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Original Article

Factors Affecting The Short Term Outcome Of Pyeloplasty In Congenital Primary Unilateral Pelvi-Ureteric Junction Obstruction In Infants and Toddlers: A Single Center trial

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Abstract:
Background: Congenital ureteropelvic junction obstruction (UPJO) is by far the most common cause of pediatric hydronephrosis. UPJO standard surgical treatment is open dismembered pyeloplasty (Andersons-Hyens).
Aim of the work: To study the morphological and functional outcome of dismembered pyeloplasty in infants and toddlers with unilateral UPJO.
Materials and Methods: This prospective study was carried on 50 infants and toddlers aged 2 months - 36 months with unilateral UPJO at Cairo University Children Hospital.
Results: The mean age of studied group was 11 ± 3 months. The main symptom was recurrent urinary tract infect in 18 (36%) of cases, followed by loin pain in 12 (24%), hematuria in 4(8%) and 16 (32%). Initial pre-operative ultrasound demonstrated moderate and severe hydronephrosis (HN) in 29 (58%) and 21 (42%) of the cases, mean cortical thickness was 6.78 ± 1.57 cm and mean anteroposterior (AP) diameter was 3.27± 0.58 cm. After 3 and 6 months, 24(48%) and 30 (60%) had mild degree of HN, 23 (46%) and 17 (34%) had moderate HN and 3 (6%) and 3 (6%) had severe HN respectively (p=0.000). The mean cortical thickness increased to 8.66 ± 1.49 mm (p=0.000). The mean AP dropped substantially as well to 2.7± 0.57 cm (p=0.000). Operative time did not influence outcome (p=0.653), yet pre-operative lesser degree of HN, more cortical thickness and lesser AP diameter was associated with better outcome (p=0.000, p=0.000 and p=0.000 respectively). Those with younger age at presentation had better outcome (p=0.001)
Conclusion: The better outcome of dismembered pyeloplasty (Andersons-Hyens) relies on early diagnosis and implementation before development of HN, cortical thickness erosion and increase in AP diameter. Pyeloplasty for unilateral UPJO in younger age seems to allow cortical remodeling and regeneration. Long term follow up remains crucial to verify the long term outcome.

Keywords: Pediatric pelvi-ureteric junction obstruction; pyeloplasty; renogram; surgical outcome
Abbreviations: AP: anteroposterior; CT: computed tomography; DTPA: diethylenetriamine pentaacetate; GFR: glomerular filtration rate; HN: hydronephrosis; UPJO: ureteropelvic junction obstruction; UTI: urinary tract infection; U/S: ultrasonography.

Introduction

Congenital urinary tract obstruction is the most common fetal anomaly identified in prenatal screening of pregnant women, with an incidence of up to 1% of all pregnancies**.** With a varying incidence of approximately 1 every 750–2,000 live birth, unilateral congenital ureteropelvic junction obstruction (UPJO) represents the most common obstructive uropathy (*1*). The UPJO has epidemiological significance and long term impact on lives of the affected children. Its management comprises conservative and surgical intervention. Dismembered pyeloplasty is the surgical golden standard of management of children with unilateral UPJO (*2*). Congenital UPJO is typically intrinsic. A frequently found defect is the presence of an aperistaltic segment of the ureter, perhaps similar to that found in primary obstructive megaureter. This type of segmental defect is often responsible for UPJO and is of a great importance clinically because such ureters may appear grossly normal at the time of surgery (*3*). Ultrasonography and diuretic renography are commonly used to follow affected patients and to determine the need for surgical intervention. Anteroposterior diameter of the pelvis on ultrasound and hydronephrosis (HN) grade as described

by the Society for Fetal Urology are the most commonly used measures to assess the severity of disease and predict the need for surgery (*4*).

At present, a dismembered pyeloplasty is preferred by most urologists in the surgical repair of UPJO because this procedure is almost universally applicable to the different clinical scenarios. Only a dismembered pyeloplasty allows complete excision of the anatomically or functionally abnormal UPJO itself (*5*). We aimed to study the morphological and functional outcome of dismembered pyeloplasty in infants and toddlers with unilateral UPJO.

