“Correlation of the anteroposterior diameter of the renal pelvis and parenchymal thickness after 3 months of Anderson-Hynes Dismembered Pyeloplasty in predicting change in the glomerular filtration rate and split renal function after 1 year in children with Ureteroplevic Junction Obstruction”

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ABSTRACT

BACKGROUND:

The Gold standard surgical treatment for pelviureteric junction obstruction is Anderson Hynes dismembered pyeloplasty. The Objective evidence of improvement is change in pelvic anteroposterior diameter (APD), parenchymal thickness and increased GFR(glomerular filtration rate) in DTPA. On extensive English language based literature search, literature on correlation of the post operative ultrasound parameters in predicting the functional improvement is sparse. The following study is an attempt to assess the various ultrasound parameters in predicting the change in the renal function after pyeloplasty.

OBJECTIVE:

To correlate the ultrasound variables with changes in GFR after one year in predicting the functional outcome of pyeloplasty

MATERIAL AND METHODS:

A retrospective study was conducted at NU Hospitals Bangalore between January 2012 to March 2016. All children underwent ultrasound abdomen preoperatively and 3 months after pyeloplasty to record the APD of renal

pelvis, parenchymal thickness. As a protocol isotope renogram in the form of DTPA (DiethyleneTriaminePentaacetic Acid) scan was done preoperatively and at 1 year of follow up. Statistical analysis was performed using Pearson correlation coefficient to correlate the ultrasound variables in predicting the change in renal function in DTPA after 1year of pyeloplasty.

RESULTS

45 children studied. The mean pre operative APD was 4.01 cm. The mean post operative APD was 3.08 cms (p= <0.005). The mean pre operative parenchymal thickness was 4.072mm. The mean increase in parenchymal thickness was 6.01 mm. The mean preoperative GFR was 36.4 ml/min and mean GFR postoperatively was39.4ml/min. Among the total, 39 renal units had increased split renal function of more than 5%. Pearson correlation coefficient for parenchymal thickness was 1.1 and for pelvic diameters was 0.78.

CONCLUSION

APD correlates better than parenchymal thickness reflecting the change in renal function after 1 year of pyeloplasty.

ABBREVIATIONS

UPJO- Uretero Pelvic Junction Obstruction, **USG** - Ultrasonography

DTPA- Diethylene Triaminep Pentaacetic Acid, **AP**- Antero Posterior

GFR- Glomerular Filtration Rate, **PT**- Parenchymal Thickness

AH- Anderson Hynes, **SD**- Standard Deviation, **NU**- Nephro Urology

F- Furosemide, EANM- European Association of Nuclear Medicine

KEY WORDS: Pelviureteric junction, Pyeloplasty, Renogram

1. INTRODUCTION

Pelviureteric junction obstruction (PUJO) is the most common cause of pediatric hydronephrosis[1]. The obstruction is usually functional and the bolus of urine is not effectively propelled across the pelviureteric junction[2]. With the routine use of antenatal ultrasound, antenatal hydronephrosis (ANH) is now more commonly detected and the commonest age at presentation is in early post natal life with history of antenatally detected hydronephrosis[3]. The most common presentation in other age groups is abdominal pain. It is not uncommon to see a patient who are asymptomatic, detected incidentally, with significant renal damage or a non functioning kidney[4].

It is one of the common differential diagnosis in a child presenting with flank pain. However confirmation needs either an IVU(intravenous urography) or a DTPA scan[4].

The Gold standard surgical treatment for PUJO is Anderson Hynes(AH) dismembered pyeloplasty. Pyeloplasty results in a dependent, tension free, anastamosis with meticulous attention to the vascularity, which relieves the obstruction and is also expected to help in functional improvement[5]. There are certain parameters to assess the post operative outcomes of pyeloplasty. The ultrasound parameters are, the reduction in the AP diameter of the pelvis, calyceal diameters and increase in paranchymal thickness in a growing kidney. The definitive evidence of improved function is by doing an isotope renogram in the followup period, objectively to look for the improvement in GFR(glomerular filtration rate) and also the radiotracer clearance from the PCS (pelvicalyceal system).

