



Long Term Functional Success After Pyeloplasty for Pelvi-Ureteral Junction Obstruction in Unilateral Poorly Functioning Kidney in Exclusively Adults Population

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OBJECTIVES	To assess long-term clinical and functional outcomes postpyeloplasty in unilateral UPJO in poorly functioning kidneys in exclusive adult population.
MATERIALS AND METHODS	We reviewed the database of all cases admitted with unilateral UPJO treated with pyeloplasty and preoperative split renal function (SRF) was $<30\%$ (by diuretic MAG-3 renography). We further subdivided patients into 2 groups; group (A) $SRF \leq 20\%$ and group (B) $SRF >20\%$ and $<30\%$. Renal function difference was evaluated by the changes in SRF at last follow-up, where 5% change was considered significant. Functional success was defined as absence of obstructive pattern on diuretic renogram with no decline in renal function. Clinical success is defined as no need of secondary intervention (redo pyeloplasty, nephrectomy, stenting, or endopyelotomy).
RESULTS	Among 211 patients. The mean SRF was $20.5 \pm 6.6\%$. After a median follow-up of 67.1 ± 11.8 months, SRF increased significantly to 23.5 ± 7.5 ($P < .0001$). In group (A) 92 patients, SRF increased from 14.3 ± 4.9 to 18.7 ± 7.1 ($P < .0001$). Functional success was achieved in 88 (95.6%) patients. Whereas, in group (B), SRF increased from 24.9 ± 3.3 to 27.2 ± 6.3 ($P < .0001$) at last follow-up. Functional success was achieved in 121 (95%) patients. Static SRF in serial follow-up renography had been observed after 12 months of follow-up.
CONCLUSION	Pyeloplasty provides high rates of functional success in poorly functioning kidneys. After 12 months follow-up, SRF seems to be static without deterioration. UROLOGY 131: 234–239, 2019. © 2019 Elsevier Inc.

Ureteropelvic junction obstruction (UPJO) is the most common form of chronic upper urinary tract partial obstruction hindering free urine passage from renal pelvis to ureter either functionally or anatomically. Regardless the underlying causes (intrinsic or extrinsic), the renal pelvis by its compliance can accommodate urine for a certain time then once losing its elasticity, progressive renal functional deterioration occurred.¹ Surgical repair is indicated to achieve nonobstructive renal drainage when split renal function (SRF) lies between 15% and 40%. Other indications for repair are pain relief, treating

secondary pathologies like stones and infections, and, if possible, regain the lost renal function.²

Renal function recoverability after pyeloplasty is not guaranteed in all cases. It is affected by hyperfiltration developed as a primary phenomenon in UPJO which may have a fundamental role in progression to irreversible renal damage.³ Also, pretreatment SRF is a strong predictor of functional outcome. In previous study, 6 out of 17 renal units with $SRF <30\%$ were associated with abnormal changes in the renal biopsy and none showed improvement on follow-up postoperatively. On the other hand, patients with SRF greater than 44% had normal biopsies.⁴ This came with the same findings of Ortapamuk et al, whereas kidneys with $SRF <30\%$ showed no improvement after pyeloplasty.⁵

In previous studies, patients with $SRF <40\%$ had a significant increase in SRF function after pyeloplasty.^{6,7} Kidneys with Glomerular Filtration Rate (GFR) >10 mL/min showed either improvement or stabilization in renal function over 13 months follow-up after treatment (63.7% and

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4.4%, respectively).⁸ Recently, Nayyar et al reported higher rates of functional success of pyeloplasty performed for kidneys with SRF $\leq 20\%$ or estimated GFR (eGFR) ≤ 20 mL/min.⁹

However, the results of the previous studies should be considered cautiously because of the small sample size, short term follow-up and the contradictory results. So, we conducted this retrospective study to evaluate the long-term functional outcome of pyeloplasty performed for repair of poorly functioning kidneys.

