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Original Article

Long-term Outcomes of Patients with Giant Hydronephrosis After Pyeloplasty

Çocukluk Çağı Dev Hidronefroz Olgularının Pyeloplasti Sonrası Uzun Dönem Sonuçları

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ABSTRACT

Objective: The study aims to assess the long-term outcomes of pyeloplasty performed for ureteropelvic junction obstruction (UPJO) with giant hydronephrosis (GH).

Method: Data of 94 patients with ipsilateral UPJO patients who underwent pyeloplasty were analyzed. Patients' demographic characteristics, pre-, and postoperative anteroposterior diameters (APDs) of their kidneys, parenchymal thickness (PT) ratio (PT of ipsilateral/contralateral kidneys) of kidneys, differential renal function (DRF) and surgical outcomes were compared between the GH (group of patients with AP diameter of at least 50 mm as measured on two ultrasonographys with thinner PT than ½ of the contralateral kidney) and the non-GH groups.

Results: Six female, and 18 male children were included in the GH (mean APD: 60.46±9.25 mm), and the remaining 21 female, and 49 male patients in the non-GH group were used as controls. Preoperative PT ratios and DRFs were found to be impaired in the GH group compared to the non-GH group ($p<0,05$). No significant differences were found between the groups in terms of age, gender, laterality of pyeloplasty, operative success. APD and PT ratios of GH and non-GH groups of patients. APD and PT ratios were found to improve significantly after pyeloplasty ($p<0.05$). GH patients who underwent pyeloplasty before 1 year of age experienced significant improvement in their DRFs and PT ratios, while these parameters did not improve in older children who underwent pyeloplasty.

Conclusion: Long-term outcomes of pyeloplasty are satisfactory in pediatric UPJO patients with GH, and their DRFs were stable even in late renograms. Early relief of the obstruction improves PT and renal functions in GH patients younger than 1 year of age.

Keywords: Differential renal function, poorly functioning kidney, pyeloplasty, ureteropelvic junction obstruction, renal parenchymal thickness

ÖZ

Amaç: Çalışmamızın amacı dev hidronefrozu (DH) olan üreteropelvik darlık olgularının (UPD) pyeloplasti sonrası uzun dönem sonuçlarının değerlendirilmesidir.

Yöntem: Kliniğimizde pyeloplasti yapılan toplam 94 (ortalama izlem süresi: 4,8 yıl) tek taraflı UPD hastası analiz edildi. Hastaların demografik özellikleri, ameliyat öncesi ve sonrası ön-arka çap (AP), parankimal kalınlık (PK) oranı (ipsilateral PK/kontralateral PK), diferansiyel böbrek fonksiyonu (DF) analiz edildi ve DH olan ve olmayan gruplar arasında karşılaştırıldı.

Bulgular: DH grubunda (AP çap: 60,46±9,25 mm) 24 (K/E: 6/18) olgu mevcuttu. DH'si olmayan 70 (K/E: 21/49) UPD olgusu kontrol grubu olarak kullanıldı. Ameliyat öncesi DF ve PK oranı DH grubunda DH olmayan gruba göre anlamlı olarak azalmış bulundu ($p<0,05$). Gruplar arasında yaş, cinsiyet, taraf, operatif başarı açısından anlamlı farklılık yoktu. Her iki grupta da hastaların AP çap ve PK oranlarının pyeloplasti sonrası önemli ölçüde düzeldiği görüldü ($p<0,05$). Bir yaştan önce pyeloplasti yapılan DH olgularında DF ve PK oranında anlamlı iyileşme görülürken, 1 yaşından sonra cerrahi uygulanan GH hastalarında anlamlı düzelme saptanmadı ($p<0,05$).

Sonuç: DH olgularında pyeloplasti sonuçları güz güldürücüdür. Özellikle bir yaşın altındaki olgularda obstrüksiyonun ortadan kalkması belirgin bir nefron koruması sağlar.

Anahtar kelimeler: Diferansiyel böbrek fonksiyonu, fonksiyonu bozulmuş böbrek, pyeloplasti, üreteropelvik bileşke darlığı, renal parankimal hasar

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INTRODUCTION

Giant hydronephrosis (GH) is most often defined as the accumulation of more than one liter of fluid in the collecting system or the hydronephrotic kidney crossing the midline or extending more than five vertebral lengths[1,2]. However, these definitions mostly based on adult series are outdated, are not precise or quantitative, and require application of percutaneous nephrostomy or radiological techniques for their confirmation. A few series with a limited number of patients and follow-up intervals have been published in the literature on pediatric patients with GH due to ureteropelvic junction obstruction (UPJO). Most of them have not defined any inclusion criteria for GH in their series[3-5]. Thus there is no consensus on the definition of GH in the pediatric age group.