The ultrasound is a simple, non invasive, easely availailable and commonly used investigation, used to assess the children

postoperatively. The change in ultrasound parameters reflect the intrapelvic pressure in the PCS[6]. There are no standardised ultrasound parameters which exactly reflects the functional improvement afetr AH. The available ultrasound parameters are the supportive parameters in the form of reduction in pelvicalyceal diameter as a result of low pressure in the PCS, which helps in unhampered renal growth reflected as increased paranchymal thickness. The questions that arise are, does improvement in ultrasound parameters really reflects functional improvement? Which of the ultrasound parameters correlates better in indicating functional improvement? so can investigations involving radiation to assess functional improvement can be safely avoided in the follow up period.

The need for this study is, in the literature there are many studies which studied the various pre-operative parameters which influence the post-operative outcomes after pyeloplasty. In reality there are various ultrasound parameters in the post operative period which indicate the change in renal function. Our study is an effort to find out the correlation of the post operative ultrasound parameters in predicting the change in GFR (Glomerular filtration rate).

AIMS AND OBJECTIVE

- To compare two ultrasound variables, (Parenchymal Thickness and Pelvic Anteroposterior Diameters) before and 3 months after pyeloplasty.
- To correlate ultrasound parameters at 3 months with the GFR after one year to find out whether change in ultrasound parameters reflects the change in GFR of that renal unit in DTPA after 1 year of pyeloplasty.
- To evaluate which of these two ultrasound parameters correlates better in predicting the change in GFR of that renal unit.

MATERIALS AND METHODS

A retrospective study was conducted from January 2012 to March 2015 at NU Hospitals Bangalore, to look for the "Correlation of the anteroposterior diameter of renal pelvis and parenchymal thickness after 3 months of Anderson-Hynes dismembered pyeloplasty in predicting change in the glomerular filtration rate and split renal function after 1 year in paediatric patients with ureteroplevic junction obstruction". A minimum of 38 patients were required for the study with confidence level of 95% and a margin error of 5%. We included 45 children for the ease of calculation.

All subjects were selected from the pool of children who attended our outpatient department and have proven PUJO and meeting the criteria for the need of surgical intervention. The Inclusion criterion was children below 18 years who underwent AH pyeloplasty for ureteropelvic junction obstruction. Children with Horseshoe kidney with UPJO, Pelvic kidney with UPJO, Bilateral UPJO, Patients, who were Lost to follow up, Redo pyeloplasty, Secondary cause of UPJO, Renal failure were excluded.

All children had undergone basic evaluation of blood and urine. An ultrasound abdomen was done at first visit to specifically look at the size of the kidney, AP diameter between the two lips of the kidney, calyceal diameter, parenchymal thickness, renal echogenicity, content in the pelvis and the presence of scars. A DTPA scan was done to confirm the diagnosis and also to measure the GFR and split function of each kidney. DTPA was performed using a standard protocol. Children were well hydrated before the procedure, F_0 protocol was used in most the children. F-15 protocol in gross hydronephrosis. Dose of Lasix in children was

1mg/kg body weight. Dose of radiopharmaceutical required was calculated using EANM paediatric dosage card[7]. Preoperative urine culture was mandatory and if found positive was treated before the surgery. All children had undergone an open Anderson Hynes pyeloplasty. The kidney was approached through a tip of 12th rib incision. Intraoperatively, the length of the narrow segment , degree of pelvic dilation needing reduction, presence of a crossing vessel, extent of renal flaccidity as an indirect measure of parenchymal thickness[8], content of the PCS and presence of cortical scars. A dependent, tensionless anastomosis was performed over a stent between the ureter and the pelvis by giving meticulous importance to the vascularity of the both ends. No drain was placed. Bladder was drained with a Foley catheter in older children, but not in neonates. All children were discharged on 2nd post operative day. The stent was removed after 3 weeks. As a protocol all, children had undergone an ultrasound abdomen after 3 months post op to look at the changes in the APD of renal pelvis and parenchymal thickness. A DTPA renogram was done at 1 year after pyeloplasty using F-0 protocol to look at the drainage[9], change in GFR and spilt renal function.

