Review article

Surgical indications for unilateral neonatal hydronephrosis in considering ureteropelvic junction obstruction

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A B S T R A C T

Prenatal hydronephrosis is one of the most common urological congenital abnormalities detected by ultrasound. The incidence ranges from 0.59% to 0.69%. Approximately 50% of these fetuses do not have hydronephrosis on postnatal examination, whereas 25–33% of the rest have persistent hydronephrosis leading to the diagnosis of ureteropelvic junction (UPJ) obstruction. Renal ultrasonography and renal radionuclide scanning are the major modalities used for assessment and follow-up. Three main criteria used to determine the presence of obstruction are: (1) the magnitude of hydronephrosis present on ultrasound, (2) the relative renal function (RRF) measured by renography, and (3) the response of radionuclide washout with furosemide. Unfortunately, it is not always easy to determine obstruction; different types of management have been developed. Without depending on the severity of renal pelvis dilation, percentage of RRF, and response of radionuclide washout in the initial presentation, early surgery to preserve renal function and aggressive observation to prevent unnecessary surgery are two extremes on the spectrum of management for neonatal UPJ obstruction. Relying on renal function in renography, <35–40% or 5–10% of a decrease in the percentage of RRF or on the enlarging of hydronephrosis, respectively, and parenchymal thinning on ultrasonography are the indications for the surgical management to recover renal function in time. In addition to renal function change and imaging progression, the follow-up protocol and family compliance are the other considerations in prevention of impaired renal function. Through more than 40 years of development in the field of UPJ obstruction in infants, there have been several advances in management but controversies remain to be resolved. In this review, we focus on the surgical indications for the UPJ obstruction in this cohort.

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1. Background

Since the 1970s, the introduction of prenatal ultrasound has enabled the detection of hydronephrosis in the fetus as early as 18–20 weeks of gestation. The degree of hydronephrosis is defined based on the Society of Fetal Urology grading system by the ultrasound appearances of the pelvicalyceal system and renal parenchyma (Table 1), or on the maximal renal pelvis diameter (RPD) measurement popularly used in clinical practice. Prenatally, the incidence of hydronephrosis, defined as RPD >5 mm or 10 mm, by the ultrasound, ranged from 0.59% to 0.69%. The dilation of the renal pelvis does not imply obstruction or indicate prenatal renal function impairment, and the condition may improve or spontaneously resolve during postnatal follow-up. Because of its uncertainty, the clinical significance of dilation of the renal pelvis has been discussed for >40 years and persists.

The postnatal prognosis is significantly proportional to the severity of prenatal hydronephrosis. In addition, the diagnosis of the disease entity is closely related to the degree of prenatal hydronephrosis. Approximately 50–63% of prenatal hydronephrosis cases are resolved in the postnatal period and a 25–33% of the rest involve UPJ obstruction (Table 2). Currently there are no reliable indicators to predict the outcome of UPJ obstruction. Therefore, for cases with unilateral hydronephrosis suggesting UPJ obstruction, postnatal management varies from early surgery to close observation. Although in current practice the number of patients who need surgery is reduced, the surgical indications are still controversial and warrant discussion.
impairment. However, if the phenomenon of contralateral hydronephrosis, also indicates ipsilateral renal function obstruction.

whereas reduction of the renal pelvis indicates an equivocal parameter. Progressive dilation usually indicates an obstruction, hydration status or bladder condition. 10 mm and 15 mm, and pertrophy develops, it usually means the change of renal function of renal pelvis enlargement does not specifically indicate the presence of obstruction and does not predict whether hydronephrosis will worsen or improve. Grignon et al showed that 94% of patients with RPD ≥20 mm, 50% of patients with RPD between 10 mm and 15 mm, and <3% of the patients with RPD <10 mm have a significant abnormality requiring surgery on long-term follow-up. In the newborn, the hydronephrosis transiently improves or disappears during the 1st week of life and fluctuates depending on the hydration status or bladder condition.

Serial examination is another avenue to obtain a useful parameter. Progressive dilation usually indicates an obstruction, whereas reduction of the renal pelvis indicates an equivocal condition or nonobstruction. In addition to the appearance of the renal pelvis, progressive parenchymal thinning indicates deterioration of obstruction.

Contralateral kidney hypertrophy, compared with a normal renal growth curve, also indicates ipsilateral renal function impairment. However, if the phenomenon of contralateral hypertrophy develops, it usually means the change of renal function impairment is irreversible.

