Evaluation of Surgical Outcome of Pelviureteric Junction Obstructive Patients by ^{99m}Tc-DTPA Renography

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ABSTRACT

Objectives: Pelviureteric junction (PUJ) obstruction is the most common congenital abnormality of urinary tract and accounts for about 80% cases. ^{99m}Tc-DTPA renography with diuretic challenge helps to distinguish obstructive hydronephrosis from non-obstructive calyceal dilatation and also allows the surgeons to select cases for surgical intervention. This study aims to compare and evaluate the surgical outcomes of PUJ obstructive patients by ^{99m}Tc-DTPA renography.

Patients and Methods: This prospective, longitudinal study was carried out at the Institute of Nuclear Medicine & Allied Sciences (INMAS), Dhaka, during July 2016 to June 2017 and ^{99m}Tc-DTPA renography was done in diagnosed cases of PUJ obstruction (diagnosed by ultrasonography and intravenous urography) before and 3 months after Anderson Hynes (A-H) pyeloplasty. Static renal imaging was also done after 1 and 2 hours after the dynamic acquisition to compare the pre and postoperative anatomical findings.

The study included a total of 70 patients with PUJ obstruction before and after A-H pyeloplasty. Patients with GFR < 10 ml/min, serum creatinine level > 3 mg/dl and pregnancy were excluded.

Result: In this study, 70 (100%) of the preoperative patients had obstructive uropathy. Following surgery, 31 patients (44.3%) had obstructive uropathy, 22 patients (31.4%) had partial obstruction, and 17 patients (24.3%) had functional obstruction. Before surgery, the individuals' mean differential renal function (%) was 38.7 ± 8.2, and after surgery, it was 41 ± 9.8. In preoperative subjects, the mean glomerular filtration rate (ml/min) was 42.1 ± 9.1, while in postoperative ones, it was 46.2 ± 10.8. In preoperative subjects, the mean total glomerular filtration rate (ml/min) was 92.1 + 8.9, while in postoperative ones, it was 95.5 ± 10.4. The pre- and postoperative DTPA renography results differed in a statistically significant way ($p < 0.05$).

Before surgery, the patients had a mean serum creatinine (mg/dl) of 1.3 ± 0.4, and after surgery, it was 1.2 ± 0.4. The pre- and postoperative differences were not statistically significant ($p > 0.05$). Static images of the DTPA renogram acquired one and two hours in post pyeloplasty patients revealed the characteristics of obstruction. Three months after the pyeloplasty, 23 (32.9%) of the participants had stable renal function, 36 (51.4%) had improved renal function, and the remaining 11 (15.7%) had worsened renal function in 99mTc-DTPA renogram.

Conclusion: Most of the study subjects showed improved renal parenchymal function and glomerular filtration rate (GFR) in post pyeloplasty ^{99m}Tc-DTPA renograms at 3 months. Routine ^{99m}Tc-DTPA renogram of all the patients with PUJ obstruction before and after the pyeloplasty might be beneficial for further management as it is a simple, non-invasive, cost-effective technique with low radiation exposure.

Keywords: PUJ obstruction, A-H pyeloplasty, ^{99m}Tc-DTPA renogram, renal function

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INTRODUCTION

Pelviureteric junction (PUJ) obstruction is a blockage at the point where part of the kidney attaches to the ureter. It blocks the flow of urine. It is the most common congenital abnormality of the urinary tract and accounts for about 80% of cases. The frequency of unilateral PUJ obstruction is 1 per 5000–8000 live births (1). It is bilateral in 10–15% of cases (2). It is more common in males, with a male-to-female ratio of 2:1 (3). It is less common in adults than in children, but it is not rare in either population. It is the most common pathological cause of antenatally detected hydronephrosis (4). In general, the peak incidence is in the first six months of life. The left side is more frequently affected (up to approximately 67%), than the right side (5).

The most common presenting symptom of PUJ obstruction is usually intermittent flank or abdominal pain, reported in approximately 50% of older children. Other symptoms include urinary tract infections, hematuria, and palpable intra-abdominal masses. In infants, approximately 50% of intra-abdominal masses are of renal origin, and 40% of them are associated with PUJ obstruction (5). Today, the majority of cases are identified in the perinatal period (6).

PUJ obstruction from congenital causes may result from either an anatomical or a physiologic defect in the upper urinary tract, as primary luminal narrowing caused by an incomplete recanalization, the presence of an aperistaltic segment of the ureter, abnormal or high insertion of the ureter, or ureteral kinks or valves produced by infoldings of the ureteral mucosa and musculature may also cause obstruction. Acquired causes can be due to upper tract infection, stones, or trauma, which can cause reactive fibrosis and the formation of strictures (3).