Statistical analysis was performed using Statistical Package for the Social Sciences [SPSS version 20.0]. Continuous values were presented as mean ± standard deviation [SD]. Non-continuous values were countable or in percentages. For Continuous data, Independent t test and Mann Whitney test have been used to calculate statistically significant value i.e. P-value. For Non-continuous data, Fisher exact test has been used to calculate P-value. P-value less than 0.05 was considered as statistically significant. Pearson correlation coefficient was calculated to correlate the two variables. Multivariate logistic regression analysis of clinical,

scintigraphic and ultrasonographic co variables were undertaken to determine which factors better predicted change in renal function.

RESULTS

During the study period, total 45 children underwent Anderson Hynes Pyeloplasty satisfied the inclusion criteria. All underwent open AH pyeloplasty. The mean age of presentation was 6,08years with a standard deviation of 5.1. Seventeen patients had presented with antenatally diagnosed hydronephrosis. The average age at surgery was 6.42 years with a standard deviation of 5.12.

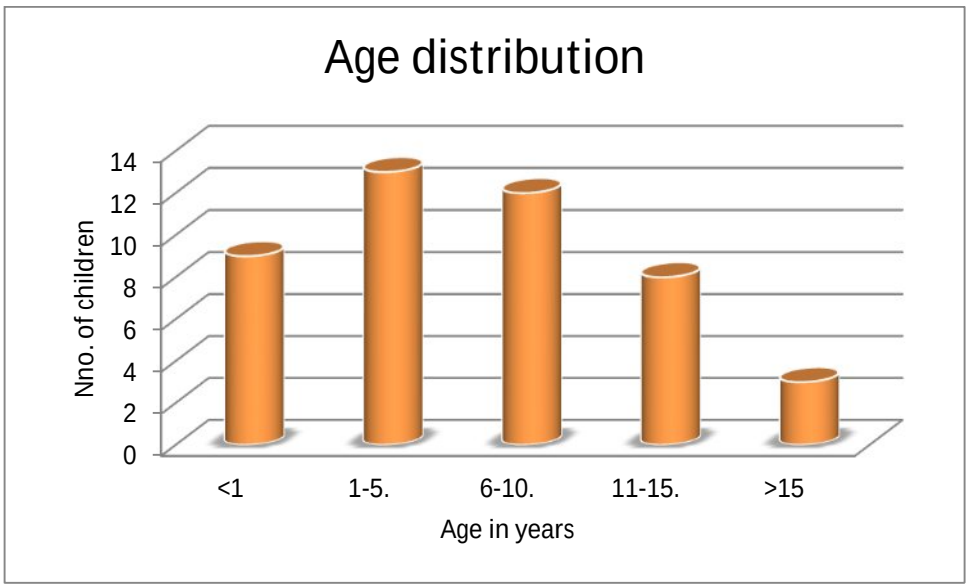

Chart 1. Age distribution

In our study 33 were males and 12 were females. There was a male preponderance with a ratio of 2.7: 1. Left UPJO was more common than the right side.