Subjects and Methods

This prospective cohort study was conducted at the Children Hospital, Faculty of Medicine, Cairo University Hospitals. The study was approved by the Ethical Committee of the Faculty of Medicine, Cairo University, Egypt (MS65-2020). All the caregivers of included children consented to the study.

Participants

Fifty children aged 2 months to 3 years with confirmed congenital primary unilateral UPJO were included. Patients with bilateral pelvi-ureteric obstruction, or renal insufficiency were excluded. Patients who had previous operations on same UPJO or were grossly infected (pyonephrosis) were excluded as well.

Methods

They all underwent open dismembered pyeloplasty (Anderson Hynes technique) (*6*). The pre-operative assessment included full history taking, kidney functions, urine analysis, and routine pre-operative labs pre-operative abdominal ultrasound (Siemens Acuson Origin Ultrasound system, Germany), renal radionuclide dimercaptosuccinic acid scan (DMSA) and diethylene triamine pentaacetic acid (DTPA) using Philip's axis gamma camera device (US). Post-operative assessment includes recording complications like hemorrhage and leakage in the early pre-operative period. Late follow up includes ultrasound after 3 and 6 months, renogram at 6 months. Ultrasonography including cortical thickness, anteroposterior diameter an ureteric dilatation was assessed. Society of Fetal Urology Guidelines on hydronephrosis was followed (*4*). They were divided into a successful outcome group, where the relief of obstruction was associated with HN decrease or disappearance, symptomatic relief and had improved glomerular filtration rate (GFR) on renogram (DTPA and DMSA). The poor outcome group were those whose HN did not improve or worsened by time, GFR decreased or the renogram demonstrated obstruction.

Statistical Analysis

The sample size was calculated to be 50 patients using Epi 6 program as number of attending patients was 180, at power of test 80% and confidence interval 95%. Analysis of data was done using SPSS (statistical program for social science version 22, IBM, USA) as follows: description of quantitative variables as mean, SD and range, description of qualitative variables as number and percentage. Chi-square test was used to compare qualitative variables between groups, while Fisher exact test was used when the expected frequency was less than 5. Unpaired t-test and Mann Whitney test was used to rank variables versus each other directly or inversely. The p value >0.05 was considered insignificant and $p<0.05$ was considered significant while $p<0.001$ considered highly significant (*7*)**.**

Results

The mean age of studied group was 11 ± 3 months (range 3-36 months). The main symptom was recurrent UTI presented in 18 (36%) patients, followed by loin pain in 12 (24%), hematuria in 4(8%), while 16 (32 were asymptomatic. Five (10%) patients underwent previous urological surgical procedure with no surgical history on the same side of pyeloplasty. Radiological evaluation of the studied groups preoperatively by ultrasound showed moderate hydronephrosis in 29 (58%) of patients, while 21 (42%) suffered from severe HN, with mean cortical thickness (CT) 6.78± 1.57 mm, and mean anteroposterior (AP) diameter 3.27± 0.58 cm. Preoperative renal isotope scan showed diminished GFR range from 20 – 43 ml/min, while split function ranged between 10.5 – 41 %, with obstructed curve in all patients.

Mean surgical duration was 112 min+/- 14 min (75-180 min). Post-operatively 40 (80%) of the patients had loin pain related to wound site and relieved with medications (acetaminophen).

Post-operatively 25 (50%) had mild hematuria, 8 (16%) complained of postoperative fever and 2 (4%) complained of postoperative urine leakage. The median hospital stay postoperative was 4 days (mean± SD= 4.6± 1.2), and only 1 patient stayed 14 days for wound infection. (Figure 1).

After 3 months, 24 (48%) patients had mild degree of hydronephrosis, 23 (46%) had moderate HN and 3 (6%) had severe hydronephrosis. The mean cortical thickness improved from 6.78± 1.57 mm pre-operatively to 8.66 ± 1.49 mm. The mean anteroposterior diameter post-operatively was 2.7± 0.57 cm compared to 3.27± 0.58 cm pre-operatively (p=0.0005). Postoperative ultrasound after 6 months showed that 60% of patients (30 patients) had mild degree of hydronephrosis, 34% (17 patients) had moderate hydronephrosis, whilst only 6% (3 patients) still had severe hydronephrosis.