PATIENTS AND METHODS

After obtaining Internal Board Review acceptance, we retrospectively retrieved the records of all patients who underwent pyeloplasty for UPJO in a tertiary referral high volume center from January 2000 to December 2016. Those with UPJO with SRF $\leq 30\%$ preoperatively and completed more than 24 month of follow-up were included in the study. Patients with recurrent UPJO, solitary kidney, anatomically abnormal kidney, bilateral UPJO, less than 18 years old or older than 50 years, those with systemic diseases, that is, hypertension or diabetes mellitus or chronic renal failure were excluded.

Intervention

UPJO was diagnosed on F-15min diuretic TC₉₉-MAG₃ renography with obstructed pattern (T1/2 >20 minute). Noncontrast or contrast-enhanced computed tomography was obtained if renal pelvis is dilated more than the basal or to localize stones whenever they were reported by abdominal ultrasound. Grades of hydronephrosis were classified according to Society of Fetal Urology.¹⁰

Open or laparoscopic pyeloplasty was done according to the surgeons and patients' preference. The indications for surgery were flank pain, deteriorating renal function on diuretic renography, presence of secondary stones and/or recurrent urinary tract infection. In most patients, Andersons-Hynes dismembered pyeloplasty was performed. In case of laparoscopy, after excision of ureteropelvic junction segment and reduction (if required), ureteropelvic anastomosis was made in a single-layer continuous sutures using either 3-0 or 4-0 Vicryl suture. Whereas in open pyeloplasty, the anastomosis was performed in interrupted, continuous or mixed fashion using the same 4-0, 5-0 Vicryl sutures. During pyeloplasty, antegrade DJ stenting was fixed for 4-8 weeks. The included cases were operated by 6 experienced urologists (>10 -year experience) and 12 urologists in training.

Follow-Up

According to our protocol, all patients were followed up by abdominal ultrasound and diuretic renography 6 months after the procedure then biannual ultrasound and annual renography for 3 years. Repeated renography was recommended for persistent manifestations, progressive hydronephrosis or deterioration of SRF in the initial follow-up renography.

Outcomes

The primary outcome is to assess the long-term renal function among the studied population. This was done by comparing the SRF, GFR, and T1/2 (*un-obstructed*: <10 min, *equivocal*: 10-20 min, and *obstructed*: >20 min) at last follow-up with baseline values estimated by diuretic TC₉₉-MAG₃ renography. Functional success was defined as absence of obstructive drainage

pattern on diuretic renography with no decline in renal function. A change of $>5\%$ SRF on operated side was considered significant.^{5,11-13} Patients were categorized into 3 groups according to SRF-changes into: static, decreased and improved SRF. Clinical success is defined as no need of secondary intervention (redo pyeloplasty, nephrectomy, stenting, or endopyelotomy) and resolution of symptoms. The secondary outcome was to define time at which follow-up renography should be stopped in this specific group of patients.

Patients then subdivided into 2 groups group (A) patients with SRF $\leq 20\%$ and group (B) patients with SRF $>20\%$ and less than 30% and the outcome was compared between both groups.

STATISTICAL ANALYSIS

Continuous data were expressed as mean \pm SD or median (range) according to the pattern of distribution. Comparison of SRF through the study period was done using paired sample *t* test. Univariate analysis of factors affecting the functional success was done using independent sample *t* test, chi-square and Mann-Whitney *U* tests. Repeated measured ANOVA was carried out to determine change in renal function in both groups. Multivariate analysis was performed by logistic regression analysis. All statistical tests were carried out using IBM "SPSS" statistics version 21, with a *P* value of less than .05 was considered significant.

RESULTS

The study included 221 patients (139 male and 82 females) with mean \pm SD age of 29.5 ± 11.3 years. The mean \pm SD SFR and GFR were 20.5 ± 6.6 and 15 ± 6 mL/min, respectively. Patients' demographic criteria were illustrated in (Table 1).

