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Research Article

Outcomes of Prenatally Diagnosed Moderate to Severe Hydronephrosis at a Single Institution

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Abstract

Background: The best treatment for neonates with prenatally diagnosed severe Hydronephrosis (HN) secondary to Ureteropelvic Junction Obstruction (UPJO) is still debated. Some argue for early operation to protect renal function, while others argue for operation only after compromised renal function, worsening HN, febrile UTI or symptomatology. We hypothesized that initial postnatal grade 4 HN secondary to UPJO would require operation more frequently than grade 3 HN and that most children would not require surgery.

Methods: A retrospective, single center chart review was performed on 202 patients with prenatally diagnosed HN and unilateral postnatal SFU grade 3 or 4 HN presenting between 2001-2015. Children with confounding urinary anomalies such as bilateral HN, Lower Urinary Tract Obstruction (LUTO) or Vesicoureteral Reflux (VUR) were excluded.

Results: Two hundred two neonates were diagnosed with unilateral SFU grade 3 or 4 HN and renal scans consistent with UPJO. The majority was male (71%) and affected the left kidney (63%). On initial ultrasound, 39% of children presented with SFU grade 3 HN, and 61% presented with SFU grade 4 HN. An initial renal differential function 10% or greater was found in 13% of patients; they underwent immediate surgical correction. Eighty-seven percent underwent initial surveillance. With a mean follow-up of 44 months, 167 of 176 (95%) children who initially underwent observation progressed to surgery, with the majority occurring shortly after the first year (mean 17 months, median 7 months). There was no difference in operation rate between initial grade 3 or 4 HN (93 vs 96%, respectively). Indications given for surgery varied widely, with worsening HN (39%) or renal differential of greater than or equal to 10% (27%) being the most common. Postoperative complications occurred in 13% with urinary tract infection as most common.

Conclusions: The majority of children with prenatally diagnosed SFU grade 3 or 4 HN secondary to UPJO progressed to surgical correction (193 of 202, 96%). Surgical rate was no different whether the initial HN was grade 3 or grade 4.

Keywords: Hydronephrosis; Outcome Assessment; Prenatal Diagnosis; Ureteral Obstruction; Ureteropelvic Junction Obstruction

Abbreviations

HN	:	Hydronephrosis
LUTO	:	Lower Urinary Tract Obstruction
UPJO	:	Ureteropelvic Junction Obstruction
SFU	:	Society for Fetal Urology
fUTI	:	febrile Urinary Tract Infection
VCUG	:	Voiding Cystourethrogram
VUR	:	Vesioureteral Reflux
PCN	:	Percutaneous Nephrostomy

Introduction

Fetal hydronephrosis is the most common congenital genitourinary anomaly, affecting between 1-5% of pregnancies [1]. As prenatal ultrasound utilization increases, incidence is also increasing. UPJO is the most common significant renal anomaly causing hydronephrosis [2]. UPJO can have serious consequences such as urinary tract infections, kidney stones and irreversible loss of renal function. Before several sentinel studies in the 1980s [3,4], most UPJO cases underwent surgical correction using a dismembered pyeloplasty [5]. The dismembered pyeloplasty has good outcomes with acceptable complication rates [6]. Following the 1980s discovery that many hydronephrotic patients will spontaneously recover, most physicians opt for an approach that promotes active surveillance with serial imaging and surgery is only reserved for select indications. Currently, The European Association of Urology recommends pyeloplasty for symptomatic UPJO including febrile Urinary Tract Infections (fUTIs) or recurrent flank pain [7]. Other possible indications for surgical intervention listed in the guidelines include differential renal function less than 40%, a subsequent decrease in renal function of 10%, obstructive parameters on Lasix renal scan, worsening refractory hydronephrosis, and Society for Fetal Urology (SFU) grade 3 or 4 renal pelvis dilatation [8]. No specific guidelines are mentioned by the American Urological Association.

