

# Evaluation of renal function after pyeloplasty determined by <sup>99m</sup>Tc DTPA renogram

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## ABSTRACT

**Background:** Hydronephrosis (HDN) due to pelviureteric junction (PUJ) obstruction is a common congenital anomaly of urinary tract which is generally treated by pyeloplasty. But the extent of functional recovery is still debated. Considering the existing controversies, this study was designed to evaluate the changes of renal function after pyeloplasty measured by <sup>99m</sup>Tc-DTPA renography.

**Methods:** This study was done in the department of urology, National Institute of Kidney Diseases and Urology (NIKDU) and Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) General Hospital from July 2014 to December 2020. Sixty patients were included in this study and underwent Anderson-Hynes (A-H) dismembered pyeloplasty for PUJ obstruction. All patients were evaluated with diuretic <sup>99m</sup>Tc-DTPA renogram before and at 3 and 6 months after pyeloplasty. Improvement of renal function was evaluated by comparing preoperative and postoperative differential renal function (DRF) and glomerular filtration rate (GFR).

**Results:** Sixty patients (34 male and 26 female) with unilateral HDN due to PUJ obstruction were included in this study with mean age of 15.6 years (ranged from 3 – 38 years). Out of 60 patients, 56.7% had left sided HDN and 43.3% had right sided HDN. The mean preoperative DRF was  $16.72 \pm 8.35\%$  at baseline which increased to  $26.03 \pm 7.08\%$  at the end of 3rd month and  $28.15 \pm 5.84\%$  at the end of 6th month. The mean preoperative GFR was  $14.29 \pm 6.73$  ml/min/1.73 m<sup>2</sup> at baseline which increased to  $24.13 \pm 5.31$  ml/min/1.73 m<sup>2</sup> at the end of 3rd month and  $27.38 \pm 4.78$  ml/min/1.73 m<sup>2</sup> at the end of 6th month.

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

**Key words:** hydronephrosis, pelviureteric junction obstruction, pyeloplasty, <sup>99m</sup>Tc-DTPA renography, differential renal function, glomerular filtration rate.

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## INTRODUCTION

Hydronephrosis (HDN) due to pelviureteric junction (PUJ) obstruction is the most common upper urinary tract congenital anomaly that causes variable symptoms

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like flank pain, hematuria, urinary tract infection (UTI) and deterioration of renal function. It is reported to occur in 1:500 to 1:1250 live births.<sup>1</sup> Widespread use of perinatal ultrasonography (USG) and the advancement of new imaging modalities contributed to earlier diagnosis of childhood HDN. As majority of the infants are asymptomatic, it is important to assess the extent of anatomical and functional deterioration of the hydronephrotic kidney.<sup>2</sup> For evaluation of obstruction and renal function (RF) intravenous urography (IVU) and diuretic renography are done. The initial differential renal function (DRF) and the time activity curve in diuretic renogram of the affected kidney help to determine the treatment protocol.<sup>3,4</sup>

PUJ obstruction is treated surgically and early intervention prevents potential complications.<sup>2</sup>

Anderson-Hynes (A-H) dismembered pyeloplasty is the commonly employed surgical procedure for correction of this problem. Success is defined as resolution of symptoms and stabilization or improvement in function on diuretic renogram.<sup>5</sup> After pyeloplasty, improvement of renal function depends on multiple factor like, degree of obstruction<sup>4</sup>, duration of obstruction<sup>6</sup>, preoperative DRF on radionuclide renogram<sup>7,8</sup>, renal cortical thickness<sup>8</sup> and the age of patient at the time of relief of obstruction.<sup>9</sup>

As pelviectasis and caliectasis both may exist in an unobstructed system, ultrasonography (USG) and intravenous urography (IVU) do not provide adequate early postoperative functional assessment.<sup>10</sup> In contrast, diuretic renography offers a truly quantifiable assessment of renal function that can be objectively compared with the preoperative scan. Moreover, persistent obstruction can be detected promptly to allow further intervention. This study was designed to evaluate the changes of renal function after pyeloplasty measured by <sup>99m</sup>Tc-DTPA renography.

## METHODS

This multicenter prospective quasi experimental study was conducted in the department of Urology, NIKDU and BIRDEM from July 2014 to December 2020. Patients with 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 preoperative DRF and GFR. Under general anaesthesia, retrograde pyelography (RGP) was done. Then A-H pyeloplasty was carried out by retro-peritoneal flank approach, over a D-J stent. 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 <sup>99m</sup>Tc-DTPA renogram. Data were collected on variables of interests and were analyzed using chi-square ( $\chi^2$ ) 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

In present study, mean age of the patients was 15.6 years, ranged from 3 – 38 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.

**Table I** Distribution of patients by age

| Age   | 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.

Fifty percent 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 ± 8.35 and the lowest and highest DRF were 10% and 33% Respectively.

**Table II** explains the changes in DRF at different time interval. The mean DRF was 16.72 ± 8.35% at baseline which increased to 26.03 ± 7.08% at the end of 3<sup>rd</sup> month and 28.15 ± 5.84% at the end of 6<sup>th</sup> month. ANOVA statistics revealed significant improvement in DRF at 3<sup>rd</sup> month and 6<sup>th</sup> month from their baseline status.

