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Improvement of Renal Function after Pyeloplasty Determined by 99mTc DTPA Renogram

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Abstract

Objective: *To evaluate the improvement of renal function after pyeloplasty measured by 99mTc-DTPA renography.*

Materials and Methods: *This hospital based quasi experimental study was done in the department of urology, National Institute of Kidney Diseases and Urology (NIKDU) and Bangladesh Institute of Research and Rehabilitation for Diabetes, Endocrine and Metabolic Disorders (BIRDEM) from July 2014 to December 2020. Sixty patients were included in this study who underwent Anderson-Hynes (A-H) dismembered pyeloplasty for pelviureteric junction (PUJ) obstruction. All patients were evaluated with diuretic 99mTc-DTPA renogoam before and at 3 and 6 months after operation. Improvement of renal function was evaluated by comparing preoperative and postoperative differential renal function (DRF) and glomerular filtration rate (GFR).*

Results: *Sixty patients with unilateral hydronephrosis due to PUJ obstruction were included in this study. Of these patients 34 male and 26 female with mean age of 15.6 years (ranged from 3 – 38 years). Out of 60 patients, 56.7% had left sided hydronephrosis and 43.3% had right sided hydronephrosis. Diuretic renography was done using 99mTc-DTPA in all patients preoperatively and at 3 and 6 months postoperatively. Preoperative mean DRF and GFR were compared with post-operative findings. The mean preoperative DRF in the study was 16.72 ± 8.35% at baseline which increased to 26.03 ± 7.08% at the end of 3rd month and 28.15 ± 5.84% at the end of 6th month. The mean preoperative GFR was 14.29 ± 6.73 ml/min/1.73 m^2 at baseline which increased to 24.13 ± 5.31ml/min/1.73 m^2 at the end of 3rd month and 27.38 ± 4.78 ml/min/1.73 m^2 at the end of 6th month.*

Conclusion: *The result demonstrates that, after pyeloplasty renal function improves. Highest recovery of renal function occurs in children and patients with poor pre-operative DRF and GFR.*

Keywords: Renal function, Pyeloplasty, ATPA

Introduction:

Pelviureteric junction (PUJ) obstruction is probably the commonest congenital abnormality of the ureter. It is reported to occur in 1:500 to 1:1250 live births.[1] Most cases of childhood HDN are now detected by perinatal ultrasonography (USG). As, in majority of the cases infants are asymptomatic, it is important to assess deterioration of anatomical and functional status of the hydronehrotic kidney.[2] For evaluation of obstruction and renal function (RF) intravenous urography (IVU) & diuretic renography are done. The initial differential renal function (DRF) and the time activity curve in

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diuretic renogram of the affected kidney help to determine the treatment protocol.[3,4]

PUJ obstruction is treated surgically and early intervention prevents possible complication (2). Among different surgical techniques of pyeloplasty, Anderson-Hynes (A-H) dismembered pyeloplasty has become the most commonly employed surgical procedure. Success is defined as resolution of symptoms and stabilization or improvement in function on diuretic renogram.[5]

The potential improvement of renal function after pyeloplasty depends on multiple factor like, degree of obstruction[4],duration of obstruction[6], preoperative DRF on radionuclide renogram[7,8], renal cortical thickness[8] and the age of patient at the time of relief of obstruction.[9] Factors that have a positive influence on functional recovery include a smaller degree of obstruction, greater compliance of the collecting system and presence of pyelo-lymphatic backflow.[10] Conversely, older age and decreased renal cortical thickness are predictors of diminished recovery of renal function.[11]

USG and IVU do not provide adequate early postoperative functional assessment as, pelviectasis and caliectasis both may exist in an unobstructed system.[12] In contrast, diuretic renography offers a truly quantifiable assessment of renal function and drainage that can be objectively compared with the preoperative scan. Consequently, persistant obstruction can be detected promptly to allow further intervention.