Most mild hydronephrosis will spontaneously resolve without intervention [9,10]; it is unclear, however, how children with severe hydronephrosis will fare. There are no clear data for this group: some report 50-78% resolution of high grade UPJO within 24 months of birth [3,9,11,12]. We hypothesized that initial postnatal grade 4 HN secondary to UPJO would require operation more frequently than grade 3 HN and that most children would not require surgery. We report the clinical and surgical outcomes of children with prenatally diagnosed SFU grade 3 and 4 HN secondary to UPJO at our institution. We also compare surgical rates with initial postnatal grade 3 HN versus grade 4 HN.

Materials and Methods

Data

After institutional review board approval, a retrospective chart review regarding patients diagnosed with prenatal hydronephrosis and/or neonatal UPJO at our institution between January 2001 and March 2015 was performed. Demographic information, including gender, ethnicity, right or left side, and SFU grade of hydronephrosis was collected for each patient. Age at first post-natal ultrasound, results of MAG-3 and DMSA, age at first surgery, indication for first surgery, complications, and last clinical visit or study (follow up) were recorded. The approach to surgery and any complications were recorded.

Inclusion and Exclusion Criteria

Prenatal diagnosis of hydronephrosis was confirmed by postnatal ultrasound. Only children with unilateral SFU Grade 3 or 4 HN were included. Any children with confounding factors such as vesicoureteral reflux (VUR), megaureter, ureterocele, LUTO, neurogenic bladder, solitary kidneys or multicystic dysplastic kidney were excluded.

Observational Protocol

All seven physicians followed a similar surveillance protocol. Children identified with prenatal hydronephrosis received postnatal ultrasounds to confirm the diagnosis after 2 weeks of age. They also underwent VCUG to rule out VUR at approximately 1-3 months of age. In the absence of reflux, the children then had a nuclear renal scan. Periodic ultrasounds were performed for surveillance in children that met criteria for observation. This included an ultrasound every 3 month for the first year of life and then yearly ultrasounds.

Outcomes, Data Analysis and Statistical Analysis

Primary outcomes included surgical intervention for hydronephrosis secondary to UPJO and the presence of grade 3 or grade 4 HN on initial postnatal ultrasound. Secondary outcomes were reasons for surgical intervention and complications resulting from surgery. Statistical evaluations were performed with the Wilcoxon rank test and Fisher exact test (2-tailed) using SAS, version 9.3. Time to surgery analysis graft was created using SAS 9.3 software.

Results

Cohort Characteristics

Three thousand six hundred and six children with a diagnosis of UPJ obstruction or hydronephrosis were identified between January 2001 and March 2015 (Figure 1).

