

Follow-up imaging after pediatric pyeloplasty

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ABSTRACT

Introduction: The duration, methods and frequency of radiographic follow-up after pediatric pyeloplasty is not well-defined. We prospectively evaluated a cohort of children undergoing pyeloplasty to determine the method for follow-up.

Methods: Between 2000 and 2008, children undergoing pyeloplasty for unilateral ureteropelvic junction obstruction were evaluated for this study. All patients were evaluated preoperatively with protocol ultrasound (USG) and diuretic renal scan (RS). On the basis of preoperative split renal function (SRF), these patients were divided into four groups - Group I: SRF > 40%, Group II: SRF 30–39%, Group III: SRF 20–29%, and Group IV: SRF 10–19%. In follow-up, USG and RS were done at 3 months and repeated at 6 months, 1 year, and then yearly after surgery for a minimum period of 5 years. Improvement, stability, or worsening of hydronephrosis was based on the changes in anteroposterior (AP) diameter of pelvis and caliectasis on USG. Absolute increase in split renal function (SRF) >5% was considered significant. Failure was defined as increase in AP diameter of pelvis and decrease in cortical thickness on 3 consecutive USG, $t\frac{1}{2}$ >20 min with obstructive drainage on RS and/or symptomatic patient.

Results: 145 children were included in the study. Their mean age was 3.26 years and mean follow-up was 7.5 years. Pre- and post-operative SRF remain unchanged within 5% range in 35 of 41 patients (85%) in Group I. While 9 of 20 patients (45%) in Group II, 23 of 50 patients (46%) in Group III, and 14 of 34 patients (41%) in Group IV exhibited changes >5% after surgery. 5 patients failed, 2 in Group III, and 3 in Group IV. None of the patients deteriorated in Group I and II.

Conclusion: After pyeloplasty in children with a baseline split GFR >30%, if a diuretic renogram and USG performed 3 months postoperatively shows nonobstructive drainage with $t\frac{1}{2}$ <20 min and decreased hydronephrosis, no further follow-up is required.

Key words: Children, follow-up, pyeloplasty, renal scans

INTRODUCTION

Ureteropelvic junction obstruction (UPJO) is the most common form of obstruction in the children.^[1] It is reported to occur in 1:500–1:1250 live births.^[2,3] Surgical repair is indicated for significantly impaired renal drainage or progressive deterioration of renal

function. Other indications for active intervention are to relieve pain or treat pathologies secondary to obstruction such as calculi and infections.^[4,5]

Pyeloplasty is followed by an improvement in the renal dilatation and excretion pattern in up to 98% of patients.^[6] Despite high reported success rates, there are no established recommendations to guide follow-up modality, timing, or duration after pediatric pyeloplasty. Many modalities have been suggested, including intravenous pyelography (IVP), radionuclide renography, magnetic resonance

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urography,^[7] and ultrasonography (USG), either alone or in combination at various time intervals.

USG and diuretic renal scan (RS) are the most widely used investigations for diagnosis and postoperative follow-up.^[8] The success of pyeloplasty is based on the serial USG improvement of pelvicalyceal dilatation and improved drainage on RS with possible recovery of split renal function (SRF) in addition to clinical improvement. However, the duration of such scans long-term renal function on consecutive RS is not clear. Therefore we aimed to determine the appropriate duration and method of follow-up of these children.

METHODS

Children undergoing Anderson-Hynes dismembered pyeloplasty with double J stent for unilateral UPJO at our tertiary care hospital between January 2000 and December 2008 were included for this study. Patients with bilateral disease, vesicoureteral reflux, solitary functioning kidney, recurrent UPJO, and patients in whom the follow-up is less than 5 years were excluded.