At a mean \pm SD follow-up of 67.1 ± 11.8 months, the mean \pm SD SRF increased to 23.5 ± 7.1 ($P < .0001$) and the mean \pm SD GFR increased to 23.4 ± 9.5 mL/min ($P < .0001$). T1/2 improved significantly from 38.4 ± 16 min to 8.4 ± 4 min ($P < .0001$). SRF was static, improved and decreased in 150 (67.9%), 59 (26.7%), and 12 (5.4%) patients, respectively. Preoperative renal drainage (either by JJ stent or PCN) was carried out in 8 patients due to infected renal units resistant to medical treatment or septic shock at initial presentation. Functional success was achieved in 209 (94.6%) patients. Clinical success was achieved in 214 (96.8%) patients. In view of persistent symptoms, 4 patients required LASER endopyelotomy and 3 patients underwent secondary nephrectomy for infected non-functioning kidneys. However, 5 patients didn't undergo any intervention being asymptomatic and refusing intervention with median decrease of SRF by 7.8%. In univariate analysis, none of the perioperative parameters showed statistically significant impact on the functional outcomes (Table 2).

In group (A), 92 patients with SRF $\leq 20\%$ were treated by pyeloplasty. At last follow-up, SRF increased significantly from 14.3 ± 4.9 to 18.7 ± 7.1 ($P < .0001$). T1/2 improved significantly from 38.7 ± 18 minutes to 9.1 ± 4.1 minutes ($P < .0001$). At last follow-up, 74 (80.4%) patients had T1/2 <10 minutes, 15 (16.3%) patients had T1/2 between 10 and 20 minutes and 3 (3.3%) patients had T1/2 >20 minutes. Functional and clinical success were achieved in 88 (95.6%) patients. Two cases required LASER endopyelotomy for obstructed and decreased

Table 1. Comparison between patients with SRF $\leq 20\%$ group (A) and SRF $>20\%$ and $<30\%$ group (B)

Variable	Total Group (n = 221)	SRF $\leq 20\%$ Group (A) (n = 92)	SRF $>20\%$ Group (B) (n = 129)	PValue
Age in years *(mean \pm SD)	29.5 \pm 11.3	29 \pm 10.2	29.6 \pm 11.5	0.9
Sex (no.of.pts) [†]				
• Male	139	50	89	
• Female	82	42	40	0.08
Complaint (no.of.pts) [†]				
• Pain	184	82	102	
• Incidentally discovered	24	7	17	0.1
• Infection	13	3	10	
Urine culture (no.of.pts) [†]				
• Positive	120	55	65	0.1
• Negative	111	37	64	
Side (no.of.pts) [†]				
• Right	100	41	59	0.8
• Left	121	51	70	
• APD of renal pelvis in cm*	4.2 \pm 1.7	4.4 \pm 2	4.1 \pm 1.8	0.1
Grades of Hydronephrosis (no.of.pts) [†]				
• Grade I	4	0	4	
• Grade II	85	35	50	0.1
• Grade III	121	51	70	
• Grade IV	11	6	5	
Stones presence (no.of.pts) [†]				
• No	201	85	116	
• Yes	20	7	13	0.5
Presence of crossing vessels (no.of.pts) [†]				
• No	187	76	111	0.6
• Yes	34	16	18	
Primary surgeon (no.of.pts) [†]				
• Expert	141	61	80	0.5
• Nonexpert	79	31	48	
Pyeloplasty technique(no.of.pts) [†]				
• A-H pyeloplasty	216	90	126	0.9
• Y-V pyeloplasty	5	2	3	
Type of intervention(no.of.pts) [†]				
• Open	187	75	112	0.07
• Laparoscopic	34	17	17	
Preoperative SRF % (mean \pm SD)	20.5 \pm 6.6	14.3 \pm 4.9	24.9 \pm 3.3
Preoperative GFR mL/min (mean \pm SD)	15 \pm 6	18.9 \pm 5.7	29 \pm 5.8
Preoperative t1/2 in minute (mean \pm SD)	38.4 \pm 16	38.7 \pm 18	34.6 \pm 14.5

no.of.pts = number of patients.

*t-Test.

[†] Chi-square.