Our study aims to investigate the long-term outcomes of pyeloplasty in pediatric UPJO patients with GH and proposes a simpler and more practical method for defining GH in the pediatric age group.

MATERIALS and METHODS

Patients with UPJO who underwent dismembered pyeloplasty at our institution from 2008 to 2020 were retrospectively analyzed. Children with bilateral UPJO, solitary kidney or kidney with suprarenal function, as well as those with any other urinary system disorders including vesicoureteral reflux, ureterocele, megaureter, bladder outlet obstruction, and those who have not completed at least one year of follow-up or with missing data, were excluded. Ninety-four patients were divided into GH and non-GH groups according to their parenchymal thickness (PT) ratios, and anteroposterior diameter (APD) of renal pelvises. Patients with an APD of at least 50 mm on two ultrasonographys (USGs) and thinner PT than ½ of the contralateral kidney were included in the GH group. APD measured between the points where the parenchyma ends in the hilus in sections taken in the transverse plane of the kidney by the pediatric radiologist. PT was measured as the minimum distance from the renal capsule to the edge of the renal sinus in the midline sagittal view. APD and PT measured at the last USG before the operation were included in the study as preoperative APD and PT, and one year after the operation as postoperative APD and PT.

Patients' demographic characteristics, preoperative and postoperative APDs, PT ratios (involved side PT/contralateral side PT)[6], differential renal functions (DRFs), and surgical outcomes were compared between groups.

The preoperative and postoperative parameters were compared between groups to clarify the operative benefit. GH patients were also grouped by age (≥1 year of age). Results of DRF, APD, and PT ratios were also compared between both groups.

Negative voiding cystourethrography was seen in all patients. Indications for surgery included impaired split kidney function at and/or a significant obstruction (poor or no response to furosemide) on 99mTc-MAG3 scintigraphy, and impaired PT. Deterioration (≥5%) in renal functions, and an increasing degree of hydronephrosis in successive studies were also considered an indication for operation. Open Anderson-Hynes pyeloplasties were performed on all patients. All GH patients underwent renal pelvic reduction, the extent of which was decided by the surgeons. A double J ureteral stent was inserted in all patients during surgery and removed three weeks later. The success of pyeloplasty was described as gradual improvement of hydronephrosis revealed in postoperative USG and improvement of drainage as detected in MAG3 scintigraphy[7].

Following standard guidelines, DRF was assessed as the percentage of the relative renal activity over the sum of background-corrected total renal activity at 1-2 minutes after the intravascular (IV) injection of radiopharmaceutical agent. Twenty minutes after the injection of a radiopharmaceutical agent, furosemide (1 mg/kg IV) was injected (F+20). Drainage seen on diuretic renogram, starting before or immediately after IV injection of furosemide was termed as Grade 0, delayed drainage after furosemide as Grade 1, and poor or no response to furosemide with a plateau or an upward curve as Grade 2[7]. The 99mTc-MAG3 diuretic renograms were evaluated by the same nuclear physician.

Renal USG was performed one month after the operation, then every 3 months, and yearly thereafter. A 99mTc-MAG3 renogram was performed routinely 6 to 12 months after the operation to confirm operative benefit.

The results of the patients who had undergone renal scintigraphy at postoperative 2-8 years were also compared with the postoperative first year scans to assess whether there was a long-term deterioration in DRF. Unfortunately, since ours was a retrospective study the indications for requesting late-term scintigraphy, which is not used in routine practice could not be fully determined.

Statistical Analysis

The data were analyzed by SPSS V20 software using descriptive (percentage, median, and mean) and analytical statistics (Mann-Whitney U, Wilcoxon Signed Ranks, Pearson's chi-square, and Fisher's exact tests). P<0.05 was considered statistically significant.

Ethical Approval

This study approval by the University of Health Sciences Turkey, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital Clinical Research Ethics Committee (approval number: 2023/09-09-847, date: 22.06.2023). All patients were given information about the procedure, and their consent were obtained.