All patients were evaluated preoperatively with protocol renal USG (i.e., anteroposterior [AP] diameter of the pelvis with cortical thickness at each pole of the kidney) and technetium-99m ethylene dicycstine (99m Tc-EC) diuretic RS (F '0' diuretic renogram). Society for fetal urology (SFU) grading system was used for hydronephrosis.^[9] Data obtained from the RS reports included SRF and the presence or absence of significant obstruction, defined as $t_{1/2} > 20$ min with an obstructive drainage curve. Obstruction was ruled out if $t_{1/2}$ was < 10 min. A $t_{1/2}$ of 10–20 min was considered equivocal. The indication for surgery was based on the symptoms of pain, fever or lump in the abdomen; or decreased cortical thickness on USG (< 5 mm), and obstructed drainage on RS.

On the basis of preoperative SRF, these patients were divided into four groups: Group I: SRF $> 40\%$, Group II: SRF 30–39%, Group III: SRF 20–29%, and Group IV: SRF 10–19%. In follow-up, patients were evaluated for symptoms, physical examination along with USG and RS, at 3 months and repeated at 6 months, 1 year, and then yearly after surgery for a minimum period of 5 years.

On USG, improvement, stability, or worsening of hydronephrosis was based on changes in AP renal pelvic diameter and caliectasis. On RS, improvement, stability, or worsening in renal function was based on changes in SRF. An absolute increase in SRF of more than 5% in the operated kidney was considered significant. Failure was defined as an increase in AP diameter of pelvis and decrease in cortical thickness on 3 consecutive USG, $t_{1/2} > 20$ min with obstructive drainage on postoperative 99m Tc-EC scan and/or symptomatic patient.

Statistical analysis was performed using the Wilcoxon signed ranks test. Written informed consent of all patients was taken. Institutional ethics and review board approval were obtained.

RESULTS

A total of 104 boys and 41 girls who underwent 145 pyeloplasties met the inclusion criterion. Boys to girl's ratio were 2.54. Mean age was 3.26 years at the time of operation (range 6 months to 10 years). Laparoscopic pyeloplasty was performed in 122 (84.13%) and open surgery in 23 (15.8%). 67 patients (46%) were operated on the right side, and 78 (54%) were on the left side. A total of 30 patients were diagnosed prenatally and 115 postnatally. The main indications for surgery were symptomatic obstruction with pain (47 cases), mass (19), or infection (15), obstructive RS (39), with secondary calculi (6) and worsening hydronephrosis (19).

There were 41, 20, 50, and 34 children in Group I, II, III, and IV, respectively. Preoperative RS was reported as obstructive in 136 kidneys and equivocal in 9. Of the 9 equivocal studies, 3 patients were symptomatic (pain), 4 exhibited worsening hydronephrosis, and 2 had a reduction in differential renal function. Preoperatively USG revealed Grade III and IV hydronephrosis in 99 and 46 patients respectively.

The mean follow-up was 5 years. During follow-up, 140 patients had improvement in hydronephrosis and decreased caliectasis. The number of children with Grade II, III, and IV hydronephrosis was 43, 72, and 30 respectively. 5 patients had worsening of hydronephrosis with concomitant obstructive drainage on RS. Postoperative RS was reported as obstructive in these 5 children and nonobstructive in the remaining 140. Changes in SRF after pyeloplasty are given in Table 1a.

None of the patients in Group I (41 patients) or Group II (20 patients) showed a deterioration in function. In Group III (50 patients), 2 (4%) patients deteriorated while in Group IV (34 patients), 3 patients (9%) deteriorated. These 5 kidneys showed no improvement on postoperative USG. Two exhibited Grade III, and three exhibited Grade IV hydronephrosis preoperatively, while all five exhibited worsening of hydronephrosis postoperatively.

Redo pyeloplasty was performed in 2 patients belonging to Group III with preoperative Grade III hydronephrosis and 22% and 16% SRF with a $t_{1/2}$ of 22 and 25 min, respectively. The initial postoperative USG and RS showed Grade IV hydronephrosis and obstructive drainage at 3 months in these 2 patients.