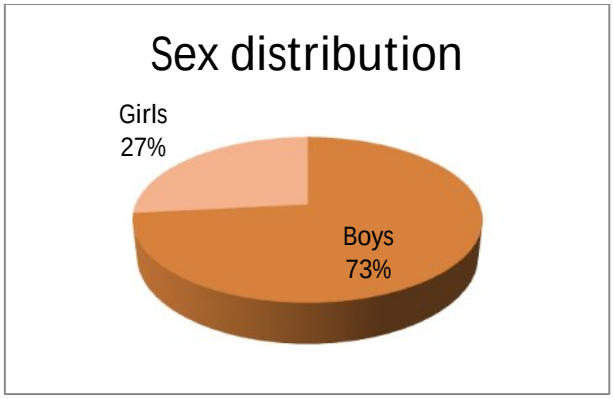

Chart 2. Sex distribution

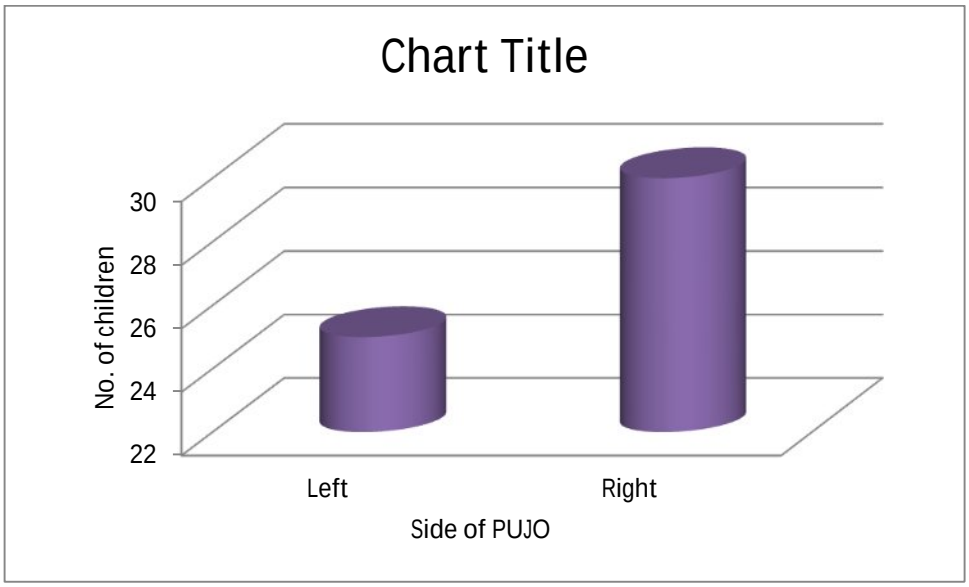

Chart 3. Distribution of side

1. ULTRASOUND PARAMETERS:

1.1. PELVIC ANTERIOPOSTERIOR DIAMETER

The mean pre operative AP diameter of the pelvis was 4.01 cms with a standard deviation of 2.06. The mean post operative AP diameter was 3.08 cms with a standard deviation of 3.24. There was a significant reduction in the overall pelvic diameters postoperatively (p= <0.001). In one child the postoperative APD was remained same and also the parenchymal thickness. In another child the AP diameters actually

increased marginally but the renal function was significantly improved and both children were asymptomatic postoperatively. The correlation coefficient between decrease in APD and GFR was 1.1 indicating positive correlation.

Characteristics	Pre operative	Post operative	P- value
AP diameter in centimeter	4.29 ± 2.12	2.52 ± 1.39	<.0001
Parenchymal thickness in centimeters	0.7 ±0.42	0.86 ± 0.38	.007

Table 5. Ultrasound parameters and their significance.