2. Clinical studies

2.1. Ultrasoundography

Ultrasonography is a convenient and noninvasive tool in the diagnosis and follow-up of hydronephrosis. Hydronephrosis is defined according to the classification of the Society of Fetal Urology Society or the RPD, commonly described as ≥5 mm or 10 mm. Although the magnitude of renal pelvis dilation is strongly correlated with the likelihood of abnormality after delivery, the degree of renal pelvis enlargement does not specifically indicate the presence of obstruction and does not predict whether hydronephrosis will worsen or improve. Grignon et al showed that 94% of patients with RPD ≥20 mm, 50% of patients with RPD between 10 mm and 15 mm, and <3% of the patients with RPD <10 mm have a significant abnormality requiring surgery on long-term follow-up. In the newborn, the hydronephrosis transiently improves or disappears during the 1st week of life and fluctuates depending on the hydration status or bladder condition.

Table 1

<table>
<thead>
<tr>
<th>Grade</th>
<th>Central renal complex (pelvis)</th>
<th>Renal parenchymal thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Intact</td>
<td>Normal</td>
</tr>
<tr>
<td>1</td>
<td>Mild splitting – dilation</td>
<td>Normal</td>
</tr>
<tr>
<td>2</td>
<td>Moderate splitting, but complex confirmed within renal border</td>
<td>Normal</td>
</tr>
<tr>
<td>3</td>
<td>Marked splitting, pelvis dilated outside renal border, and calyces dilated</td>
<td>Normal</td>
</tr>
<tr>
<td>4</td>
<td>Further pelviccalyceal dilatation</td>
<td>Thin</td>
</tr>
</tbody>
</table>

The percentage of RRF is determined from the total counts of the renogram curve for each kidney less background, during the first 60–90-second interval after isotope injection. Time–activity curve parameters during the diuretic phase of the renogram are reviewed and used to categorize the dilated kidney as follows: no obstruction, obstruction indeterminate, or obstruction.

Diuretic renography is one of the standard methods used in the diagnosis of UPJ obstruction. However, in this well-known method, there are a few pitfalls including severity of obstruction, glomerular immaturity, dilation of renal pelvis, bladder fullness, hydration status, the choice of radiopharmaceutical agent, the dose, and the timing of the administration of diuretics, and the region of interest, as well as a family’s compliance with treatment.

2.2. Diuretic renography with well-tempered renography

During the entire course of diuretic renography, the bladder is catheterized and urine output is measured at 10-minute intervals to assess hydration status and diuretic response after intravenous furosemide administration. Children are intravenously hydrated with 15 cc/kg dextrose 5% in water and 0.3% normal saline for 30 minutes, beginning 15 minutes prior to the injection of radiopharmaceutical agents and continued at a maintenance fluid rate 200 cc/kg/24 hours thereafter.

Technetium-99m-mercaptoacetyltriglycine (Tc99mMAG3) is used with activity of 50 μCi/kg and a minimum dosage of 1 mCi. Imaging is performed while the child is in the supine position. The region of interest during the renography phase includes the entire kidney and dilated renal pelvis, and an area two pixels wide around the perimeter of the kidney for background subtraction. Intravenous furosemide (1 mg/kg) is administered after the renography phase (20–30 minutes), but not prior to when the entire collecting system is believed to have been completely filled. The region of interest during the diuretic phase includes the renal pelvis and a semilunar area inferior and lateral to the lower pole of the kidney for background subtraction. Computer frame rates of 20 seconds and static images at 5-minute intervals for 20 minutes are taken.

The percentage of RRF is determined from the total counts of the renogram curve for each kidney less background, during the first 60–90-second interval after isotope injection. Time–activity curve parameters during the diuretic phase of the renogram are reviewed and used to categorize the dilated kidney as follows: no obstruction, obstruction indeterminate, or obstruction.

3. Surgical indications

Based on the assumption that severe dilation of the renal pelvis is detected by ultrasound, decreased or lowering the percentage of RRF, or prolonged half time (T½) in washout curve assessed by diuretic renography to be diagnosed as obstruction in infancy, obstruction resulting in renal damage, and early conversion to reverse the consequence, different kinds of management developed for prenatal hydronephrosis presumed UPJ obstruction in infancy (Table 3).