The remaining 3 patients belonging to Group IV showed no improvement on initial postoperative USG, and the postoperative RS was obstructive. One was treated

Table 1a: Details of split renal function pre- and post-pyeloplasty

Group (SRF) (%)	Number of patients	Decrease in split function (%)	Improvement in split function (%)	Stable split function (%)	Mean (range) (%)	
					Preoperative split renal function	Postoperative split renal function
Group I (>40)	41	-	6 (15)	35 (85)	45.5 (40-55)	47.3 (42-56)
Group II (30-39)	20	-	9 (45)	11 (55)	34.1 (30-39)	35.8 (32-40)
Group III (20-29)	50	2 (4)	23 (46)	25 (50)	25.3 (21-29)	24.9 (17-31)
Group IV (10-19)	34	3 (9)	14 (41)	17 (50)	17.2 (10-19)	16.5 (9-22)

SRF=Split renal function

successfully by redo pyeloplasty while in 2 patients, a palpable abdominal mass developed postoperatively with high-grade fever and SRF declined to less than 5%. Percutaneous nephrostomy was placed initially which drained pus and later both underwent nephrectomy [Table 1b].

DISCUSSION

The purpose of imaging after pyeloplasty is to diagnose obstruction early so that interventions may prevent further nephron loss. Success after pyeloplasty for the repair of UPJO in children has been routinely defined by a combination of clinical and radiographic criteria. In postpyeloplasty follow-up, USG and RS are the most widely used investigations. However, there is variation in modality and frequency of imaging follow-up.^[10] Contemporary series on pediatric pyeloplasty have revealed high success rates, although differing protocols exist regarding imaging surveillance [Table 2].^[11-20]

USG has been used in the pediatric population in assessing outcome after pyeloplasty by measuring changes in the AP pelvic diameter. It has been suggested that patients in whom postoperative USG reveals downgrading of AP pelvic diameter, may not require renograms to rule out the obstruction. However, difficulties with USG include operator variability, slower improvement in hydronephrosis compared with improvement seen on renogram, and the difficulties of differentiating between a dilated and an obstructed renal pelvicalyceal system. There are many variables that are not controlled for during the examination such as the level of pre-USG hydration or the amount of urine in the bladder. These factors can affect the level of hydronephrosis and thus affect clinical decision-making. Early improvement on USG could also be due to surgical reduction of the renal pelvis rather than true improvement.

Postoperative diuretics renogram is generally used to answer two questions, namely, relief of obstruction and functional recovery. Although there are arguments against radionuclide renography, most published data demonstrate its superiority in the ability to determine obstruction. RS showing improved or stable function and

Table 1b: Details of cases which failed

Group (SRF) (%)	Decrease in split function	Time of failure (months)	Surgery
Group III (20-30) (n=50)	2	3	Redo-pyeloplasty (n=2)
Group IV (10-20) (n=34)	3	6	Simple nephrectomy (n=2) Redo pyeloplasty (n=1)

SRF=Split renal function

better drainage can be regarded as proof of successful surgery and is usually performed as a baseline to subjectively document the surgical outcome.^[21] The timing and frequency of postoperative RS have become the subject of recent publications.

More recently, several groups have questioned whether even early postoperative renography is necessary after pediatric pyeloplasty. Use of a sentinel USG instead has been advocated to determine if renography is necessary. Almodhen *et al.* reported on 97 patients who underwent 101 pyeloplasties with a mean follow-up of 4.5 years. Of the 91 kidneys with improvement on postoperative USG, 2 (2%) exhibited an obstructive pattern on renography, although both spontaneously improved during follow-up. Hydronephrosis was downgraded in 46 kidneys, and none of these kidneys exhibited an obstructive postoperative scan. Of the 10 kidneys with worsened or no improvement on postoperative USG, 4 (40%) had an obstructive renogram, of which 2 were treated with a subsequent procedure. They conclude that those with preoperative function <45% may exhibit functional changes >5% that can be determined by postoperative RS.^[22] Cost *et al.* observed similar findings in 49 patients undergoing open pyeloplasty who underwent US and renography at 3 months. Of the 42 children with stable or improved hydronephrosis, 41 had stable function, and one had low function (32% split function) preoperatively but remained stable (21% split function) at longer follow-up. Of the 7 remaining patients with increased hydronephrosis 2 had worse renal function.^[23] In this study, 5 patients failed, 2 in Group III, and 3 in Group IV. None of the patient deteriorated in Group I and II.