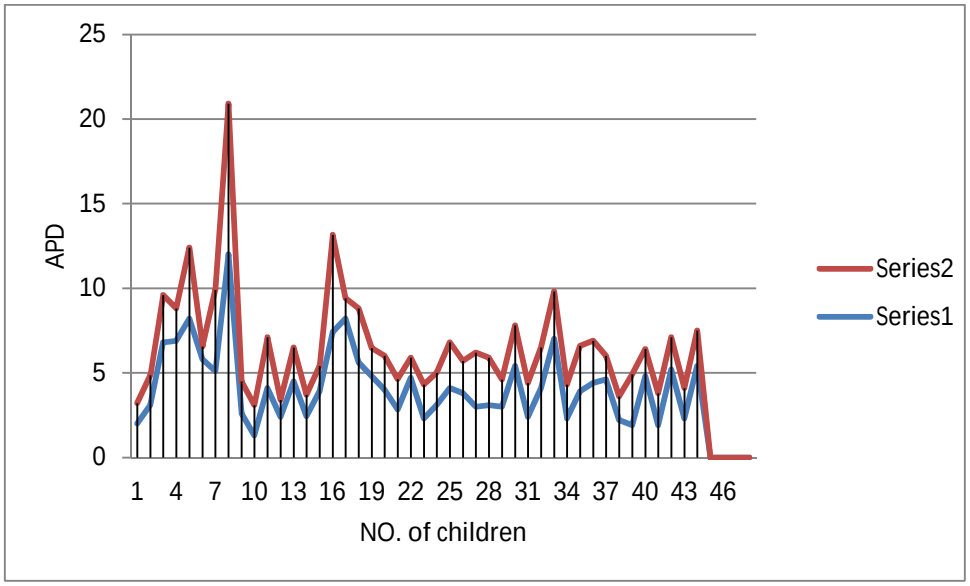

Chart 4. Pre and Post operative APD

1.2. PARENCHYMAL THICKNESS

Among the study group the mean pre operative parenchymal thickness was 4.072mm with a standard deviation of 2.06. The parenchymal thickness was ranged between 2mm to 1cms. It was been observed that parenchymal thickness is a good indicator of the pre operative renal function. Those who had good parenchymal thickness had good renal function in the DTPA. After 3 months of pyeloplasty the mean increase in parenchymal thickness was 0.6 cm with a SD of 1.7(p= 0.07). 80% of our children had increase in parenchymal thickness, 9 had same as preoperative and one had decrease in the parenchymal thickness. Those who had increase in parenchymal thickness postoperatively had mean increase in GFR of 15ml/min with a SD of 5.01. Those who had stable parenchymal thickness postoperatively also had GFR of 10 ml/min and those kidneys in which the parenchymal thickness had reduced marginally but there was a definitive decrease in AP diameter. The mean increase in GFR in that renal unit was 7ml/min. Over all there was a good correlation between the increase in parenchymal thickness to the increase in the GFR after 1 year with Pearson correlation coefficient of 0.78.

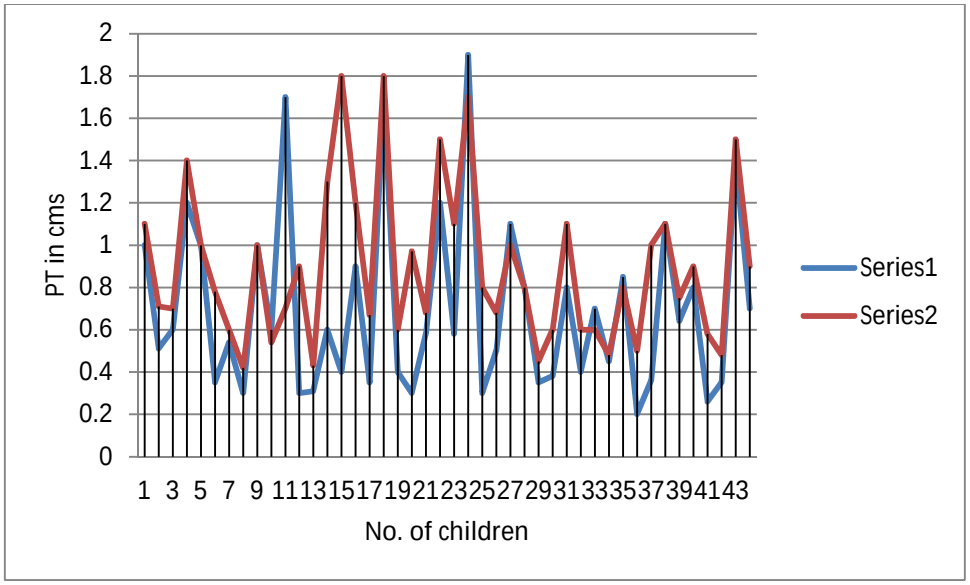

Chart 5. Pre and Post operative PT

2. DTPA PARAMETERS

2.1. GLOMERULAR FILTRATION RATE

The mean preoperative GFR was 36.4 ml/min and mean GFR postoperatively was39.4ml/min with SD 25.8. Decrease in APD diameter and increase in parenchymal thickness resulted in improved functional outcome. The lowest GFR which we operated was 12ml/min and even in that there was a significant improvement in GFR up to 20ml/min. In the study 5 children had GFR less than 15 ml/min and among which all renal units showed functional improvement up to 30ml/min.