4 Ectopic ureter, prune belly, urethral atresia, and urachal cyst.

5 Renal cyst, hydroureter, saccrococygeal teratoma, enteric duplication, duodenal atresia, and meningocele.

3.1. Aggressive observation

The most famous representation of aggressive observation of neonatal hydronephrosis suspected UPJ obstruction has been reported by Koff and Campbell. In 1992, they prospectively followed up 45 neonates with unilateral hydronephrosis and suspected UPJ obstruction nonsurgically for 30 months. Irrespective of the degree of hydronephrosis, the initial RRF, or washout curve, surgical indication is >10% lowering in RRF. None of the 30 patients with Grades 2 and 3 hydronephrosis (Society of Fetal Urology grading system) and none of the remaining 15 patients with Grade 4 demonstrated the lowering percentage of RRF needed surgical intervention. In the Grade 4 hydronephrosis group, ultrasonography showed no change in 8 patients, mild to marked improvement in 5 patients, and complete improvement in 2 patients. No contralateral kidney hypertrophy was observed. The diuretic renographic washout curve showed that only four patients showed a nonobstructive pattern (T½ < 15 minutes) and RRF of affected kidney function became >50% (7.5–42% in the initial RRF) in five patients. Therefore, they concluded that the diagnostic tests for assessing hydronephrosis in infancy were not sufficient to identify...
RRF – relative renal function.

Table 3
Criteria of pyeloplasty in neonatal hydronephrosis diagnosed ureteropelvic junction obstruction.

<table>
<thead>
<tr>
<th>Study (No.)</th>
<th>Methods</th>
<th>Criteria</th>
<th>Surgery (no.)</th>
<th>Follow-up (mo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koff and Campbell¹</td>
<td>Grade 2 or 3, (30)</td>
<td>Case cohort</td>
<td>Close observation</td>
<td>None</td>
</tr>
<tr>
<td>Koff and Campbell¹</td>
<td>Grade 4, (15)</td>
<td>Case cohort</td>
<td>10% RRF reduction</td>
<td>7 (7%)¹</td>
</tr>
<tr>
<td>Ulman et al¹⁰</td>
<td>Grade 3 or 4, (104)</td>
<td>Case cohort</td>
<td>10% RRF reduction</td>
<td>23 (25%)</td>
</tr>
<tr>
<td>Palmer et al¹⁰</td>
<td>Grade 3 or 4 and &gt;40% RRF, (32)</td>
<td>Randomized control</td>
<td>Observed group &lt;40% RRF, worsening drainage</td>
<td>4/16 (25%)</td>
</tr>
<tr>
<td>Chertin et al¹¹</td>
<td>I. (50), II. (63)⁶</td>
<td>Case control</td>
<td>I. 5% RRF reduction, T₁/₂ &gt; 20 min worsening drainage</td>
<td>113/113</td>
</tr>
<tr>
<td>Chertin et al¹²</td>
<td>Grade 1, 2, 3, 4</td>
<td>Case cohort</td>
<td>5% RRF reduction</td>
<td>179 (52.2%)</td>
</tr>
</tbody>
</table>

In 1994 and 2000, a total of 104 newborns with unilateral Grades 3 or 4 hydronephrosis underwent a long-term prospective nonsurgical intent study for 10 years and results were reported from the same group.⁵⁻⁶ Each patient was administered prophylactic antibiotics for the 1st year of life or until there was significant improvement in hydronephrosis. All patients underwent initial and periodic assessment of hydronephrosis using ultrasonography and standardized diuretic renography. The protocol for follow-up assessment during the first 2 years was as follows: every 3 months in cases with RRF ≥ 40%, every 2 months in cases with RRF 30–40%, every 1 month in cases with RRF 20–30%, and every 2 weeks in cases with RRF < 20%. Of these infants, 23 (22%) aged < 18 months required pyeloplasty for a decrease in RRF > 10% and/or progressive hydronephrosis. In the nonsurgical group, hydronephrosis resolved in 69% and improved in 31% of cases during the period of 2.5 years from mean to maximum improvement. Of these nonsurgical patients, 76% with an initial RRF ≥ 40% had a mean final RRF 49%; whereas 24% with an initial RRF < 40% (mean 23%) had a mean final function increasing to 47%. In the surgical group, initial T₁/₂ < 20 minutes was 42% and the final T₁/₂ < 20 minutes was 67%. In addition, of the surgical group, the T₁/₂ < 20 minutes prior to pyeloplasty was 4% and after pyeloplasty was 63%.