van den Hoek *et al.* reported that SRF remained unchanged within the 5% range in 75 of 87 patients (86%) with initial

Table 2: Selected contemporary series on pediatric pyeloplasty including at least 50 cases

References	Approach (n)	Age (years)	Follow-up (months)	Definition of success/failure	Percentage of success	Imaging follow-up protocol
Szavay et al.	Lap transperitoneal	Median 1.7	Median 24	-	98	US every 3 months; MAG3 at 3 months, 12 months
Olsen et al.	Robotic retroperitoneal (67)	Mean 7.9	Median 12.1	Absence of symptoms and/or decreased intrarenal pelvis anteroposterior diameter (US), or unchanged or improved differential function (RS)	94	US + RS at 3 months, 12 months
Minnillo et al.	Robotic transperitoneal (155)	Mean 10.5	Mean 31.7	Improved symptoms, improved hydronephrosis (US) and/or improved drainage parameters (RS)	96	US at 1 month, 3 months, then yearly; MAG3 if recurrent symptoms or not improved on US
Zhou et al.	Laparoscopic retroperitoneal (62)	Mean 3	Mean 24	-	98	IVP + US at 3 months, 6 months, then yearly
Blanc et al.	Laparoscopic retroperitoneal (104)	Mean 6.2	Median 25.2	Decreased or resolved hydronephrosis (US) & improved drainage with residual <50% at 20 min after furosemide administration with stable differential function (RS)	96	US 1 month after stent removal (6 weeks), every 3 months for 1 year, then yearly for 5 years; MAG3 or MR urography if no significant improvement on US, recurrent symptoms or significant preoperative asymmetrical function
Valla et al.	Lap retroperitoneal (45) versus open (45)	Mean 5.1 versus 1.8	Mean 25 versus 38	Symptom improvement & improved hydronephrosis (US) or renal drainage/function (RS)	97 versus 96	US at 3-6 months, then yearly; RS at 1 year
Braga et al.	Lap transperitoneal (41) versus open (67)	Mean 7.9 versus 8.1 (flank), 7.3 (dorsal)	Mean 28 versus 49 (flank), 47 (dorsal)	Symptom resolution, improved hydronephrosis (US) and/or decreased t½ at last, clinical appointment (RS)	95 versus 96	Routine US; RS reserved for prolonged, persistent or worsening hydronephrosis
van der Toorn et al.	Lap transperitoneal (57) versus open (57)	Mean 8.1 versus 7.8	Mean 12 versus 72	Symptom resolution, no conversion/reintervention, decreased hydronephrosis (US) and/or improved drainage (RS)	98 versus 95	Routine US; RS reserved for prolonged, persistent or worsening hydronephrosis
García-Aparicio et al.	Lap transperitoneal (26) versus open (32)	Mean 0.4	-	Improved hydronephrosis (US)	100	US at 1 month, 6 months, 12 months; MAG3 at 6 months
Barbosa et al.	Robotic transperitoneal (58) versus open (154)	Median 7.2 versus 1.2	Median 33 versus 31	Hydronephrosis improved (US) by at least two grades (0-5 scale)	74 versus 70	US at 0-6 months, 6-12 months, after 12 months; MAG3 if no improvement on US
Present study	Lap transperitoneal (122) and open (23)	Mean 3.26	Mean 60	Failure was defined as increase in AP diameter of pelvis and decrease in cortical thickness, t½ >20 min with obstructive drainage on postoperative 99m Tc-EC scan and/or symptomatic patient	96	RS and US at 3 months post operatively; when it shows nonobstructive drainage and decreased hydronephrosis, safely stop follow-up in children with SRF >30.