SRF by follow-up renography and 2 patients required open nephrectomy due to loss of renal function after 6 and 12 months, respectively. Twenty-seven patients had SRF $\leq 10\%$ preoperatively. After a mean \pm SD of 64 \pm 12 months, SRF increased significantly from 7.9 \pm 1.1 up to 16.2 \pm 7% ($P < .0001$). Also, GFR increased significantly from 9.3 \pm 4.1 mL/min to 15.9 \pm 6.7mL/min ($P < .0001$). T1/2 improved from 38.9 \pm 18.4 minutes to 9.4 \pm 3.7 minutes postoperatively. At last follow-up, 102 (79.1%) patients had T1/2 < 10 min, 19 (14.7%) had T1/2 between 10 and 20 minutes and 8(6.2%) patients had T1/2 > 20 minutes. All patients had static (7 patients) or improved renal function (20 patients). None developed renal function loss. With functional and clinical success reached 100%.

Similarly in group (B), SRF increased from 24.9 \pm 3.3 to 27.2 \pm 6.3 ($P < .0001$) at last follow-up. Renal T1/2 improved from 34.6 \pm 14.5 minutes preoperatively to 8.7 \pm 4 postoperatively ($P < .0001$). Functional success was achieved in 121 (95%) patients. Clinical success was achieved in 126 (97.7%) patients, where 2 patients required LASER endopyelotomy and 1 patient

required open nephrectomy. Comparison of the functional outcomes between group (A) and (B) was illustrated in (Table 3).

Early postoperative complications was recorded in 7 (3.1%) patients with no statistically significance difference between both groups (3 vs 4, $P = .2$). Fever, urinary leakage and displaced internal stent were recorded in 5, 1, and 1 patients, respectively. Cystoscopic-guided readjustment of the stent was performed (Clavien IIIa), otherwise, other complications were conservatively managed (Clavien II).

Functional and clinical failure was diagnosed between 6 and 12 months of follow-up. Moreover, SRF in both groups were nearly static with no loss or reduction of renal function with insignificant increase in SRF in serial follow-up renography had been observed after 12 months of follow-up (Table 4; Fig. 1).

DISCUSSION

Functional recoverability of the kidney after release of obstruction is of great clinical importance. If recoverability

Table 2. Univariate analysis for detection of renal function recoverability postpyeloplasty

Variable	Static SRF (n = 150)	Improved SRF (n = 59)	Decreased SRF (n = 12)	PValue
Age in years * (mean ± SD)	28.3 ± 11.9	29.6 ± 10.2	27.8 ± 9.1	0.7
Sex [†]				
• Male	109	28	2	0.06
• Female	41	31	10	
BMI kg/m ² *	26.6 ± 5.2	28.1 ± 5.9	27.6 ± 6.6	0.2
APD of renal pelvis in cm*	4.2 ± 1.5	4.2 ± 1.9	4.6 ± 2.1	0.7
Grades of Hydronephrosis (no.of.pts) [†]				
• I	2	1	1	0.2
• II	56	26	3	
• III	82	31	8	
• IV	10	1	0	
Presence of crossing vessels(no.of.pts) [†]				
• No	126	51	1	0.6
• Yes	24	8	1	
Presplit renal function* (mean ± SD)	21.7 ± 5.5	17.2 ± 8	22.3 ± 5.3	0.07
Primary surgeon (no.of.pts) [†]				
• Expert	93	40	8	0.5
• General	57	19	4	
Type of intervention(no.of.pts) [†]				
• Open	131	46	10	0.1
• Laparoscopic	19	13	2	

* One-way ANOVA.

[†] Chi-square.

is suspected, surgical relief of obstruction is a must even though there is substantial initial function loss. Contrary, in irreversibly damaged kidneys, it may be desirable to apply nonsurgical management or even nephrectomy if the patient has persistent symptoms. Patient with unilateral UPJO with SRF <30% is still debatable in their outcomes. Therefore, assessment of renal function before and after surgery is essential in cases of UPJO. There is no universally agreed protocol and minimum duration of follow-up in patients with UPJO after surgical intervention. The cutoff

value for significant changes in SRF postpyeloplasty is still a matter of debate. As recommended by other investigators,^{5,11-13} we considered change in SRF to be 5% as a significant change in postoperative follow-up renography. It seems more precise value for this specific group of patients with low SRF where any changes have a great clinical influence of the renal unit function.