RESULTS

A total of 94 patients were allocated to GH (6 F/18 M) and non-GH (21 F/49 M) groups according to their APD and PT ratios. The median age of the patients at the time of operation (36.25±51.23 months), the mean APD (60.46±9.25 mm), and the median follow-up period (6.71±3.55 years) were as indicated in the GH group. No significant differences were found in age, gender, laterality of pyeloplasty, and operative success rates between the groups. In the non-GH group, the median age of the patients at the time of operation (30.24±38.33 months) the mean APD (28.55±8.5 mm), and the median follow-up period (4.23±2.89 years) were as indicated (Table 1). Preoperative PT ratios (p<0.001), DRF (p=0.023), and PT (p=0.004) were found to be significantly impaired in the GH group compared to the non-GH group (Table 2). Contrary to DRF, significantly improved postoperative PT ratios, and PT were noted in both groups (Table 2).

Seventeen (70.8%) patients in the GH, and 42 (60%) patients in the non-GH group were younger than 1 year of age. Preoperative DRF was significantly impaired in patients older than one year of age (p=0.024) in the GH group, and PT ratios, and DRFs did not improve after the operation. Contrarily, PT ratios and DRFs significantly improved in patients younger than one year of age (Table 3).

The perioperative and postoperative processes were uneventful for all patients. No anesthesia-related complications were observed in all patients including infants. No patient experienced acute obstruction, urinary leakage, or unexpected readmission.

Reoperation was performed due to a gradual increase in APD in the postoperative period and persistent obstructive drainage pattern (Grade 2) in 99mTc-MAG3 scintigraphy. Reoperation was required in 3 (12.5%), patients in the GH and in 6 (8.6%) patients in the non-GH group. The reoperation rate was not statistically significantly different between groups (p=0.689). One patient in the GH group underwent ureterocalicostomy as a second operation because the ureter was not long enough to perform the ureteropelvic anastomosis.

In the GH group, the preoperative drainage pattern on 99mTc-MAG3 scintigraphy was classified as Grade 2 in 23, and Grade 1 in one patient. In 13 patients, including patients with reoperation, good drainage was observed, and in 8 patients drainage pattern was improved from Grade 2 to 1 in the GH group after the operation. APDs of all patients was also improved in the follow-up visits.

One patient with DRF<10% in the GH group developed hypertension that was controlled by medication after the operation. In the GH group, a second scintigraphy had been performed in 19 patients 2 to 8 years after the operation. Any statistically significant difference was not detected between scintigraphies performed postoperative 1, and also 2-8 years were in terms of DRFs (p=0.944).

Table 1. Comparison of demographics in GH and non-GH group

	GH group	Non-GH group	p-value
Number of the patients	24	70	
Age of the patients (months)	36.25±51.23	30.24±38.33	0.551
Patients <1 year of age	17 (70.8%)	42 (60%)	0.343
Side (R/L)	5/19	21/49	0.386
ANH	19 (79.2%)	50 (71.4%)	0.459
Gender (F/M)	6/18	21/49	0.64
Reoperation	3 (12.5%)	6 (8.6%)	0.689
Follow-up (year)	6.71±3.55	4.23±2.89	0.003

GH: Giant hydronephrosis, R/L: Right/Left, F/M: Female/Male, ANH: Antenatal hydronephrosis

Table 2. Comparison of the preoperative and postoperative DRF, APD, PT and PT ratio in GH group and non-GH group

	GH group	Non-GH group	p-value
DRF			
Preoperative	32.07±14.14	39.13±11.99	0.023
Postoperative	34.83±13.75	39.83±12.99	0.122
p-value	0.057*	0.214**	
APD			
Preoperative	60.46±9.25	28.55±8.5	<0.001
Postoperative	19.48±12.61	11.12±6.14	0.001
p-value	<0.001*	<0.001**	
PT			
Preoperative	3,24±1,46	4.71±2.1	0.004
Postoperative	7,13±2,98	7.31±2.46	0.419
p-value	<0.001*	<0.001**	
PT ratio			
Preoperative	0.33±0.15	0.5±0.2	<0.001
Postoperative	0.65±0.33	0.72±0.22	0.162
p-value	<0.001*	<0.001**	

*Comparison of the preoperative and postoperative DRF, APD, PT and PT ratio in GH group, **Comparison of the preoperative and postoperative DRF, APD, PT and PT ratio in non-GH group. DRF: Differential renal function, APD: Anteroposterior diameter, PT: Parenchymal thickness, GH: Giant hydronephrosis

Table 3. Comparison of preoperative and postoperative DRF, APD, PT and PT ratio in GH group according to age