Method

After taking prior approval from respective ethical committees, this hospital based quasi experimental study was conducted in the department of Urology, NIKDU and BIRDEM from July 2014 to December 2020. Patients with asymptomatic or symptomatic unilateral HDN due to PUJ obstruction, with or without any complication attending in the urology outdoor and consented for the study, were admitted in different urology units. Patients with bilateral HDN, HDN due to vesicoureteral reflux (VUR) and recurrent PUJ obstruction were excluded. We divided our study population in different groups in respect of age, preoperative DRF and GFR. Under general anaesthesia, retrograde pyelography (RGP) was done. Then A-H pyeloplasty was carried out over a D-J stent by retro-peritoneal flank approach. After 6 weeks, D-J stents were removed as an outpatient procedure. During their follow up, after 3 and 6 month, every patient was evaluated by taking history, clinical examination and 99mTc-DTPA renogram. Data were collected on variables of interests and were analyzed using chi-square (x^2) test, ANOVA and Wilcoxon Signed Rank Test. For all analytical tests, the level of significance was set at 0.05 and p value <0.05 was considered significant.

Results

Table I: Age distribution of patients (n = 60)

Age (years)	Frequency	Percentage
<10	20	33.3
10 - 20	22	36.7
>20	18	30.0

Mean age = (15.6 ± 9.8); **range** = (3-38) years.

Table II : Distribution of Patients by baseline DRF.

Baseline DRF (%)	Frequency	Percentage
Poor (< 20%)	30	50
Moderate (20 – 30%)	28	46.7
Good (> 30%)	2	3.3

Mean ± SD = (16.72 ± 8.35) %; **range** = 10 – 33%.

Table III: Changes in DRF at different time interval following pyeloplasty.

DRF (%)	Mean	S.D	p value*
Pre-operative	16.72	8.35	0.02
3 months post-op.	26.03	7.08	
6 months post-op.	28.15	5.84	

* Data were analyzed using ANOVA test.

Table IV: *Baseline status and change in DRF of operated kidney after 6 month.*

Functional status of kidney at baseline	DRF (Mean ± SD)			p value*
	Baseline (Pre-operative)	After 6 month of intervention	Percentage Improvement	
Poor (n = 30)	15.20 ± 4.09	25.85 ± 5.92	70.06	0.020
Moderate (n = 28)	21.50 ± 4.86	26.65 ± 3.48	24.88	0.018
Good (n = 2)	32.10 ± 1.25	34.50 ± 1.15	12.45	0.018

*Data were analyzed using Wilcoxon Signed Rank Test.

Table V : Improvement of DRF in different age groups, after 6 months of pyeloplasty.

Age (years)	DRF (Mean ± SD)			p value*
	Baseline (Pre-operative)	6 months after intervention	Percentage Improvement	
< 10 (n = 20)	15.78 ± 4.78	27.40 ± 5.13	73.63	0.028
10 – 20(n = 22)	16.75 ± 4.24	27.03 ± 6.48	61.37	
> 20 (n = 18)	17.15 ± 3.56	26.11 ± 4.67	52.24	

* Data were analyzed using Wilcoxon Signed Rank Test.

Table VI: *Distribution of patients by baseline GFR.*

Baseline GFR (ml/min/1.73 m^2)	Frequency	Percentage
Poor (< 20)	50	83.3
Moderate(20 – 30)	7	11.7
Good(> 30)	3	5.0

Table VII: GFR at different time interval.

GFR(ml/min/1.73 m^2)	Mean	S.D	p value*
Initial (Pre-operative)	14.29	6.73	0.026
3 months post-op.	24.13	5.31	
6 months post-op.	27.38	4.78	

* Data were analyzed using ANOVA test.

Table VIII: Baseline status and change in GFR of affected kidney after 6 month.

Functional status of kidney at baseline	GFR (ml/min/1.73 m^2) (Mean ± SD)			p value*
	Baseline (Pre-operative)	After six month Of intervention	Percentage Improvement	
Poor (n = 50)	11.74 ± 3.43	26.02 ± 3.84	121.63	0.01
Moderate (n = 7)	25.14 ± 3.02	33.99 ± 3.34	35.21	0.018
Good(n = 3)	31.47 ± 1.48	34.67 ± 1.15	10.17	0.02

* Data were analyzed using Wilcoxon Signed Rank Test.