It was reported that renal function recoverability depends on patient's age, preoperative renal function, and degree of parenchymal thickness.⁶ Khalaf et al⁸ found that preoperative selective GFR and renal perfusion were the independent predictors of renal function recoverability among patients with UPJO after pyeloplasty in multivariate analysis. Conversely, Li et al concluded that preoperative SRF can not independently predict the postoperative renal function recoverability in adult patients with unilateral renal obstruction. Patient age, hydronephrosis grade, and preoperative renal resistive index were significantly associated with the recoverability of renal function in adult patients.¹⁴

Bhat et al reported that renal biopsy was a better predictor of pyeloplasty outcome compared with preoperative SRF in UPJ obstruction. In the presence of severe obstructive changes in renal biopsy, renal function recoverability was hampered despite achieving proper drainage.¹³ Herein among patients with poor renal function, patients' age, grades of hydronephrosis and preoperative SRF had no significant impact on renal function outcome. Lower preoperative SRF and female gender showed worth renal function outcome though statistically significance was not reached.

In both adult and pediatric patients, kidneys with SRF <30 have been reported to have a little chance of

Table 3. Comparison of the functional outcome between group A and B at last follow-up

Variable	Group A (No. 92)	Group B (No. 129)	PValue
SRF (%) *			
• Preoperative	14.3 ± 4.9	24.9 ± 3.3	0.06*
• At last follow-up	18.7 ± 7.1	27.2 ± 6.3	
• P value	<0.0001	<0.0001	
GFR (mL/min) *			
• Preoperative	18.9 ± 5.7	29 ± 5.8	0.07*
• At last follow-up	23.9 ± 10.2	31.9 ± 10.3	
• P value	<0.0001	<0.0001	
T1/2 at last follow-up (min) [†]			
• <10	74(80.4%)	102(79.1%)	0.5
• 10-20	15(16.3%)	19(14.7%)	
• >20	3(3.3%)	8(6.2%)	
Functional success [†]	88 (95.6%)	121 (95%)	0.1
• Static	52 (65.5%)	98 (76%)	
• Improved	36 (39.1%)	23 (17.8%)	
• Deteriorated	4 (4.4%)	8 (6.2%)	

* Difference in changes in both groups using repeated measure ANOVA.

[†] Difference between both groups was done using chi-Square test.

Table 4. SRF changes in all periods of the study in both groups

Variable*	SRF% after 1 year (mean ± SD)	SRF% after 2 year (mean ± SD)	SRF% after 3 year (mean ± SD)	SRF% >3 years (mean ± SD)
Group (A)	17.1 ± 6.2	17.9 ± 6.8 (P= .4)	17.5 ± 5.8 (P= .3)	20.6 ± 8.5 (P = .07)
Group (B)	26.7 ± 5.8	26.6 ± 6.2 (P= 0.9)	27.5 ± 5.8 (P = .8)	27.4 ± 6.8 (P = 0.8)

P value: represented comparison of SRF between 1 year follow-up and 2, 3 and more than 3-year follow-up.

* Paired sample t Test.