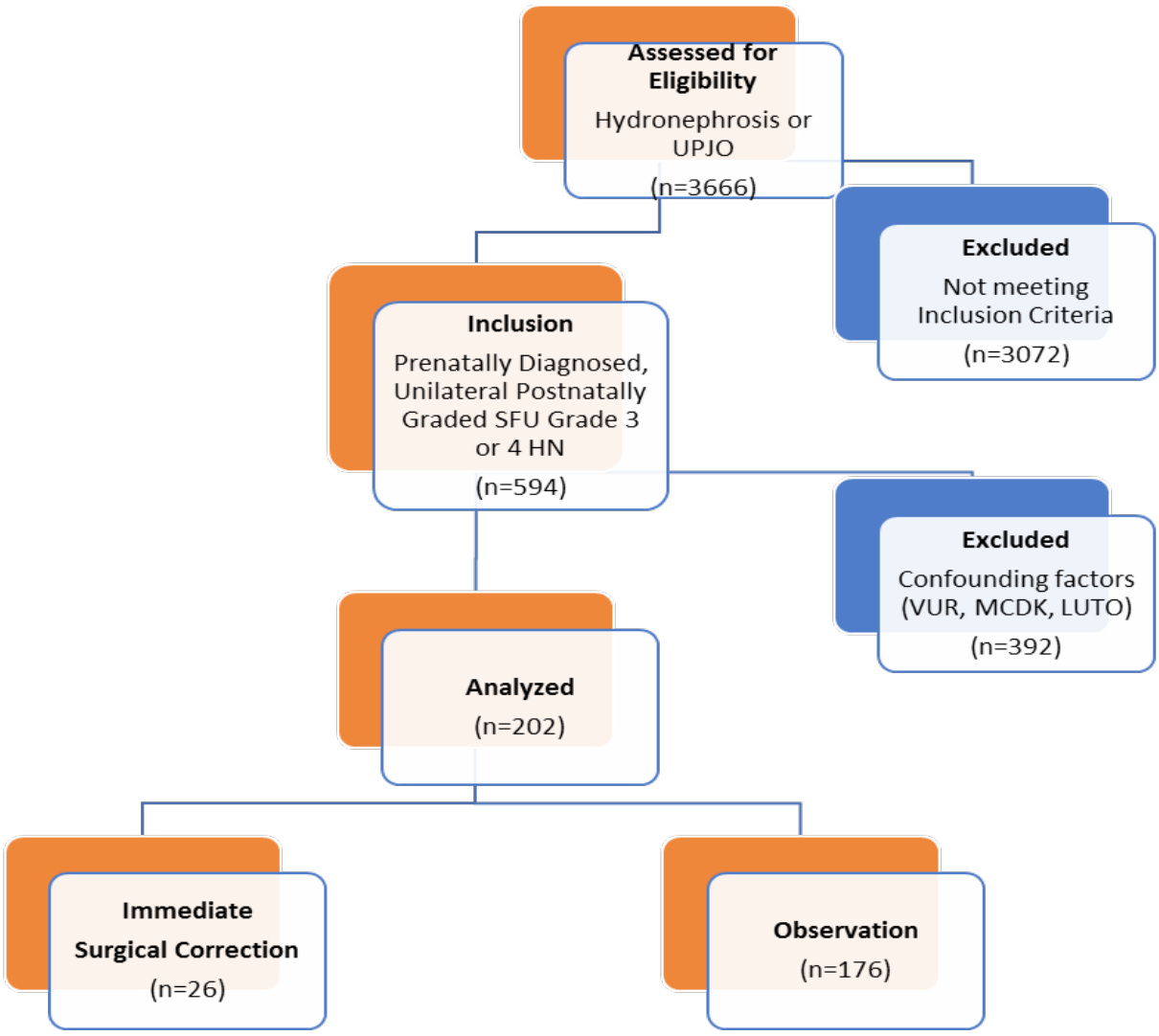

Figure 1: CONSORT Diagram showing inclusion criteria. Children were included in the study only if they had prenatally diagnosed post-natal unilateral obstruction SFU grade 3 or 4 HN secondary to UPJO and no confounding factors. Twenty-six children underwent immediate surgical correction for reduced renal function while 176 children were observed through repeat renal ultrasounds and/or a nuclear renal scan.

Only 594 children had postnatal unilateral SFU grade 3 or 4 hydronephrosis. Manual chart reviews were performed to exclude postnatal diagnoses and urological diagnoses of VUR, ureterectasis, ureterocele, LUTO, neurogenic bladder, and solitary or multicystic dysplastic kidneys. All subjects had post-natal ultrasounds and VCUG within 1-3 months of life. Ninety-three percent (n=188) of children had nuclear renal scans confirming obstructive parameters defined as T 1/2 > 20 minutes. The other 7% of children were diagnosed with UPJO by renal scans from outside hospital (n=7) or based on worsening hydronephrosis in the absence of VUR and lower urinary tract anomalies.

Of the 202 children who met inclusion criteria, 144 children were male (71%) and the remaining 58 children were female (29%) (Table 1).

Characteristic	Overall (N = 202)
Gender	
Male, n (%)	144 (71)
Female, n (%)	58 (28)
Race	
Caucasian, n (%)	98 (48)
Black, n (%)	17 (8.4)

Hispanic, n (%)	67 (33)
Asian/Pacific Islander, n (%)	9 (4.4)
Native American, n (%)	1 (0.5)
Unable to determine, n (%)	10 (4.9)
Side of Affected Kidney	
Right n (%)	75 (37)
Left n (%)	127 (62)
SFU Grade	
Grade III, n (%)	78 (38)
Grade IV, n (%)	121 (59)
Unable to determine, n (%)	3 (1.5)
Age at last Follow-Up (months)	
Mean (SD)	44 (38)

Table 1: Demographics.

