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Basics of Diagnosing Congenital Hydronephrosis in Children

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Abstract: Congenital obstruction of the ureteropelvic junction (UPJ) and hydronephrotic transformation are well-known conditions to clinicians. Diagnosis, examination algorithms, and successful surgical treatments have been repeatedly described in articles and pediatric surgery manuals. However, with the introduction of ultrasound into routine perinatal practice in the 1980s, as well as the use of modern radionuclide and imaging techniques and minimally invasive surgical correction methods, our understanding of hydronephrosis has significantly changed in several aspects.

Key points: endovideosurgery; hydronephrosis; children's urology; laparoscopy; pyeloplasty; retroperitoneoscopy.

The causes of dilation of the collecting system in fetuses and newborns can be either obstructive or non-obstructive. Ultrasound findings can often be interpreted quite subjectively, highlighting the need for a standardized approach and adherence to diagnostic protocols. Attitudes toward radiographic methods of investigation (excretory urography, cystography, CT) in newborns and infants have also changed significantly. As a result, the focus has shifted toward radionuclide diagnostic methods and MRI.

Finally, the widespread use of laparoscopy, retroperitoneoscopy, and even robotic technology for performing pyeloplasty necessitates mastering these techniques, understanding potential complications, and knowing methods of prevention. From these perspectives, it is essential to articulate modern approaches to these issues.

We hope this will spark interest and potentially foster discussions among pediatric urologists-andrologists and pediatric surgeons involved in diagnosing and treating hydronephrosis in children.

Undoubtedly, the vast majority of urinary tract anomalies are diagnosed antenatally, leading to these patients being concentrated in neonatal surgery departments. Thus, pediatric surgeons are faced with several critical questions to address: How likely is spontaneous resolution of UPJ obstruction? What criteria indicate a non-obstructive nature of collecting system dilation? Is surgical intervention necessary, and if so, at what age? What approach and method of surgical correction should be chosen? Will kidney function recover after surgery? Are there criteria for predicting surgical outcomes?

UPJ obstruction is the most commonly detected anomaly during prenatal screening, accounting for 44–65% of cases. The causes of prenatally diagnosed hydronephrosis are diverse, ranging from functional states to pathological conditions associated with a high risk of developing renal failure in the postnatal period.

Depending on ultrasound characteristics, dilation of the collecting system is detected between the 16th and 20th weeks of intrauterine development, with a frequency of 1 in 50–100 pregnancies. Most such ultrasound findings resolve spontaneously before birth. About 70% of urinary tract anomalies are diagnosed at the 20th week of gestation, while the remaining 30% are identified in the third trimester.

It is crucial to analyze various parameters to differentiate between neonates who will require postnatal monitoring and intervention and those who will not. Considering the intrarenal anatomy of the collecting system in newborns, ultrasound should account for the presence or absence of calyceal dilation. Additional parameters to assess include the longitudinal size of the kidney (incorporating the upper and lower pole calyces), transverse diameter of the mid-pole, parenchymal echogenicity, ureter dilation, bladder wall thickness, and bladder content.

Perinatal dehydration and low glomerular filtration rates can influence studies conducted immediately after birth. If urethral obstruction, multicystic dysplastic kidney, and severe bilateral hydronephrosis are excluded, ultrasound is recommended to be delayed for at least 3–7 days, and in cases of unilateral dilation with normal contralateral kidney function, up to 10–14 days.

The necessity of performing voiding cystourethrography (VCUG) is considered unwarranted, particularly in children with prenatally diagnosed hydronephrosis and a normal postnatal ultrasound pattern. VCUG is indicated in cases of increased bladder volume (suggesting infravesical obstruction), bilateral upper urinary tract dilation, ureteral dilation, and duplex kidney to diagnose vesicoureteral reflux, ectopic ureterocele, and posterior urethral valves.

When ureteral dilation is ruled out, and UPJ obstruction is suspected, ultrasound should be complemented with MAG-3 renography. UPJ obstruction is characterized by an increased half-life ($t^{1/2}$) of the tracer during radionuclide renography with MAG-3, exceeding 20 minutes (normal range: 0–10 minutes).

Currently, the treatment of postnatally diagnosed hydronephrosis remains a topic of discussion. Most patients with a pelvic dilation of less than 20 mm exhibit no functional kidney changes, and surgical intervention is not required.

However, two risk groups can be distinguished among these patients. The first group includes children with an intrarenal pelvic structure and calyceal dilation accompanied by significant thinning of the parenchyma. In such cases, obstruction is responsible for marked calyceal dilation, which poses a threat to the renal parenchyma. Radionuclide studies with MAG-3 often reveal stretched and thinned parenchyma in these patients.

A considerable number of intrarenal hydronephroses are prenatally misinterpreted as multicystic kidney due to the calyces resembling cysts. However, unlike multicystic lesions, kidney function may be preserved. Ultrasound scanning typically identifies a centrally located cystic structure with proportionally dilated peripheral calyces that connect to the central complex.

Differentiating hydronephrosis from multicystic dysplasia is crucial, as intrarenal hydronephrosis requires immediate surgical correction.

The second risk group includes children with progressive dilation of the pelvis, measuring 15–20 mm (moderate dilation), with involvement of the calyces. If moderate dilation with calyceal involvement is detected, MAG-3 renography should be performed, and follow-up with ultrasound is required. Surgical intervention becomes necessary if ultrasound monitoring reveals worsening changes.