These abnormalities impair the drainage of urine from the kidney into the ureter, resulting in elevated intrarenal back pressure, dilatation of the collecting system, and hydronephrosis. If the obstruction persists, the resultant back pressure within the renal pelvis results in thinning of the renal parenchyma and progressive loss of renal function (7).

Renogram with ^{99m}Tc-DTPA (Diethyle triamine pentaacetic acid) is a nuclear medicine technique where images are acquired by a gamma camera right after injecting a bolus of radiopharmaceutical intravenously and later graphical representation of renal function is produced. It is a dynamic functional imaging technique that is generally acquired in two consecutive phases- i) Renal blood flow- assessed in the first minute and ii) uptake and clearance- assessed in the next 29 minutes. Well hydration and voiding right before acquisition are usual pre-requisite. Intravenous diuretic (Furosemide) administration to evaluate true obstruction is practiced usually at the 13th to 15th minute of the study period. Two-time activity curves (TACs)—one for each kidney—are generated in a renogram where counts (radioactivity) are drawn against the time (in minutes). Three phases are normally seen in TACs: the perfusion phase (blood flow or 1st phase), the cortical uptake phase (2nd phase), and the clearance phase (3rd phase) (8). The interpretation of a renogram is done by the combination of images, curves, and quantitative parameters (differential renal function, glomerular filtration rate) (9).

Renograms are widely used to assess the extent of obstruction and renal function before and after A-H pyeloplasty (10). The dynamic diuretic renal scintigraphy is important in distinguishing kidneys with poor drainage from non-obstructive hydronephrosis with good drainage (8).

Follow-up of patients after A-H pyeloplasty can be done by ultrasonography, radionucleide renography, and intravenous urography (IVU). Radionuclide renography is usually booked subsequently at 3 months, 6 months, 12 months, and thereafter. Some postoperative patients may not show significant improvement in renal function at 3 months but may improve at 6 months and 12 months after surgery (7).

PATIENTS AND METHODS

This prospective, longitudinal study was carried out at the Institute of Nuclear Medicine & Allied Sciences (INMAS), Dhaka Medical College Hospital Campus, during July 2016 to June 2017 to perform 99mTc-DTPA renogram in diagnosed cases of PUJ obstruction (diagnosed by ultrasonography and intravenous urography) before A-H pyeloplasty and to perform 99mTc-DTPA renogram in same subjects at 3 months after A-H pyeloplasty and also to perform static renal images 1 hour & 2 hours in DTPA renogram in selected postoperative subjects as well as to compare the pre and postoperative renogram to assess outcome. For this purpose, a total of 70 patients with PUJ obstruction before A-H pyeloplasty in the above Institute were included in this study. Patients with GFR < 10 ml/min, serum creatinine level > 3 mg/dl and pregnancy were excluded from the study.

Sample size was calculated by power analysis for the difference between two means (11). Verbal and written informed consents were taken from each participant patient and from guardian in case of minor. At first clinical history, anthropometric measurements (standing height, weight) were recorded in a structured data

collection sheet. Then the patients were given ^{99m}Tc-DTPA i.v (5 mCi in adults and 0.05 mCi/kg body weight, minimum dose 1 mCi in children), and dynamic images were taken. Diuretic (Furosemide) was also given i.v at a calculated dose (based on serum creatinine level in adults and 1 mg/kg body weight to a maximum of 40 mg in children) at the 13th minute of the study. The total study was performed for 30 minutes. The same procedure was repeated in the same patients at 3 months after A-H pyeloplasty. Static renal images at 1 hour and 2 hours were also done in postoperative patients with features of obstructive uropathy in DTPA renography.

Statistical analyses were performed using the Statistical Package for Social Sciences version 20.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Categorical data were expressed in numbers and percentages. Parametric data were expressed as mean $\pm$ SD. Parametric data were evaluated by a paired t-test. Chi-square test was used to evaluate categorical data. Significance was defined by p value < 0.05.

RESULT

In this study, majority (42.9%) subjects belonged to age $\leq$ 10 years. The mean age was 18.5 $\pm$ 16.1 years with ranged from 5 months to 55 years.

Figure-1 pie chart showing the sex distribution of the study subjects.