Hydronephrotic kidneys were left-sided in 127 (63%) patients and right-sided in 75 (37%), consistent with previous reported gender and lateral disparities [13]. Of the ethnicities, 98 (48%) children identified as non-Hispanic whites, 67 (33%) children as Hispanic whites, 17 (8%) children as African American, 9 (4%) children as Asian, 1 child as Native American and 10 (5%) children did not provide their ethnic background.

All subjects had post-natal ultrasounds prior to any surgical intervention. The SFU grade was measured as grade 4 in 124 (61%) and grade 3 in 78 (37%) of children. Three children had renal ultrasounds from outside hospital; though films were not available for review, SFU grading was reported in their charts. Nuclear renal scans were available for review in 188 children (93%). All children with initial postnatal SFU grade 3 or 4 HN had obstructed post-natal renal scans T1/2 >20 minutes. The median postnatal follow up was 44 months.

Interventions and Indications for Surgery

Ninety-six percent (193) of patients underwent surgical intervention (Figure 2).

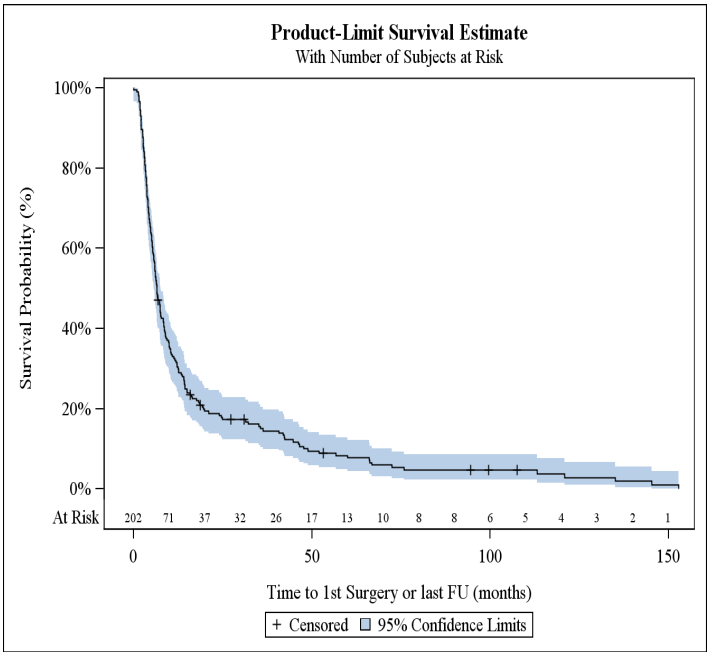

Figure 2: Total patient's time to surgical repair.

Thirteen percent (26) of children underwent surgical intervention after their first post-natal nuclear renal scan showed differential function of > 10%. The other patients underwent observation until 167 of 176 (95%) children progressed to surgery. Most underwent surgery shortly after infancy (mean 17 months) though the range of ages was from 2m to 12y. The surgical approach depended on surgeon's preference and age of presentation (Table 2).

Total patients undergoing surgery for UPJO, n (%) 193 (95.5%)	
Patients who failed initial observation, n (%) 167 (94.9%)	
Surgical Approach*	(N=217)
Laparoscopic pyeloplasty#, n (%)	27 (12.4)
Open pyeloplasty, n (%)	167 (77.0)
Ureteral stent/PCN, n (%)	5 (2.3)
Endopyelotomy, n (%)	3 (1.4)

Nephrectomy, n (%)	5 (2.3)
Prenatal aspiration, n (%)	1 (0.5)
No surgical procedure, n (%)	9 (4.1)
* Some children required more than one surgical correction	
# Includes robotic-assisted laparoscopic pyeloplasty	

Table 2: Observation & Surgical Correction.

Two patients (1%) required percutaneous nephrostomies prior to pyeloplasty due to pyelonephritis or sepsis. The most common indications for surgery included worsening hydronephrosis on serial ultrasounds (n=66, 39%) and renal differential greater than 10% (n=48, 27%) (Figure 3).