Table IX: Improvement of GFR in different age groups, after 6 months of pyeloplasty

Age (years)	GFR (ml/min/1.73 m^2) (Mean ± SD)			p value*
	Baseline (Pre-operative)	After six month of intervention	Percentage Improvement	
< 10 (n = 20)	13.73 ± 5.62	22.60 ± 4.82	64.60	0.03
10 – 20(n = 22)	13.40 ± 5.31	23.01 ± 4.87	71.72	
> 20 (n = 18)	20.43± 8.51	31.83 ± 7.00	55.80	

*Data were analyzed using Wilcoxon Signed Rank Test.

Discussion

Sixty (60) patients with unilateral HDN due to PUJ obstruction were included in this study. The age ranges of the patient were 3 to 38 years with a mean age 15.6 ± 9.8 years. It was observed that the highest frequency of patients (36.7%) was in the age group 10 - 20 years. Over one quarter (33.3%) of patients was below 10 years of age and 30.0 % was above 20 years. Of these patients 34 male and 26 female. Out of 60 patients, 56.7% had left sided HDN and 43.3% had right sided HDN.

This study demonstrates that, 50% of the patient had baseline DRF below 20%, another 46.7% had DRF between 20-30% and the rest 3.3% had DRF more than 30%. The mean base line DRF was 16.72 ± 8.35and the lowest and highest DRF were 10% and 33% respectively.

The mean preoperative DRF in the study was 16.72 ± 8.35% at baseline which increased to 26.03 ± 7.08% at the end of 3rd month and 28.15 ± 5.84% at the end of 6th month. ANOVA statistics revealed significant improvement in SRF at 3rd month and 6th month from their baseline status.

This study also showed that, poorly functioning kidney (DRF <20%) at baseline exhibited improvement in DRF by 70.06%, while moderately functioning kidney (DRF 20-30%) by 24.88% and good functioning kidney (DRFÃ30%) did not experienced significant improvement in DRF at 6 month (12.45%). This data thus indicate that preoperative poor functional status is associated with better recovery of renal function after pyeloplasty.

The association between initial DRF and functional improvement at 6 month was notable. Over 58% (n = 30) of patient of initial DRF <20% showed improvement, where in DRF 20-30% group showed 39.2% (n = 20) and DRF Ã30% group only 2%(n=1) showed improvement. In the not improved group, about 89% (n=8) patient had DRF 20-30% and about 11% (n=1) patient had DRF Ã30%. Patients with preoperative DRF <20% exhibited significant improvement at 6 month compared to other patients who had initial DRF more than that.

In the series of Harraz et al. (8), their primary outcome measures were greater than 5% improvement in baseline DRF. They found that, DRF was more likely to improve when preoperative DRF was less than 40%. This could be explained by the fact that in patients with lower baseline DRF there is more space for the kidney to recover than in those with better baseline DRF. Their result was consistent with Almodhen et al. (13). In their series none of 49 patients with baseline DRF greater than 45% achieved more than 5% improvement postoperatively compared to 43% with baseline DRF less than 45%, who achieved greater than 5% improvement. Our result is also consistent with earlier studies. Wagner et al. (14) studied with 32 children with unilateral hydronephrosis due to PUJ obstruction. Among three groups, patient with initial DRF <10% showed highest improvement (DRF 53%) on 12 month follow-up and supports their approach of performing pyeloplasty in patients even with an initial DRF of <10 %. So the finding of higher recovery or improvement of renal function with initial lower DRF in this study is consistent with previous works.