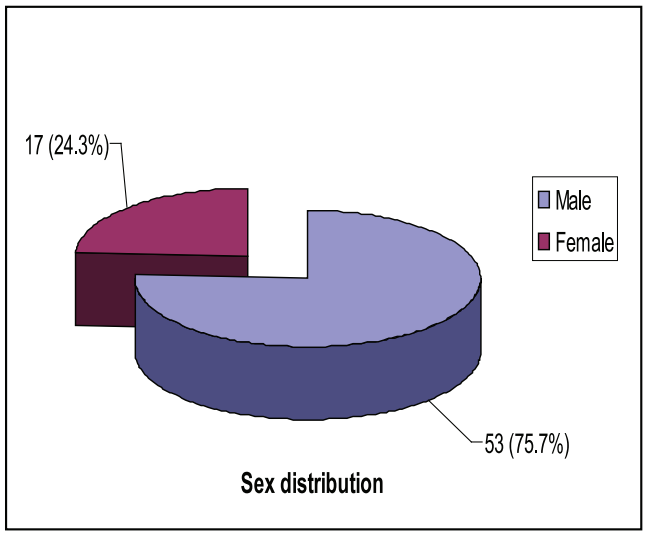

Figure 1: Sex distribution of the study subjects. There were 53 (75.7%) males and 17 (24.3%) females out of 70 subjects.

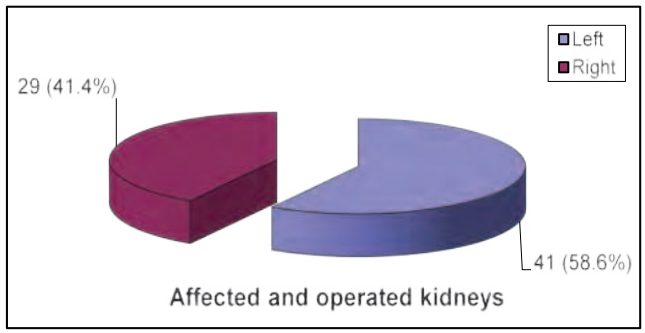

Figure-2: Distribution of affected and operated kidneys. Out of total 70 affected and operated kidneys, 41(58.6%) were left kidneys and 29 (41.4%) were right kidneys.

The commonest clinical presentation was back or flank pain (77.1%) followed by fever (58.6%), urinary tract infection (54.3%), retention of urine (40%), lump in the abdomen (27.1%), hematuria (8.6%), urolithiasis (8.6%) and pyelonephritis (7.1%) respectively. Most of the patients had multiple clinical presentations.

Table 1 illustrates the etiology of PUJ obstructions. Out of the 70 cases, 59 (84.3%) had congenital PUJ obstruction, while 11 (15.7%) had acquired obstruction.

Table 1: Distribution of the study subjects by etiology of PUJ obstruction (n=70)

Etiology	Number of patients (n=70)	Percentage (%)
Congenital	59	84.3%
Acquired	11	15.7%

Table 2 displays the excretion pattern of kidneys found in 99mTc-DTPA renography. About 31 (44.3%) of the participants had obstruction, 22 (31.4%) had partial obstruction, and 17 (24.3%) had functional obstruction after surgery. Of the subjects, 70 (100%) had obstruction before surgery. Pre- and postoperative renography showed a statistically significant ($p<0.05$) difference.

Table 2: Distribution of excretion pattern of the affected kidneys by ^{99m}Tc-DTPA renography (n=70)

Excretion pattern	Preoperative		Postoperative		value
	n	%	n	%	
Obstruction	70	100.0	31	44.3	0.001^{s}
Partial obstruction	0	0.0	22	31.4	
Functional obstruction	0	0.0	17	24.3	

s = significant
p value reached from chi square test

The mean differential renal function (%) was 38.7 ± 8.2 and 41.0 ± 9.8 in pre and postoperative period (Table 3). Mean glomerular filtration rate (ml/min) was 42.1 ± 9.1 and 46.2 ± 10.8 in pre and postoperatively respectively. Mean total glomerular filtration rate (ml/min) was 92.1 ± 8.9 and 95.5 ± 10.4 in pre and postoperatively respectively. The differences were statistically significant ($p<0.05$) between pre and postoperative periods.

Table 3: Distribution of the affected kidneys by differential renal function and glomerular filtration rate in ^{99m}Tc-DTPA renography (n=70)

Parameters	Preoperative Mean ± SD	Postoperative Mean ± SD	
Differential renal function (%)	**38.7 ± 8.2**	**41.0 ± 9.8**	0.016[s]
Range (min, max)	18.9, 57.8	18.2, 58	
Glomerular filtration rate (ml/min)	**42.1 ± 9.1**	**46.2 ± 10.8**	0.001[s]
Range (min, max)	20.3, 65	23.3, 68.3	
Total glomerular filtration rate (ml/min)	**92.1 ± 8.9**	**95.5 ± 10.4**	0.001[s]
Range (min, max)	60.6, 115.2	65.8, 117	

s = significant
p value reached from paired t-test

In this study, the mean serum creatinine (mg/dl) was 1.3 ± 0.4 in preoperative subjects and 1.2 ± 0.4 postoperatively. The difference was statistically not significant ($p > 0.05$) between pre and postoperative periods.

