.[23] However, it remains a nondefinitive open surgery and creates a high-grade secondary VUR.

Follow-up in our cases ranged between 16 and 112 months. All though the longer followup is needed to look for the long term results of management of such cases. In our study, the renal moiety showed good growth with no significant difference between the healthy and the contralateral side. In a study by Scharlotte *et al*., the late renal function deterioration has been reported only after residual dilatation of the urinary tract and not after spontaneous regression.[14]

Limitations of our study were as follows: it was a retrospective study, presentation of the patients was not uniform, as different patients entered in this study at different times (antenatal, postnatal, and late presentation). Follow-up for some patients was short.

CONCLUSION

The babies with POM either present antenatally as HDN/megaureters and postnatally as HDN or UTI. The babies with POM are to be managed conservatively and followed closely. The nuclear renal function scans DTPA/MAG-3 is a baseline investigation to follow such patients. We recommend antibiotic prophylaxis in all such cases. The prediction of the long-term outcome is difficult. The results of our study affirm the belief that POM cases can be observed closely for spontaneous resolution, with surgery needed in almost half of these cases. We recommend babies to be subjected to surgery if function is <40% at the initial scan or there is >5% split function deterioration in subsequent renal scan. DJ stent/PCN or ureterostomy is helpful as a stabilizing procedure in sick babies with POM before definitive reconstruction. Long-term follow-up of these patients will allow us to establish a final course of the treatment.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Angerri O, Caffaratti J, Garat JM, Villavicencio H. Primary obstructive megaureter: Initial experience with endoscopic dilatation. J Endourol 2007;21:999-1004.
2. Shokeir AA, Nijman RJ. Primary megaureter: Current trends in diagnosis and treatment. BJU Int 2000;86:861-8.
3. Stephens FD, Smith ED, Hutson JM. Megaureters in congenital anomalies of the urinary and genital tracts. Oxford: Isis Medical; 1996. p. 187-92.
4. Keating MA, Escala J, Snyder HM 3rd, Heyman S, Duckett JW. Changing concepts in management of primary obstructive megaureter. J Urol 1989;142:636-40.
5. Ichikawa I, Kuwayama F, Pope JC 4th, Stephens FD, Miyazaki Y. Paradigm shift from classic anatomic theories to contemporary cell biological views of CAKUT. Kidney Int 2002;61:889-98.
6. Hellström M, Hjälmås K, Jacobsson B, Jodal U, Odén A. Normal ureteral diameter in infancy and childhood. Acta Radiol Diagn (Stockh) 1985;26:433-9.
7. Smith ED, Cussen LJ, Glenn J, Raimund Stein, Peter Rubenwolf ,Christopher Ziesel, *et al*. Report of working party to establish an international nomenclature for the large ureter. Birth Defects Orig Artic Ser 1977;13:3.
8. Beetz R, Mees A, Mannhardt W, Schofer O, Bokisch A, Fisch M, *et al*. Primärer, nicht-refluxiver megaureter im kindesalter. Aktuelle Urol 1994;25:282-90.
9. Liu HY, Dhillon HK, Yeung CK, Diamond DA, Duffy PG, Ransley PG. Clinical outcome and management of prenatally diagnosed primary megaureters. J Urol 1994;152:614-7.
10. Farrugia MK, Hitchcock R, Radford A, Burki T, Robb A, Murphy F. British Association of Paediatric Urologists consensus statement on the management of the primary obstructive megaureter. 1477-5131/$36 [a] 2013 Journal of Pediatric Urology Company. Published by Elsevier Ltd. http://dx.doi.org/10.1016/j.jpurol.2013.09.018.
11. Antón-Pacheco Sanchez J, Gomez Fraile A, Aransay Brantot A, Lopez Vazquez F, Encinas Goenechea A. Diuresis renography in the diagnosis and follow-up of nonobstructive primary megaureter. Eur J Pediatr Surg 1995;5:338-41.
12. Carrico C, Lebowitz RL. Incontinence due to an infrasphincteric ectopic ureter: Why the delay in diagnosis and what the radiologist can do about it. Pediatr Radiol 1998;28:942-9.
13. Wille S, von Knobloch R, Klose KJ, Heidenreich A, Hofmann R. Magnetic resonance urography in pediatric urology. Scand J Urol Nephrol 2003;37:16-21.
14. Gimpel C, Masioniene L, Djakovic N, Schenk JP, Haberkorn U, Tönshoff B, *et al*. Complications and long-term outcome of primary obstructive megaureter in childhood. Pediatr Nephrol 2010;25:1679-86.
15. Nicotina PA, Romeo C, Arena F, Romeo G. Segmental up-regulation of transforming growth factor-beta in the pathogenesis of primary megaureter. An immunocytochemical study. Br J Urol 1997;80:946-9.
16. Tanagho EA, Smith DR, Guthrie TH. Pathophysiology of functional ureteral obstruction. J Urol 1970;104:73-88.
17. Grégoir W, Debled G. The etiology of congenital reflux and primary megaureter. Urol Int 1969;24:119-34.
18. McLellan DL, Retik AB, Bauer SB, Diamond DA, Atala A, Mandell J, *et al*. Rate and predictors of spontaneous resolution of prenatally diagnosed primary nonrefluxing megaureter. J Urol 2002;168:2177-80.
19. Chertin B, Pollack A, Koulikov D, Rabinowitz R, Shen O, Hain D, *et al*. Long-term follow up of antenatally diagnosed megaureters. J Pediatr Urol 2008;4:188-91.
20. Stehr M, Metzger R, Schuster T, Porn U, Dietz HG. Management of the primary obstructed megaureter (POM) and indication for operative treatment. Eur J Pediatr Surg 2002;12:32-7.
21. Farrugia MK, Hitchcock R, Radford A, Burki T, Robb A, Murphy F, *et al*. British Association of Paediatric Urologists consensus statement on the management of the primary obstructive megaureter. J Pediatr Urol 2014;10:26-33.
22. Kitchens DM, DeFoor W, Minevich E, Reddy P, Polsky E, McGregor A, *et al*. End cutaneous ureterostomy for the management of severe hydronephrosis. J Urol 2007;177:1501-4.
23. Kaefer M, Maizels M. Obstructed megaureter in the newborn-Repair by temporary refluxing megaureter reimplantation. J Pediatr Urol 2015;11:110-2.