Emergency diuretic renography (DR) and kidney function assessment are warranted in cases of grade 3–4 hydronephrosis (severe dilation exceeding 20 mm) and suspected bilateral obstruction at the ureteropelvic junction (UPJ).

Pelvic dilation reaching 30 mm is generally associated with kidney deterioration, making surgical intervention imperative. In all other cases, surgery is required when the dilation of the calyceal-pelvic system progresses, kidney function drops below 40%, or clinical symptoms (e.g., urinary tract infection, pain) develop.

Over the past 30 years, approaches to the timing of UPJ obstruction correction have changed. While early surgical correction of hydronephrosis (at 2–4 weeks of age) was previously preferred, most pediatric urologists now favor extended observation. This shift is based on numerous studies

employing similar criteria, which show that even the most severe forms of hydronephrosis resolve spontaneously in 70% of cases.

The age range in which improvement occurs averages 12–24 months of life, though in some cases it may take longer [8–10]. This resolution is likely due to the maturation of the peristaltic mechanism of the smooth muscle in the proximal ureter and renal pelvis. The low degree of pelvic dilation observed in premature boys might be explained by high intravesical pressure, though this has not been definitively proven. In cases of grade 1–2 calyceal-pelvic system (CPS) dilation, resolution is likely to occur between 1 and 3 years of age, though sometimes over a more extended period. For grade 3–4 hydronephrosis, careful dynamic observation with continuous ultrasound monitoring and diuretic renography (DR) is necessary, as kidney function is likely to decline, and the progression of the condition cannot be predicted.

At present, DR is considered a reliable method for assessing renal function and remains the "gold standard" for diagnosing obstruction. The fundamental principle of DR lies in the fact that the amount of isotope uptake by the second minute after injection correlates with glomerular filtration rate (GFR). However, DR cannot evaluate tubular function, including concentrating ability, acid-base balance, and hormonal functions, though these are rarely clinically significant in unilateral obstruction. In cases of bilateral obstruction, DR becomes challenging as it does not reflect the state of the renal parenchyma.

What is the approach in cases of significant kidney function suppression in hydronephrosis?

There is no consensus on this issue. Some experts advocate for surgical intervention, citing improved renal function in children post-surgery. In cases of severe suppression, percutaneous nephrostomy may be performed to assess daily urine output and concentration function, helping to determine further management and prognosis.

Decisions regarding reconstructive surgery are critically important. Indications for surgery include recurrent pain combined with increasing CPS dilation, abnormalities detected on MAG-3 radionuclide imaging, the presence of calculi, pyelonephritis, and reduced relative function on dynamic radionuclide studies. Relative indications for surgical correction include low kidney function in hydronephrosis. Some suggest that grade 4 hydronephrosis combined with relative kidney function below 40% warrants surgery. Persistent CPS dilation with stable kidney function over several years is also a relative indication, given evidence suggesting that kidney function deteriorates with age.

Surgical Correction of Hydronephrosis. Since the mid-1980s, resection pyeloplasty using the Hynes-Anderson technique for ureteropelvic junction (UPJ) obstruction has become widely adopted and is now considered the "gold standard." First described in 1949 for retrocaval ureter cases, this technique has gained worldwide acceptance due to its high success rate, achieving positive outcomes in 95–98% of cases.

Given that in 20% of cases, the cause of UPJ obstruction may be an aberrant vessel, it is crucial to confirm its absence, particularly when employing a lumbar surgical approach.

Analysis of Pyeloplasty Techniques in Pediatric Hydronephrosis. The widespread success of the Hynes-Anderson technique raises questions about the interest in alternative pyeloplasty methods for pediatric hydronephrosis. The principles of pyeloplasty, as detailed by W.H. Hendren [12], emphasize adequate but not excessive mobilization of the renal pelvis, ureteropelvic junction, and proximal ureter. Over-dissection, particularly excessive ureteral resection, can lead to tissue tension, compromised blood supply at the anastomotic site, subsequent stenosis, and recurrence of hydronephrosis.

A critical aspect of the procedure is the careful handling of tissues during anastomosis formation, which prevents damage, edema, and complications. Both interrupted and continuous sutures can be used to connect the renal pelvis and ureter. Modern suture materials, characterized by their exceptional strength, minimal reactivity, and fine diameters, are well-suited for such procedures.

Monofilament sutures sized 5/0 to 7/0 are preferred, depending on the patient's age. Most surgeons favor Monocryl 6/0 over PDS due to its faster absorption rate.

Drainage of the Collecting System. Postoperative drainage of the calyceal-pelvic system (CPS) is a crucial component of pyeloplasty. The majority of surgeons routinely use temporary drainage. However, some opt for non-drainage methods, which may result in urine leakage or obstruction, potentially necessitating wound drainage, additional interventions, or even repeat surgery [13].

From our perspective, the use of JJ stents for internal drainage helps mitigate such complications. JJ stents can be placed antegradely during surgery or retrogradely before the procedure. Alternatively, external temporary drainage of the collecting system may be employed, but this approach lengthens the hospital stay and increases the risk of urinary tract infections.

The choice of drainage method is determined by the anatomical features of the upper urinary tract but often reflects the preferences of the operating surgeon and the practices of the specific clinic.

Advances in Minimally Invasive Approaches. The push for minimally invasive techniques and advancements in technology have driven the development of reconstructive endovideosurgery in pediatric urology. This progress enables more precise, less traumatic interventions, further enhancing outcomes for children undergoing pyeloplasty.

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