Table 4 shows post pyeloplasty prognosis of renal parenchymal function by DTPA renogram that revealed stable renal function in 23 (32.9%) subjects, while improvement was noticed in 36 (51.4%) subjects and remaining 11 (15.7%) subjects had deterioration in renal parenchymal function.

Table 4: Distribution of the study subjects by post pyeloplasty prognosis of renal\parenchymal function by DTPA renogram (n=70)

Etiology	Improvement	Stable	Deterioration	Total
Congenital	32 (45.6%)	19 (27.2%)	8 (11.4%)	59 (84.3%)
Acquired	4 (5.7%)	4 (5.7%)	3 (4.3%)	11 (15.7%)
Total	36 (51.4%)	23 (32.9%)	11 (15.7%)	70 (100%)

DISCUSSION

The study was conducted to compare the pre and post operative DTPA renography findings.

It was observed that the majority of 42.9% of subjects belonged to age ≤10 years, and the mean age was 18.5 ± 16.1 years, with a range of 5 months to 55 years. Islam, M. W. et al. found the mean age was 24.8 ± 13.6 years and ranged from 5 to 42 years (6).

It was noted that 75.7% of subjects were male and 24.3% were female, and the male-to-female ratio was almost 3:1. Siddique, M. et al. found the male-to-female predominance was greater than 2.6:1, which closely resembled the study (12).

A-H pyeloplasty was done in 41 (58.6%) subjects in the left kidney and 29 (41.4%) in the right kidney. Hamed, M. A. G. observed 42 subjects with unilateral obstruction, out of which 26 (61.9%) were on the left side and 16 (38.1%) on the right side, which was closely similar to our study (13).

The commonest presentation was back or flank pain (77.1%), followed by fever (58.6%), urinary tract infection (54.3%), and retention of urine (40%). Khan, M. et al. reported that the predominant clinical presentation was back or flank pain in 70.83%, which resembled the study (1).

It was observed that obstruction was present in 70 (100%) preoperative subjects and in postoperative subjects; obstruction was seen in 31 (44.3%), partial obstruction in 22 (31.4%), and functional obstruction in 17 (24.3%) subjects. The difference was statistically significant ($p < 0.05$) between the preoperative and postoperative periods. Vinayak, W. et al. reported that drainage was improved in 19 (76%) of the 25 subjects, remained obstructed in four subjects (16%), and was non-assessable in two due to grossly reduced renal function (14).

The mean differential renal function (%) was 38.7 ± 8.2 and 41.0 ± 9.8 preoperatively and postoperatively, respectively. The mean differential renal function (%) was significantly ($p < 0.05$) increased postoperatively in comparison to the preoperative period. Islam, M. W., et al. also revealed improved postoperative mean differential renal function in comparison to the preoperative period (6).

The mean glomerular filtration rate (ml/min) was 42.1 ±

9.1 and 46.2 ± 10.8 in preoperative and postoperative conditions, respectively. The mean glomerular filtration rate significantly ($p < 0.05$) increased postoperatively in comparison to the preoperative period. Morsi, H. A. et al. (15) revealed an improved glomerular filtration rate from 37.25 ± 15.33 to 41.7 ± 19.34 ml/min, which is similar to the study.

It was noticed that post-pyeloplasty ^{99m}Tc-DTPA renograms at 3 months revealed stable renal function in 32.9% of subjects, while improvement in renal function was seen in 51.4% of subjects, and the remaining 15.7% of subjects had deterioration in renal parenchymal function. Khan, M. et al. reported that post-pyeloplasty renograms at 3 months revealed stable renal function in 39.6 % of subjects, while improvement was noticed in 43.8 % of subjects. The remaining 16.6% had deterioration in renal function (1).

CONCLUSION

In most of the study subjects, the differential renal parenchymal function and glomerular filtration rate were significantly increased in the postoperative period. Post-pyeloplasty ^{99m}Tc-DTPA renograms at 3 months revealed that about half of the patients had improved renal function. So, a routine 99mTc-DTPA renography of all of the patients with PUJ obstruction before and also after A-H pyeloplasty will be helpful to evaluate the renal parenchymal function as well as plan for further management as a simple, non-invasive, relatively cheap, and cost-effective method in a developing country like Bangladesh. However, a nationwide, large-scale study and six months of postoperative follow-up would be the better way for proper evaluation and clinical validation.

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