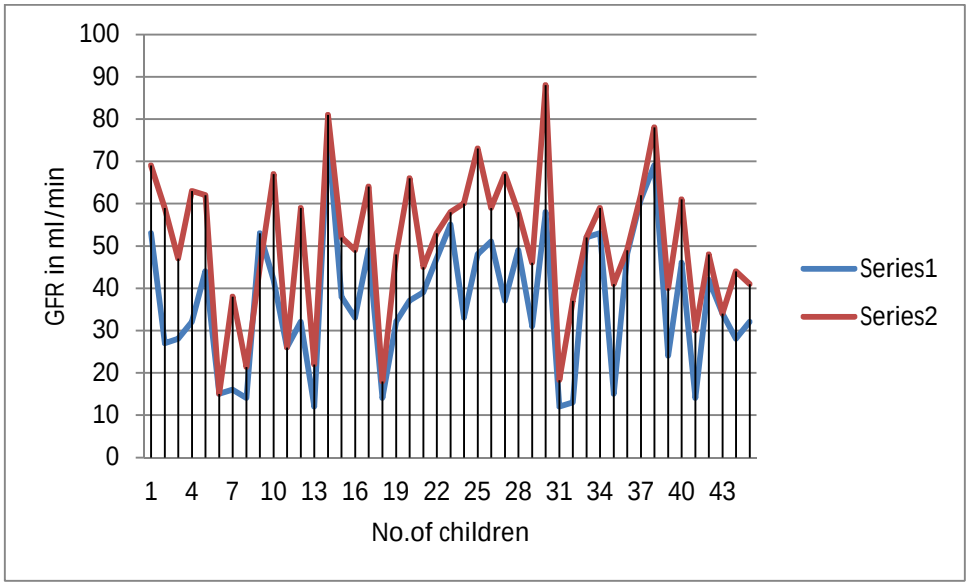

Chart 5. Pre and Post operative GFR

Pre op GFR	Post op GFR	P value
32.4 ml/min	**39.8ml/min**	<0.001

Table 6. Statistical analysis of pre and postoperative DTPA renogram parameters

2.2. SPLIT RENAL FUNCTION

Among the 45 pediatric renal units which we studied, 39 renal units had increased split renal function, 5 had remained the same and one was marginally deteriorated. On Pearson correlation, there was a good correlation (correlation coefficient 0.8) between the decrease in AP diameters and improvement in split renal function noted .

Correlations				
		APD	PT	GFR
APD	Pearson Correlation	1	-.065	1.1
	Sig. (2-tailed)		.676	.771
	N	45	45	45
PT	Pearson Correlation	-.065	1	0.78
	Sig. (2-tailed)	.676		.423
	N	45	45	45
GFR	Pearson Correlation	1.1	0.78	1
	Sig. (2-tailed)	.771	.423	
	N	45	45	45

Table 7. Correlation coefficient for ultrasound parameters.

DISCUSSION

Our study has stressed upon the importance of ultrasound parameters in the post operative period after AH pyeloplasty. It has shown that ultrasound parameters can be used as a surrogate for DTPA; however it cannot replace the need for DTPA if needed in the post operative follow up. Pyeloplasty is the one of the most common paediatric urological surgery[10]. The management of PUJO has evolved over a long period from Open Anderson Hynes pyeloplasty to minimally invasive robotic pyeloplasty. There are various parameters can be used to assess the postoperative outcome

irrespective of the surgical technique used to correct the UPJO. Various prenatal and also preoperative parameters also are described to influence the postoperative outcome[11]. Those parameters are, age at surgery, degree of pelvic dilatation, degree of calyceal dilatation, parenchymal thickness, echogenicity of the renal cortex, presence or absence of infection and renal scaring. **Berk Burgu et al[12]**, has described that reduction in pelvic diameters in the post operative period can be taken as relief of obstruction but persistence of the hydronephrosis doesn't mandate obstruction. Increasing pelvic diameters in serial ultrasound or increased APD in the postoperative period should be considered as persistence of obstruction and warrants early renal scan. It also has been stated by **Berk Burgu et al[12]** that reduction pyeloplasty influence the pelvic diameters in the early postoperative period but not in the late postoperative periods. In our study also reduction in APD was observed in 42 cases. All renal units which showed reduction in pelvic diameters showed significant increase in GFR. In two renal units where the APD remained same and in one renal unit there was marginal increase in APD, the GFR was at one year was stable and renogram curve was non obstructive. Our study shows that APD after 3 months can be used as a surrogate marker of successful pyeloplasty. The accuracy and reliability increases if the ultrasonography is done at a single institution and by a single radiologist. **Amling et al[13] and neste et al[14]** also stated in their paper that reduction in APD is a sure sign of good drainage but if remains same shouldn't warrant failure of pyeloplasty. In our study there was a significant correlation between the reduction in the APD and improvement in the GFR.