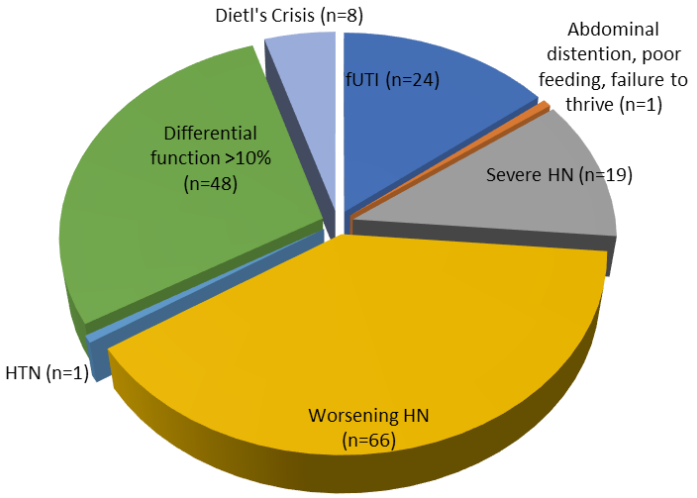

Figure 3: Indications for surgery after failing observation.

Other indications included recurrent febrile UTIs refractory to antibiotics in 24 children (14%), severe hydronephrosis in 19 children (11%), Dietl's crisis/flank pain in 8 children (5%). In one patient, abdominal distension, poor feeding and failure to thrive (n=1, 0.5%) was the primary indication for intervention while another patient developed hypertension (n=1, 0.5%). Surprisingly, there was no statistical difference in surgical rates between initial grade 3 and grade 4 SFU hydronephrosis: 73/78 children (93%) in our cohort with grade 3 HN received surgical intervention compared to 120/124 (96%) of grade 4 HN, p=0.3.

Follow up and Complications

Patients underwent post-operative surveillance with renal US alone though 11/193 (5%) were lost to follow up. If hydronephrosis was improved or stable, surveillance with repeat annual US was performed. If hydronephrosis worsened, a DMSA or MAG-3 renal scan was performed. None of the nine children, who did not require surgery, were lost to follow up; all were observed with periodic ultrasounds until their hydronephrosis improved or remained stable through adolescence. Complications occurred in 26 of 193 (13.4%) children after their initial respective surgery (Table 3).

Post-operative Complications*	N(%)
Clavien-Dindo Grade II	9 (34.6)
(UTI or pyelonephritis, treated with antibiotics, not requiring further surgery)	
Clavien-Dindo Grade IIIb	17 (65.3)
(Possibly required >1 intervention)	
Cystoscopy, RPG and/or ureteral stent	6
Percutaneous nephrostomy tube	2
Percutaneous drain for infected urinoma	1
Endopyelotomy	2
Lap or open redo pyeloplasty	7
Nephrectomy	3
*Complications presented in 26 of 193 patients (13.4%)	

Table 3: Post-operative Complications.

The most common complication (5%) was a post-operative UTI or pyelonephritis requiring antibiotic therapy (Clavien-Dindo grade II). Seventeen children (8%) required one or more surgeries under general anesthesia (Clavien-Dindo grade IIIb): retrograde pyelogram with stent placement (n=6, 3%), percutaneous nephrostomy tube placement (n=2, 1%), endopyelotomy (n=2, 1%), perirenal fluid collection drainage (1, 0.5%), repeat open or laparoscopic pyeloplasty (n=7, 3.6%) and nephrectomy (n=3, 1.5%). A few children required secondary to urine leak or recurrent UPJO. This complication rate is similar to what is reported at other institutions and studies [14,15].