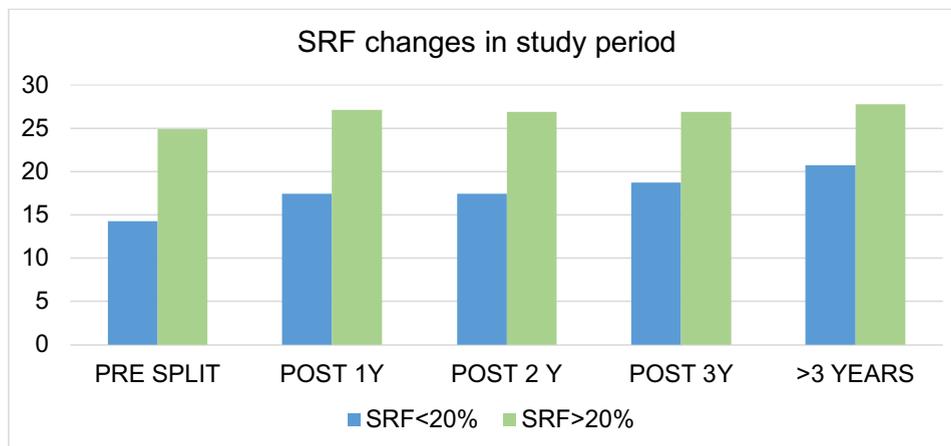


Figure 1. SRF changes in different groups throughout the study. (Color version available online.)

recoverability.^{4,5} Correspondingly, Erbagci et al defined that below SRF 40%, histologic abnormalities were apparent, which negatively correlated with postoperative SRF at 6 months, and 12-month intervals.¹⁵ In contrary, many authors^{6,7,16} reported that patients with SRF <40% had the supreme chance of postoperative renal function improvement. Bansal et al showed that over a period of 41.6 months, 88% of children with SRF of <30% had functional recovery.¹⁷ In another study⁹ including small number of patients with SRF ≤20%, 40.6% of patients showed significant improvement in renal function (>5% over preoperative), and in all except one (3.1%) case there was no further deterioration of function. Herein, in a larger number of patients with a longer follow-up duration, those with SRF <20% showed functional success in 95.6% and only 4.4% had renal function deterioration.

For those with SRF <10%, Ransley et al proposed that no benefit from drainage be suspected and nephrectomy was more cost-effective.¹⁸ However, others¹⁹⁻²¹ reported that, most of these kidneys showed improvement in function and not all such kidneys should be removed without proper drainage, especially in children and young adults. In this study, none with SRF <10 showed renal function deterioration after pyeloplasty.

Psooy et al reported that the follow-up diuretic renography postoperatively after 3 years of surgery did not show significant change from those done at 1 year. However, no definitive conclusion regarding the required follow-up duration; because clinical failure was documented even at 8 years

follow-up.²² Herein, we noticed that clinical and functional failure was in the first year. After 1 year, renal function remained static throughout the follow-up duration.

This study with this large number of patients and relatively long follow-up duration provide a reliable evidence to support the decision of reconstruction in UPJO patients with poorly functioning kidneys in exclusively adult population. However, the study has many limitations that deserve to be mentioned. It is a retrospective study with inherent nature of selection bias. There were no available data as regard renal Doppler sonography, renal resistive index or tissue biopsy to assess its correlation with the functional outcome. The outcome was measured at arbitrary time point rather than at specific postoperative time point. This could not be avoided in a retrospective study. However, we overcame this by the available close follow-up of the patients with the availability of data at different time intervals. Finally, surgeries were done by different surgeons with different experience.

CONCLUSION

UPJO in poorly functioning kidneys is a common decision-making dilemma. Pyeloplasty provides high rates of functional success even in case with SRF <10%. Low SRF is better used in context of other clinical factors to justify repair rather than nephrectomy. After 12-month follow-up, SRF seems to be static without deterioration.