Parenchymal thickness of the kidney preoperatively predicts the postoperative outcome. **Imaji and devan et al[15]** has shown in their study that improvement in the ratio of calyceal diameter to parenchymal thickness

is a better predictor of improved drainage and function. In our study 40% of the renal units had parenchymal thickness of less than 5mm. After 3 months of pyeloplasty 80% of the renal units showed increase in parenchymal thickness. All renal units which showed increased parenchymal thickness had significant increase in GFR. The remaining 20% of the renal units were stable in their parenchymal thickness except one showed marginal decrease in the parenchymal thickness but definite improvement in the GFR after 1 year. The renal unit which parenchymal thickness was marginally decreased, child was asymptomatic and the renogram curve was also non obstructive. This can be explained by the observer variation as the USG was done by a different radiologist in the postoperative period. **Baek et al**[16] has reported that in the renal units which have giant hydronephrosis with thinned out parenchyma, pyeloplasty had not resulted in the increased parenchymal thickness but they had functional improvement. They also postulated that increase in parenchymal thickness may be a result of normal growth which was facilitated by relief of obstruction after pyeloplasty. **Ahmed M. Harraz et al**[17], had studied the pre operative GFR and parenchymal thickness in predicting the postpyeloplasty outcome. They concluded that improvement in the parenchymal thickness positively correlates with the improved function.

In our study preoperative parenchymal thickness had not predicted the postoperative outcome. Among 40% of the renal units which had parenchymal thickness less than 5mm, all had improvement in GFR more than 5ml/min except 2 renal units which remained stable but renogram showed non obstructive pattern. Renal units which had good parenchymal thickness (>1cm) did show greater degree of functional improvement. Over all, increase in parenchymal thickness reflects the functional improvement but static parenchymal thickness means neither the deterioration nor the

improvement. Even in renal units which showed static renal parenchymal thickness, there was significant functional improvement as reflected by increased GFR.

Age at the surgery also has an impact on the renal recovery. These can be divided in to <1years, 1-5 years, 6-10 years and >10years. **Babu R et al[4]** has shown in their study that early age at pyeloplasty has a positive predictive value in the renal recovery. As the age progress there is a gradual permanent nephron loss resulting in functional deterioration irreversibly. In our study 9 children were less than 1 year. Upon outcome analysis, functional recovery after 1 year was better in neonates than older children indicating the advantage of early pyeloplasty in indicated infants.

Preoperative GFR will be the determinant to decide on to salvage the kidney or to do a nephrectomy. In a study by **Thorup et al[18],** the indication for nephrectomy was < 10% GFR. In our study 7 renal units had GFR <15ml/min. These renal units were salvaged and all had improvement in GFR >5ml/min at the end of one year. The mean increase in GFR was 15ml/min with SD of 5.2. This indicates that unlike in adults, pediatric renal units have potential to recover irrespective of low preoperative renal function. As mentioned by F. T Hammad et al, the neprectomy for PUJO has reduced significantly over the last decades from 13% to 4%. In a study by **Aziz et al[19]**, 12 children had PUJO with GFR varying from 0ml/min to 10 ml/min. All 12 renal units improved after pyeloplasty. This study tells us, in children irrespective of the renal function and also sonological appearance paediatric renal units have unique potential to recover.

CONCLUSIONS

A. Post operative reduction in APD reflects good drainage and predicts the improvement in renal function

B. Increase in parenchymal thickness also reflects the improvement in GFR and spilt renal function but static parenchymal growth or marginal decrease does not mean there is functional deterioration.

C. Among two ultrasound variables, in our study APD had a better correlation than parenchymal thickness reflecting the change in renal function after 1 year of pyeloplasty.

D. APD can reliably used to follow up the children after pyeloplasty.

E. Frequent radioisotope scans can reliably be avoided if APD is decreasing.

LIMITATIONS OF THE STUDY

a. Retrospective study.
b. USG parameters were assessed by more than one radiologist.
c. DTPA protocol was standardised but interpretation was done by different nuclear physicists.

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