SRF=Split renal function, US=Ultrasound, RS=Renal scan, MAG3=Merceptoacetyltriglycine, MR=Magnetic resonance, IVP=Intravenous pyelography, AP=Anteroposterior, 99m Tc-EC=Technetium-99m ethylene dicycysteine

preoperative function > 40%. In that series, only 3 patients (3%) demonstrated significant deterioration to <40%, while 27 of 51 patients (53%) with initial function <40% exhibited changes > 5% following surgery. Moreover, it was observed that SRF after pyeloplasty remained unchanged at 5–7 years compared to the initial 9-month postoperative RS. Thus, repeat RS at 5–7 years after pyeloplasty was not justified.^[21] Similarly, our data reveal that SRF remained unchanged within 5% range in 35 of 41 patients (85%) in Group I, while 11 of 20 patients (55%) in Group II, 23 of 50 patients (46%) in Group III, and 14 of 34 patients (41%) in Group IV exhibited changes > 5% after surgery.

Pohl *et al.*, suggested that follow-up can be discontinued as early as 3 months postoperatively if diuretic renogram show $t_{1/2}$ <20 min. Their data indicate that when an unobstructed 3 months renogram is followed by 1-year renogram, the second renogram never shows deterioration in drainage, and therefore, is not necessary.^[6] Tvester *et al.* also noted the similar observations.^[24]

Psooy *et al.* showed that after an unobstructed diuretic renogram, recurrence of the obstruction was unlikely and did not justify a long-term follow-up. They followed their patients radiographically with excretory urography (IVP) at 2 months; renal USG at 6 month and RS at 1 year.^[25] However, with the emergence of USG and radionuclide renography, IVP is of historical interest. There were no data on SRF in their study, and there was no subdivision of patients in groups. O'Reilly *et al.* used a repeat RS in 24 patients at 6–19 years after surgery and concluded that the results were durable.^[26]

Chandrasekharam *et al.* reported that in 68 children with symptomatic pelviureteric junction obstruction, RSs were taken 3 months, 1, 2, and 5 years after surgery, and it was concluded that in patients with impaired preoperative function, the improvement in SRF continued until 1 year after surgery. There was no further improvement after that period, and the SRF remained stable.^[27]

Although the vast majority of failures occur within 1 year after pyeloplasty. Follow-up repeat renography in a group of patients may help to reassure both the patient and surgeon that any ongoing symptoms are not due to persistent or worsening UPJO, and it act as a baseline to subjectively document the surgical outcome, as USG is operator dependant modality and not done by the same radiologist at our institute. A single renogram at 3 months is adequate, without the need of further repeat renography thereafter in Group I and II.

In this study, the limitation is number of RSs, which might associated with the radiation exposure.^[28,29] However, it can be discussed that this risk is small. Another limitation is

that USG studies performed under standardized conditions could have been influenced by the state of hydration, bladder fullness, and sonographic techniques. However, the prospective nature of the study and the substantial number of cases in each group and subdivisions of patients into subgroups according to SRF with longer follow-up contributed to the strength of this study.

CONCLUSIONS

After an unobstructed postoperative diuretic renogram at 3 months, recurrent UPJO is unlikely and does not justify long-term follow-up even in case of impaired SRF after surgery, as most renal units remain stable. After pediatric pyeloplasty, if a diuretic renogram and USG 3 months postoperatively shows nonobstructive drainage with $t_{1/2}$ <20 min and decreased hydronephrosis, we can safely stop follow-up in children with SRF > 30.

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Conflicts of interest

There are no conflicts of interest.

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