GH patients according to age, n=24	<1 years of age, n=17	>1 years of age, n=7	p-value
DRF (%)			
Preoperative	36.53±10.78	21.23±16.23	0.024
Postoperative	40.53±10.48	21.00±10.78	0.002
p-value	0.034*	1.000**	
APD (mm)			
Preoperative	60.65±8.1	60±12.37	0.609
Postoperative	16.38±8.12	27±18.46	0.192
p-value	<0.001*	0.028**	
PT (mm)			
Preoperative	3.04±1.21	3.71±1.98	0.260
Postoperative	8.03±2.98	4.93±1.54	0.006
p-value	<0.001*	0.167**	
PT ratio			
Preoperative	0.35±0.15	0.27±0.15	0.374
Postoperative	0.77±0.3	0.34±0.09	0.001
p-value	<0.001*	0.312**	

*Comparison of preoperative and postoperative DRF, APD, PT and PT ratios of patients with <1 year of age, **Comparison of preoperative and postoperative DF, APD, PT and PT ratios of patients with >1 year of age. DRF: Differential renal function, APD: Anteroposterior diameter, PT: Parenchymal thickness, GH: Giant hydronephrosis

DISCUSSION

Data regarding pediatric patients with GH due to UPJO is scarce and there is even no consensus on how to define GH in the pediatric age group[3-5]. In our study, cases with an AP diameter of at least 50 mm on two USGs and with PT thinner than ½ of the contralateral kidney were considered as GH. We thought that overexpansion of the collecting system or the amount of fluid within the collecting system (which might be changed according to the age of the patient) is not sufficient to describe GH in children. Sorrentino defined GH as not only dilatation of the extrarenal or intrarenal pelvis but also the transformation of the kidney into a fluid-filled sac with thin parenchyma[8]. Increased intrarenal pressure reduces renal blood flow and causes glomerular and tubular atrophy and eventually fibrosis[9].

Significant thinning of the renal parenchyma and severe loss of renal function are observed in GH patients. Previous studies have emphasized, but failed to define this decrease in PT[3-4]. The configuration of the renal pelvis may alter the definition of GH. It may be more appropriate to define GH not only as an excessive expansion of the pelvis but its effect on the parenchyma should be also taken into account. Onen's[10]alternative hydronephrosis grading system defines Grade 4 hydronephrosis as severe renal parenchymal loss >1/2 (cyst-like kidney with no visually significant renal parenchyma). We think that a definition that emphasizes the decrease in PT, especially to distinguish the wide extrarenal pelvis from GH, will contribute to an accurate identification of pediatric GH patients. On the other hand, AP diameter of pelvises over 50 mm is defined as gross hydronephrosis by Dhillon and is stated as a definite indication for pyeloplasty[11]. Therefore, it may be a simpler and more practical method to combine these parameters for the pediatric age group and accept cases with an AP diameter of at least 50 mm and a PT thinner than ½ of the opposite kidney as GH.

Our study has confirmed that preoperative PT ratios, DRF, PT were found to be significantly impaired in the GH group compared to the non-GH group (Table 1). In the past years, nephrectomy was preferred in these cases. The incidence of nephrectomy for GH was reported between 3% and 70%[1,12]. Kaura et al.[13] reported in their series, which included both children and adults, that nephrectomy was performed on patients with renal cortical thickness below 5 mm and renal function below 15%. We believe this approach is not suitable for children. It has been shown in pediatric patients that PT and DRF may improve after pyeloplasty[14,15]. Nephrectomy is not recommended anymore even for very poorly functioning kidneys in children[16,17].

Li et al.[15] suggested that compression of the renal parenchyma may be the cause of deterioration in kidney function in some patients and that when the obstruction is relieved, the function of the parenchyma may significantly improve. Yapanoğlu et al.[18] stated that the primary aim of GH treatment is to protect the renal parenchyma. Nerli et al.[5] reported 8 children with GH who underwent laparoscopic pyeloplasty and emphasized improvement in PT in these patients after pyeloplasty. In our series, postoperative improvement of PT was demonstrated in both groups, and improvement in DRF was significant in infants with GH, and PT ratio of GH patients became equal to that of non-GH patients. Moreover, calculating the exact preoperative renal function of a severely dilated kidney is not easy. In this series, nephrectomy was not performed on any of the patients including three cases with poorly functioning (<10%) kidneys in the GH group. PT ratios, and DRFs of all these three patients improved after pyeloplasty. Kim et al.[6] reported that performing pyeloplasty in patients under 1 year of age is an important factor in the recovery of PT. Baek et al.[3] reported that PT increased more in children with GH who underwent surgery under 1 year of age than in children over 1 year of age, and stated that in GH early relief of the obstruction is beneficial[3]. Our study confirmed that, when both groups were examined according to age, PT ratios and DRF improved significantly in patients younger than 1 year of age. Contrary to that, DRF and PT of patients older than 1 year of age were significantly impaired compared to patients younger than 1 year of age and did not improve after pyeloplasty (Table 3). These patients are also susceptible to trauma, which can delay and complicate surgery, therefore they must be diagnosed and operated on as soon as possible.