**Table II** 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 III** shows that poorly functioning kidney at baseline exhibited improvement in DRF by 70.06% improvement, while moderately functioning kidney by 24.88% and good functioning kidney did not experienced significant

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

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

\*Data were analyzed using Wilcoxon Signed Rank Test.

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.

Fifty (83.3%) of patient had baseline GFR  $<20$  ml/min/ $1.73$  m<sup>2</sup>, 11.7% (n = 7) patient had GFR between 20-30 ml/min/ $1.73$  m<sup>2</sup> and the remaining 5% (n = 3) had GFR  $\geq 30$  ml/min/ $1.73$  m<sup>2</sup>.

Table IV shows the changes in GFR at different time interval. The mean GFR was  $14.29 \pm 6.73$  ml/min/ $1.73$  m<sup>2</sup> at baseline which increased to  $24.13 \pm 5.31$  ml/min/ $1.73$  m<sup>2</sup> at the end of 3rd month and  $27.38 \pm 4.78$  ml/min/ $1.73$  m<sup>2</sup> at the end of 6th month. ANOVA statistics revealed significant improvement in GFR at 3rd month and 6th month from their baseline status.

Table V shows that, kidneys with poor GFR ( $<20$  ml/min/ $1.73$  m<sup>2</sup>) at baseline exhibited 121.63% improvement, while kidneys with moderate GFR (20-30 ml/min/ $1.73$  m<sup>2</sup>) showed 35.21% improvement and kidneys with good GFR ( $>30$  ml/min/ $1.73$  m<sup>2</sup>) showed 10.17% improvement after 6 month.

**Table IV** GFR at different time interval

| GFR(ml/min/ $1.73$ m <sup>2</sup> ) | 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 V** Baseline status and change in GFR of affected kidney after 6 month

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

\* Data were analyzed using Wilcoxon Signed Rank Test

## DISCUSSION

In the present study, most of the patient gained objective improvement demonstrated by <sup>99m</sup>Tc DTPA renogram. Most of the kidney showed functional improvement on follow-up <sup>99m</sup>Tc DTPA renogram. This finding is consistent with the study conducted by Harraz et al.<sup>8</sup>

Sixty (60) patients with unilateral hydronephrosis due to PUJ obstruction were included in this study. 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. The mean preoperative DRF was  $16.72 \pm 8.35\%$ , which increased to  $26.03 \pm 7.08\%$  at the end of 3rd month and  $28.15 \pm 5.84\%$  at the end of 6th month. ANOVA statistics revealed significant improvement in DRF 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 (DRF >30%) did not show 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 >30% 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 >30%. 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.<sup>8</sup> 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.<sup>11</sup> 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.<sup>12</sup> 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%. Our finding also matches with Abdelaziz<sup>13</sup> where pyeloplasty provides high rates of functional recovery in very poorly functioning kidneys with DRF <10% in pediatric age group. So the finding of higher recovery or improvement of renal function with initial lower DRF in this study is consistent with previous works.

In this study, kidneys with poor GFR (<20 ml/min/1.73 m<sup>2</sup>) at baseline exhibited 121.63% improvement, while kidneys with moderate GFR (20-30 ml/min/1.73 m<sup>2</sup>) showed 35.21% improvement and kidneys with good GFR (>30 ml/min/1.73 m<sup>2</sup>) showed 10.17% improvement after 6 month. The patient with initial GFR <20 ml/min/1.73 m<sup>2</sup> 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/1.73 m<sup>2</sup> showed improvement, where in GFR 20-30 ml/min/1.73 m<sup>2</sup> group 7.4% (n = 4) showed significant improvement but GFR >30 ml/min/1.73 m<sup>2</sup> 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<sup>2</sup> and remaining 50% (n=3) patient had GFR >30 ml/min/1.73 m<sup>2</sup>.

The work of Materny et al.<sup>14</sup> 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, which becomes most significant after 12 months.

DRF calculated by <sup>99m</sup>Tc-DTPA, <sup>99m</sup>Tc-MAG3, and <sup>99m</sup>Tc-DMSA renogram can be used reliably and each method gives similar measures.<sup>15</sup> Among these <sup>99m</sup>Tc-DTPA renogram is most widely available and cheap. So, we picked it as our quantification tool.

Reis et al.<sup>16</sup> enquired about adequacy of follow-up length in patients undergoing pyeloplasty. They studied 28 patient ( mean age 2.4 years ) for >5 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. In view of this study, the follow-up period of 6 month of our study is justified.

## Conclusion

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

## Limitation of the study

There are few limitations of this study like, small sample size and pyeloplasties were done by different surgeons from different urology units.

## Recommendations

In the light of observation and results of the study, it can be inferred that, pyeloplasty results in renal functional improvement which is most marked in poorly functioning kidneys. Early pyeloplasty can prevent future deterioration of renal function and can help to reduce the number of nephrectomies.

**Authors' contribution:** MTA contributed in literature search. Both MTA and ATMMC conceptualized the study design. MTA collected and analyzed data and drafted manuscript. ATMMC was involved in critical review of manuscript and overall supervision.

**Conflict of interest:** Nothing to declare.

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