This study shows highest functional improvement in young age group from their baseline status in terms of change in DRF. Patients of age <10 years (n=20) made marked improvement (73.63% improvement) compared to patients of age 10-20 years (n = 22) (61.37% improvement). Patient of Ã 20 year age (n= 18) showed lowest improvement (52.24% improvement). The data thus indicate that, lower the age higher the likelihood of improvement or recovery of function after surgical correction of PUJ obstruction. Our result matches with the inference with Castagnetti et al. (6) that, patients diagnosed postnatally because of symptoms are with the greatest likelihood of having a functional improvement after surgery. Our finding also matches with Abdelaziz (15) where pyeloplasty provides high rates of functional recovery in very poorly functioning kidneys with DRF d"10% in pediatric age group

In this study, preoperative GFR analysis revealed that, 83.3% (n = 50) of patient had baseline GFR <20 ml/ min/1.73 m^2 , 11.7% (n = 7) patient had GFR between 20-30 ml/min/1.73 m^2 and the remaining 5% (n = 3) had GFR Ã30 ml/min/1.73 m^2.

The mean preoperative GFR was 14.29 ± 6.73 ml/min/ 1.73 m^2 at baseline which increased to 24.13 ± 5.31ml/ min/1.73 m^2 at the end of 3rd month and 27.38 ± 4.78 ml/min/1.73 m^2 at the end of 6th month.

Kidneys with poor GFR(<20 ml/min/1.73 m^2) at baseline exhibited 121.63% improvement, while kidneys with moderate GFR(20-30 ml/min/1.73 m^2) showed 35.21% improvement and kidneys with good GFR(Ã30 ml/min/1.73 m^2) showed 10.17% improvement after 6 month. The patient with initial GFR <20 ml/min/1.73 m^2 exhibited significant improvement at 6 month compared to those who had initial GFR more than that.

The association between initial GFR and functional improvement at 6 month was notable. Over 92.6% (n = 50) of patient of initial GFR <20 ml/min/1.73m^2 showed improvement, where in GFR 20-30 ml/min/1.73 m^2 group 7.4% (n = 4) showed significant improvement but GFR Ã30 ml/min/1.73m^2 group showed minimal or no improvement. In the not improved group, about 50% (n=3) patient had GFR 20-30 ml/min/1.73 m^2 and remaining 50% (n=3) patient had GFR Ã30 ml/min/1.73m^2.

Postoperative GFR analysis at the end of 6 month revealed, age group <10 (n=20) year showed 64.60% improvement with baseline GFR 13.73 ± 5.62 ml/min/1.73m^2 and postoperative GFR 22.60 ± 4.82 ml/min/1.73m^2. Age group 10-20 (n=22) year showed 72.71% improvement with baseline GFR 13.40 ± 5.31 ml/min/1.73m^2 and postoperative GFR 23.01 ± 4.87 ml/min/1.73m^2. Age group Ã20 (n=18) year showed 55.80% improvement with baseline GFR 20.43± 8.51 ml/min/1.73m^2 and postoperative GFR 31.83 ± 7.00 ml/min/1.73m^2.

The work of Materny et al. (16) showed that, when preoperative and consecutive postoperative DRF values did not reveal any significant differences, a progressive increase in GFR was noted at three months from surgery, becoming most significant after 12 months.

Correction of PUJ obstruction at early age shows relatively better outcome perhaps due to less renal insult and developmental compensation. Whereas, repeated infection and scarring in an obstructed kidney hinders significant recovery of renal function after pyeloplasty in elderly patients. Compensatory hypertrophy of the normally functioning opposite kidney in elderly population also impedes the improvement of renal function after delayed intervention.

Reis et al. (17) enquired about adequacy of follow-up length in patients undergoing pyeloplasty. He studied 28 patient (mean age 2.4 years) for Ã5 years and concluded that, Satisfactory diuretic renogram at 3 to 6 months after pyeloplasty with maintained renal function and stable hydronephrosis suggests no need for further follow-up and indicates no functional loss with time. So the follow-up period of 6 month of this study is justified.

Conclusion

In a nutshell, this study clearly demonstrates that, renal function improves after A-H pyeloplasty measured by 99m Tc-DTPA renogram. Rapid and significant functional improvement occurs by 3 months and a small improvement continued thereafter. Recovery of renal function is greatest in children and patients with poor pre-operative DRF and GFR.

Conflict of interest: Nothing to declare.

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