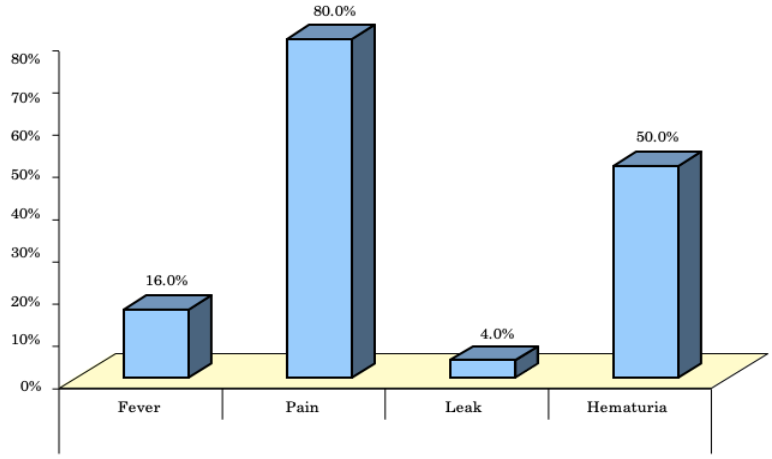

Figure 1. Early postoperative complications

Table 1. Preoperative and Postoperative imaging findings and outcome of studied children

		Preoperative	Postoperative		Test value	P value
			After 3 months	After 6 months		
Ultrasound						
HN degree Number (%)	Mild	0 (0.0%)	24 (48.0%)	30 (60.0%)	55.130	0.000
	Moderate	29 (58.0%)	23 (46.0%)	17 (34.0%)		
	Severe	21 (42.0%)	3 (6.0%)	3 (6.0%)		
Cortical Thickness (cm)	Mean ± SD	6.78 ± 1.57	8.66 ± 1.49	9.32 ± 1.38	48.429•	0.000
	Range	4 – 9	4 – 10	5 – 13		
AP diameter (cm)	Mean ± SD	3.27 ± 0.58	2.70 ± 0.57	2.53 ± 0.63	67.117•	0.000
	Range	2.5 – 4.5	2 – 4.5	1 – 4.5		
Ureter dilatation delete	Negative	50 (100.0%)	50 (100.0%)	50 (100.0%)	0.000*	1.000
	Positive	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Side	Right	26 (52.0%)	--	26 (52.0%)	0.000*	1.000
	Left	24 (48.0%)	--	(48.0%)		
Renal isotope scan						
GFR (ml/min)	Mean ± SD	35.69 ± 5.61		41.25 ± 7.00	-4.288•	0.000
	Range	20 – 43		20 – 48		
Non obstructed flow Curve	None	0 (0.0%)		44 (88.0%)	25.846*	0.000
	Obstructed	50 (100.0%)		6 (12.0%)		
Split Function	Mean ± SD	34.29 ± 5.52		40.64 ± 5.81	-4.319•	0.000
	Range	10.5– 41.1		18.2 – 47		

AP diameter: Anteroposterior diameter; GFR: glomerular filtration rate; HN: hydronephrosis.

At 6 months post-operative, the mean cortical thickness increased from the preoperative 6.78± 1.57 mm to 9.32 ± 1.38 mm, and only 6 patients had decreased cortical thickness (p=0.0001). The mean anteroposterior diameter decreased from the preoperative 3.27± 0.58 cm to 2.53 ± 0.63 cm, and only 6 patients had increased anteroposterior diameter. Postoperative renal isotope scan after 6 months showed that GFR ranged from 20 – 48 mil/min, split function range from 18.2 – 47 %, with obstructed curve in 12% of patients and non-obstructed curve in 44 (88%) of patients. By renal isotope scan, the mean preoperative GFR (of the affected kidney) was 39.22 ± 2.76 mil/min, while 6 months postoperative mean GFR was 44.55 ± 5.28 mil/min. The mean preoperative split

function was 37.36 ± 2.34%, while 6 months the postoperative mean split function was 42.67 ± 3.35% (p=0.0005).