In this series, Koff and Campbell concluded that unilateral newborn hydronephrosis appeared to be relatively benign. In most instances, renal pelvis dilatation and renal function improved with time, and standard tests for assessing obstruction in older patients appeared to be invalid in infancy because prolonged T₁/₂ and/or high-grade hydronephrosis was not an indicator for obstruction or surgery.⁸

3.2. Early intervention

The earliest reports on the management of hydronephrosis with suspected UPJ obstruction advocated for immediate surgical correction to salvage renal function and allow for correction to the age-adjusted normal value. In 1998, the Society for Fetal Urology performed a multicenter prospective randomized study to evaluate the natural history of untreated obstruction and to compare it to the benefits of pyeloplasty.⁹ A total of 32 infants from 10 centers with Grades 3 or 4 hydronephrosis and ≥ 40% RRF were randomized to observation and immediate pyeloplasty. A decrease of 10% RRF, worsening radioisotope drainage, and increased extent of hydronephrosis were indications of crossover surgery. Follow-up protocol was ultrasound and well-tempered renography at 6-month intervals for the 1st year and then annually for 2 additional years. A comparison of the surgical and observation groups revealed that at 6 months and 1 year the degree of hydronephrosis was significantly reduced and the nonobstructive pattern was more likely to be demonstrated. Of the observation group, four patients (25%) crossed over to surgery for deterioration of evaluation, and three patients did not recover to the initial level of renal function.

It was concluded that both groups had stabilized renal function, whereas prompt improvement of hydronephrosis and drainage were achieved in the surgical group, and 25% of the patients crossed over to conduct pyeloplasty from the observation group.

Early surgery was criticized for exposing patients to the risks of unnecessary surgery. However, for aggressive observation special efforts were needed to ensure that those patients were not lost to follow-up. Chertin et al¹¹ reported that two groups of patients, 50 patients with prenatal hydronephrosis in Group 1 and 63 patients with neonatal hydronephrosis who were lost to follow-up and presented with symptoms leading to the diagnosis of UPJ obstruction in Group 2, underwent dismembered pyeloplasty. Surgical indications were at least 5% deterioration of RRF, a persistent obstructive washout curve with T₁/₂ ≥ 20 minutes on repeat Diethylene Triamine Pentacetic Acid (DTPA) scans, and worsening hydronephrosis/parenchymal changes, as well as clinical symptoms such as renal colic, recurrent urinary tract infection, and renal calculi in Group 2. The mean age at surgery was 11 months in Group 1 and 5 years in Group 2. After more than 3 years of follow-up, poor RRF (< 30%) was significantly more pronounced in Group 2 than in Group 1, but significant improvements in hydronephrosis and washout curve pattern were observed in both groups. They concluded that those who had early diagnostic UPJ obstruction should be carefully and meticulously followed.

3.3. Modest management

Currently, the main strategy in the management of neonatal UPJ obstruction is neither aggressive observation nor early surgery. The recent trend is to reserve pyeloplasty for patients with severe renal functional impairment at the time of diagnosis or for patients with evidence of a progressive decline in renal function with time.
Chertin et al. attempted to define predictive factors for surgery from 343 children with antenatal hydronephrosis that led to a postnatal diagnosis of UPJ obstruction over 16 years. Surgical correction was conducted in 179 children (52.2%) during the course of conservative management. Surgical indication was at least 5% deterioration on follow-up renography. The Grade 3–4 hydronephrosis and RRF <40% were significant independent risk factors for surgery.

From the series of Koff and Campbell, it is believed that there are no reliable indicators for obstruction except close follow-up with serial renography for assessing deterioration of RRF. A total of 33 patients (32%) had not completed additional follow-up because of family noncompliance. Of the remaining 71 patients, 20 of 33 (61%) patients (32%) had not completed additional follow-up because of serial renography for assessing deterioration of RRF. A total of 33 no reliable indicators for obstruction except close follow-up with surgery. Compatible with the report of Chertin et al. the patients with high-grade hydronephrosis or initial RRF likely to undergo surgery.12

4. Conclusion

Hydronephrosis does not imply renal function impairment or obstruction. The RRF or washout curve of renography does not appear to be a valid indicator of renal function in infancy. However, these parameters are always used to predict the outcome of neonatal hydronephrosis diagnosed for UPJ obstruction. For aggressive observation, to prevent unnecessary surgery but to take the risk of loss of some renal function, a 10% decrease in RRF is the indicator used for surgery when not relying on initial severity of hydronephrosis or initial RRF. The clinician and the family need to follow a strict protocol for assessment. By contrast, for early surgery, i.e., to take the risk of unnecessary surgery but to prevent loss of renal function, the severity of hydronephrosis is the important consideration of surgery. The safest indication is neither early surgery nor aggressive observation, but severe hydronephrosis associated with <40% and a decrease of 5–10% of RRF on follow-up. However, the optimal interval for follow-up in order to avoid irreversible renal function loss and achieve better compliance of the follow-up protocol remains unclear.

Conflicts of interest

The authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

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References