Discussion

Other groups have reported much lower operative rates for high grade HN. Ross, et al. followed 125 kidneys with SFU grade 3 or 4 HN initially referred for prenatal hydronephrosis. They reported a surgical rate of 48/125 (38%) for differential function and/or obstructive parameters on diuretic renal scan. They found that SFU grade 4 kidneys were more likely to progress to surgery than grade 3 kidneys (68% vs. 15%, respectively) [12]. Another much smaller study found that in 12 patients with HN SFU grade 3 and initial renal function of > 40%, only 4 patients (25%) had worsening HN or >10% loss of function in 3 years, meeting their preset criteria for surgical intervention [16]. We demonstrated a higher rate of surgical intervention in severe hydronephrosis patients referred for prenatal hydronephrosis secondary to UPJO than the aforementioned papers (96%). Our results raise the question whether children at our institution were overtreated and whether children in previous studies were undertreated. Several explanations can be surmised: first, perhaps surgeons at our

institution are more aggressive. For instance, thirty nine percent of the operations were performed for worsening hydronephrosis. This term is ambiguous without a threshold for intervention; on the contrary, observation in the setting of worsening of SFU grade 3-4 hydronephrosis is not ideal and can lead to further loss of renal parenchyma. Additionally, another 11% were indicated for surgery due to "severe hydronephrosis". This indication is not supported by guidelines; perhaps these patients were overtreated. If we exclude these two groups, our intervention rate would decrease to 50%. Though less than 96%, this theoretical intervention rate is still almost double the published rates of intervention [12]. Therefore, aggressive surgeons are likely not the only cause. Second, since we are a tertiary referral center, legitimate pathology may be concentrated in our patient population, elevating our rates of intervention. Our cohort included more kidneys with grade 4 than grade 3 hydronephrosis (61% vs. 38%). This may account for the discrepancy between our and previously reported surgical rates as grade 4 hydronephrosis is thought to be more likely to require surgical intervention [13]. Nonetheless, 73 of 78 children (93%) in our cohort with grade 3 HN received surgical intervention. Third, smaller cohort studies may be biased. For example, neither Dietl's crises or recurrent refractory febrile UTIs were included in these indications for surgery in the other reports [12,16]. Fourth, almost 100% of our patients had proven obstructive patterns (T1/2 > 20min) on renal scans while the aforementioned reports did not require this in their inclusion criteria. Again, likely leading to our cohort having worse pathology than previously reported. The reason for our increased operative rates is likely an intersection of all four viewpoints. A prospective, randomized controlled trial would be required to answer this question.

There are some important strengths of our study. Our follow up is much longer than the prospective studies of Ross, et al. and Palmer, et al. We included children who developed Dietl's crises, though this accounted for only 5% of our surgical patients. We also performed pyeloplasties for 28 children with febrile UTIs (14%), which was an indication not included in other studies. In addition, our study was much larger and included more strict criteria for inclusion than previous studies as all the children in our study had proven UPJO on renal scan, which was not a condition included in most other studies. We did find that the majority of children who will fail surveillance generally tend to do so within the first year or two of life. This is supported by previous studies [3,12,16]. An association between the age at surgery and indication for surgery was discovered. For instance, a child with severe, worsening hydronephrosis underwent surgery at an earlier age (mean 9m, median 5m) than a child who developed Dietl's crisis (mean 90m, median 77m). Overall, the majority of children who required surgical correction did so within the first two years of life (Figure 2). As described in previous studies, if a child has not required surgical correction for UPJO within the first year or two of life, the incidence of surgical correction rapidly decreases. The current European Association of Urology guideline recommends surgical intervention in children with SFU grade 3 and 4 HN [7]. Our study supports this recommendation as 96% of children with SFU grade 3 and 4 hydronephrosis with obstructive renal parameters required surgery. Thirteen percent of children underwent immediate surgical correction for impaired renal function. Of the initially observed children, 167/176 (95%) children progressed to require surgery, generally within the first two years of life. This 95% intervention rate on initially observed children demonstrates the importance of close follow up of prenatal hydronephrosis patients.

Conclusion

Our study demonstrates that a very high number of children (96%) with prenatal hydronephrosis and postnatal severe hydronephrosis (SFU grade 3 or 4) secondary to ureteropelvic junction obstruction advance to surgical correction secondary to worsening hydronephrosis or renal function disparity of > 10% on Mag-3 renal scan. This study supports close surveillance of children born with severe unilateral hydronephrosis, especially in the first two years of life.

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