Table 2. Preoperative and postoperative imaging findings of those with successful and poor outcomes

		Successful outcome No. = 44	Poor outcome No. = 6	P-value
Preoperative Imaging				
Ultrasound				
HN degree	Mild	0 (0.0%)	0 (0.0%)	0.001
	Moderate	28 (63.6%)	1 (16.7%)	
	Severe	16 (36.4%)	5 (83.3%)	
Cortical Thickness	Mean ± SD	6.95 ± 1.52	5.50 ± 1.38	0.03
	Range	4 – 9	4 – 8	
AP diameter (cm)	Mean ± SD	3.21 ± 0.55	3.72 ± 0.59	0.03
	Range	2.5 – 4.5	2.8 – 4.5	
Ureter dilatation	Negative	44 (100.0%)	6 (100.0%)	0.0001
	Positive	0 (0.0%)	0 (0.0%)	
Side	Right	25 (56.8%)	1 (16.7%)	0.56
	Left	19 (43.2%)	5 (83.3%)	
Renal isotope scan				
GFR	Mean ± SD	36.49 ± 5.37	29.83 ± 3.71	0.0051
	Range	20 – 43	26 – 35	
Non obstructed flow Curve	Non	0 (0.0%)	0 (0.0%)	0.005
	Obstructed	44 (100.0%)	6 (100.0%)	
Split Function	Mean ± SD	34.64 ± 5.70	31.73 ± 3.27	0.001
	Range	10.5 – 41.1	26 – 35.5	
Early Postoperative				
Operative time	Mean ± SD	67.16 ± 5.85	68.33 ± 6.83	0.653
	Range	60 – 75	60 – 75	
Fever	Negative	39 (88.6%)	3 (50.0%)	0.015
	Positive	5 (11.4%)	3 (50.0%)	
Pain	Negative	9 (20.5%)	1 (16.7%)	0.828
	Positive	35 (79.5%)	5 (83.3%)	
Leak	Negative	42 (95.5%)	6 (100.0%)	0.594
	Positive	2 (4.5%)	0 (0.0%)	
Hematuria	Negative	24 (54.5%)	1 (16.7%)	0.082
	Positive	20 (45.5%)	5 (83.3%)	

AP diameter: Anteroposterior diameter; GFR: glomerular filtration rate.

Table 3. Imaging differences among those with successful and poor outcomes

Early 3 months U/S		Successful outcome No. = 44	Poor outcome No. = 6	P-value
Ultrasound				
HN degree	Mild	24 (54.5%)	0 (0.0%)	0.000
	Moderate	20 (45.5%)	3 (50.0%)	
	Severe	0 (0.0%)	3 (50.0%)	
Cortical thickness (mm)	Mean ± SD	8.75 ± 1.40	5.33 ± 1.51	0.000
	Range	4 – 10	4 – 8	
AP diameter (cm)	Mean ± SD	2.59 ± 0.48	3.50 ± 0.55	0.000
	Range	2 – 3.5	3 – 4.5	
Ureter dilatation	Negative	44 (100.0%)	6 (100.0%)	--
	Positive	0 (0.0%)	0 (0.0%)	

AP diameter: Anteroposterior diameter; HN: hydronephrosis.

Successful outcome was achieved among 44 (88%) of children after 3 months and after 6 months with decrease in HN, AP diameter by ultrasound and increase in cortical thickness and GFR by DTPA. They achieved symptomatic relief, decreased degree of hydronephrosis by US, decreased anteroposterior AP diameter by US, increased cortical thickness by US, increased GFR

by DTPA and Non obstructed flow curve by DTPA were considered successful surgery and poor outcome patients. (Tables 1 and 2). Patients with successful outcome had younger age at presentation (p=0.001) higher pre-operative cortical thickness (6.95 +/- 1.52) compared to patients with poor outcome who have less cortical thickness of 5.5 ± 1.38 (p=0.03).