References

1. Arger P, Coleman B, Mintz M, et al. Routine fetal genitourinary tract screening. *Radiology*. 1985;156:485–489.
2. Mouriquand P. Congenital anomalies of the pyeloureteral junction. Grosfeld JL, Fonkalsrud EW, eds. *Congenital anomalies of the pyeloureteral junction*. *Pediatr Surg*. 2006;5.
3. Pascual L, Oliva J, Vega-p J, Principi I, Valles P. Renal histology in ureteropelvic junction obstruction: are histological changes a consequence of hyperfiltration? *J Urol*. 1998;160:976–979.
4. Jeffrey A, Krous HF, Heffernan J, Packer M, Kaplan GW. Correlation of renal biopsy and radionuclide renal scan differential function in patients with unilateral ureteropelvic junction obstruction. *J Urol*. 1995;154:716–718.
5. Ortapamuk H, Naldoken S, Tekdogan UY, Aslan Y, Atan A. Differential renal function in the prediction of recovery in adult obstructed kidneys after pyeloplasty. *Ann Nucl Medicine*. 2003;17:663–668.
6. Harraz AM, Taha D-E, Shalaby I, Hafez AT. Evaluation of factors predicting recoverability of renal function after pyeloplasty in adults. *Urol Int*. 2014;93:403–405.
7. Rivas JG, y Gregorio SA, Eastmond MP, et al. Renal function recovery after laparoscopic pyeloplasty. *Cent Eur J Urol*. 2014;67:210.
8. Khalaf IM, Shokeir AA, El-Gyoushi FI, Amr HS, Amin MM. Recoverability of renal function after treatment of adult patients with unilateral obstructive uropathy and normal contralateral kidney: a prospective study. *Urology*. 2004;64:664–668.
9. Nayyar R, Yadav S, Singh P, Kumar R, Seth A, Dogra PN. Outcomes of pyeloplasty in very poorly functioning kidneys: examining the myths. *Urology*. 2016;92:132–135.
10. Fernbach S, Maizels M, Conway J. Ultrasound grading of hydronephrosis: introduction to the system used by the Society for Fetal Urology. *Pediatr Radiol*. 1993;23:478–480.
11. Sennewald K, Taylor JA. A pitfall in calculating differential renal function in patients with renal failure. *Clin Nucl Med*. 1993;18:377–381.
12. Chandrasekharam V, Srinivas M, Bal C, et al. Functional outcome after pyeloplasty for unilateral symptomatic hydronephrosis. *Pediatr Surg Int*. 2001;17:524–527.
13. Bhat GS, Maregowda S, Jayaram S, Siddappa S. Is renal biopsy a better predictor of the outcome of pyeloplasty in adult ureteropelvic junction obstruction? *Urology*. 2012;79:321–325.
14. Li X-D, Wu Y-P, Wei Y, et al. Predictors of recoverability of renal function after pyeloplasty in adults with ureteropelvic junction obstruction. *Urol Int*. 2018;100:209–215.
15. Erbagci A, Yağci F, Sarica K, Bakir K. Predictive value of renal histological changes for postoperative renal function improvement in children with congenital ureteropelvic junction stenosis. *Int J Urol*. 2002;9:279–284.
16. Salem YH, Majd M, Gil H, Belman AB. Outcome analysis of pediatric pyeloplasty as a function of patient age, presentation and differential renal function. *J Urol*. 1995;154:1889–1893.
17. Bansal R, Ansari M, Srivastava A, Kapoor R. Long-term results of pyeloplasty in poorly functioning kidneys in the pediatric age group. *J Pediatr Urol*. 2012;8:25–28.
18. Ransley P, Dhillon H, Gordon I, Duffy P, Dillon M, Barratt T. The postnatal management of hydronephrosis diagnosed by prenatal ultrasound. *J Urol*. 1990;144:584–587.
19. Wagner M, Mayr J, Häcker F-M. Improvement of renal split function in hydronephrosis with less than 10% function. *Eur J Pediatr Surg*. 2008;18:156–159.
20. Zhang S, Zhang Q, Ji C, et al. Improved split renal function after percutaneous nephrostomy in young adults with severe hydronephrosis due to ureteropelvic junction obstruction. *J Urol*. 2015;193:191–195.
21. Gupta D, Chandrasekharam V, Srinivas M, Bajpai M. Percutaneous nephrostomy in children with ureteropelvic junction obstruction and poor renal function. *Urology*. 2001;57:547–550.
22. Psooy K, Pike J, Leonard M. Long-term followup of pediatric dismembered pyeloplasty: how long is long enough? *J Urol*. 2003;169:1809–1812.