A severely dilated renal collecting system has difficulty restoring peristalsis and may cause poor renal clearance even after surgery in patients with GH. Nephropexy and nephroplication were suggested so as to improve postoperative drainage patterns[13,19-21]. Kato et al.[19] stated that the postoperative results of those who underwent nephroplication appeared to be better than those who did not. However, this observation was based on a very small number of patients. Shah et al.[22] reported that patients with huge extrarenal pelvis should undergo reduction pyeloplasty combined with nephropexy to reduce stasis and improve drainage by better aligning the pelvicalyceal system with the upper ureter. On the

contrary, in their adult series Sataa et al.[23] stated that such a procedure was not necessary and did not improve renal drainage. Reduction pyeloplasty was performed in this series, but none of the patients underwent nephropexy or nephroplication. It is obvious to expect a decrease in APD of the renal pelvis in patients who underwent pelvis reduction. However, it should not be forgotten that in cases with persistent obstruction and the need for reoperation during follow-up, APD of the renal pelvis increases gradually and is the first suspicious finding for recurrent obstruction. Therefore, we think that the gradual decrease in APD during follow-up, together with the regression of the obstructive pattern in MAG3 scintigraphy, is an important criterion indicating the success of the operation. It has been reported that the best indicators of the relief of obstruction in GH patients are the decrease in APD in USG and the stability of DRF in diuretic renography[3,4]. In our series, significant decrease in APD of renal pelvis was achieved, and postoperative drainage was satisfactory. The long-term preservation of renal function was also demonstrated. This may be related to the fact that all of the patients are in the pediatric age group and infants constituting the majority. Therefore, the deterioration in pelvic peristalsis may be more irreversible when detected in late childhood or adult age. Kaura et al.[13] reported a success rate of 70% in adults and 90.9% in children with GH. As shown in our series in which only pelvic reduction was performed, satisfactory drainage patterns and improvement of APD in GH patients were achieved after pyeloplasty. Pelvic reduction may improve pelvic drainage, but according to our results, we think that nephropexy and nephroplication may not be necessary in pediatric age groups.

Levitt et al.[24] performed 15 ureterocalicostomies (UC) as the primary treatment for UPJO. Ansari et al.[25] reported 25 children who underwent ureterocalicostomy and claimed that UC had excellent outcomes in children with GH due to primary and secondary UPJO. In our series, only one patient with a short ureter underwent UC as a reoperation. Based on our series demonstrating significant improvement in patients' drainage patterns in MAG3 scintigraphy, we think UC will not be the first treatment of choice in pediatric age groups but can be chosen in secondary surgery or patients with short ureters.

Study Limitations

The limitation of this study is that it was a retrospective analysis and involved a small number of patients. However, as far as we know, even though the scarce number of patients were included in this series, it has the longest follow-up period where patients in the pediatric age group with GH were monitored. The long-term preservation of renal function and improvement of PT has been demonstrated, when the patients who had undergone renal scanning at postoperative first year and in the long-term were compared.

CONCLUSION

Postoperative long-term outcomes were satisfactory in pediatric patients with GH due to UPJO and postoperative renal function and PT improved in patients younger than 1 year of age.

Since reduction pyeloplasty provides sufficient urinary clearance, nephropexy, and nephroplication are not necessary for pediatric age.

UC or nephrectomy should not be considered as the first treatment option in infants with GH.

Ethics

Ethics Committee Approval: This study approval by the University of Health Sciences Turkey, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital Clinical Research Ethics Committee (approval number: 2023/09-09-847, date: 22.06.2023).

Informed Consent: All patients were given information about the procedure, and their consent were obtained.

Author Contributions

Surgical and Medical Practices: A.B.U., A.Ş., Concept: A.B.U., Design: A.B.U., A.Ş., Data Collection and Processing: A.B.U., B.S., A.D.P., Analysis and Interpretation: A.B.U., B.S., Literature Search: A.B.U., B.S., A.D.P., Writing: A.B.U., A.Ş.

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