Discussion

At present, a dismembered pyeloplasty is preferred by most urologists in the surgical repair of UPJO because this procedure is almost universally applicable to the different clinical scenarios. This study evaluated the morphological and functional outcome of dismembered pyeloplasty in infants and toddlers with UPJO. The short term outcome in our studied cohort was successful in restoring function and relieving the obstruction in 88%, and only 12% failed and had poor outcome. The outcome of the pyeloplasty in the younger infants was substantially better than the older ones (p=0.001), which supports the previous reports (*8*) and our results discourage postponing the pyeloplasty to an older age as advocated by Salem and colleagues in 1995 (*9*). Our studied series is one of the youngest series in UPJO. the mean age was 11 ± 3 months (range 3-36 months). The study by Chipde and colleagues in 2012, included a population with higher median age (4.26 years), and they reported a stable outcome in almost 59.6%, improvement in 30.8% and deterioration in 9.6% (*10*). Many confounding factors may be responsible for this difference in outcome, but it might be attributed to the younger age of our studied cohort, where more infants achieved a successful outcome.

In our study 32% of the patients were asymptomatic, and were accidentally discovered on antenatal or post-natal ultrasound, which was similar to study done by Abdelaziz and colleagues 10 of 25 patients (40%) (*11*). This highlights the importance of antenatal and neonatal screening for PUJ. While Egypt has implemented a comprehensive neonatal screening program for detection of hypothyroidism, phenylketonuria (*12*), hearing loss (*13*), it seems prudent to study the cost-effectiveness of abdominal sonography ante-natal or early in the neonatal period for the detection of PUJ and prevention of renal function loss among Egyptian neonates.

Pre-operative ultrasonography detected a statistically significant less degree of HN and higher cortical thickness pre-operatively among those with successful outcome had (p=0.02). This finding was reported by others (*14*, *15*). This improvement was promptly detected 3 months post-operatively. Cortical thickness and anteroposterior diameter changed significantly post-operatively and may be utilized as early prognostic factors post pyeloplasty, yet their value on long term follow up needs to be studied. We found ultrasound to be a good predictor of renal function after surgery as demonstrated by the 6 months-postoperative renal isotope scan follow up where the mean split function in poor outcome cases was 28.18 ± 6.95%, while the mean split function in successful outcome cases was 42.34 ± 2.87%. The mean preoperative split function was a statistically significant prognostic factor in our studied series (p= 0.001). Yet it is alarming however that despite the improvement in the cortical thickness and reduction in AP; the associated functional statistical improvement in GFR post-operatively did not change the severity of chronic kidney disease among the studied cohort. Both pre-operative and post-operative GFR were within the limits of grade 3b of the classification of chronic kidney disease (*16*), which is in line with others (*17*). We find that patients with improvement in anteroposterior diameter and cortical thickness, do not need isotope renogram for follow up. While patients with equivocal ultrasound, renogram would be the most diagnostic confirmatory test.

It remains to be seen if the restoration and regeneration of cortical thickness encountered among the studied cohort would be associated with progressive improvement of GFR on the long term follow up. The regeneration ability of cortical renal tissue is a venue for more research and future collaborative work as it has been proven to be a viable possibility in animal models (*18*).

Patients with successful outcome had a faster recovery. Complications were minimal and easily controlled among our studied series.

There are some limitations in our study such as the small number of cases involved in the study and the short duration of follow up. It is early to say that in all cases of unilateral UPJO the preoperative imaging (ultrasound and renal scan) are good prognostic factors for the outcome of pyeloplasty (Anderson-Hynes technique) in children. More studies are needed that recruit a larger number of cases and have longer follow up durations to ensure that pyeloplasty will not cause any complications or affect need for nephrectomy later on.

Conclusion:

The better outcome of dismembered pyeloplasty (Andersons-Hyens) relies on early diagnosis and implementation before development of HN, cortical thickness erosion and increase in AP diameter. Pyeloplasty for UPJO in younger age seems to allow cortical remodeling and regeneration. Long term follow up remains crucial to verify the long term outcome. Since congenital unilateral PUJ has an incidence of 1/1000-1500 live birth, proper antenatal and postnatal screening is required and it should be mandatory at one month after birth. Mostly, that according to this study the earlier intervention and patients with better pre-operative parameters, including less hydronephrosis and higher cortical thickness have better surgical outcome.

Author Contributions

Amr Zahran collected the data, Ahmed Salem revised the statistics, Walid Ghoneima, Mohamed Ghoneimy revised the work and Mostafa Sheba edited the manuscript and submitted the work. All searched medical literature. All authors approved final draft.

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CONFLICT OF INTEREST

The authors declare no conflict of interest in connection with the reported study. Authors declare veracity of information.

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