Review Article

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Antenatally Detected Hydronephrosis and Pelvi Ureteric Junction Obstruction from a Surgical Viewpoint

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Abstract

Background: Screening for anomalies in the antenatal period has resulted in a rapid surge in the identification of fetal hydronephrosis, which forms a formidable task for the treating physician.

Summary: Pelvi-ureteric junction obstruction ranks the foremost among the children with antenatally diagnosed hydronephrosis. The dilemma of whether a dilated pelvicalyceal system is obstructed, and in need of surgical intervention to salvage from renal impairment, is a relevant point in the post-natal management of hydronephrosis detected antenatally.

Key message: Majority of Hydronephrosis detected antenatally would require observation and the renal units identified to have obstruction need to be followed up with appropriate decision making on the need for surgery.

Keywords: Antenatal diagnosis; Hydronephrosis; Pelviureteric junction obstruction.

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Introduction

Detection of fetal anomalies by sonography in the antenatal period dates back to 1970s. The enthusiasm has ever since been on the increasing trend, evidenced by the rapid increase in the detection of anomalies so much so that the current scenario is one of management of asymptomatic anomalies. The physician is faced with the challenging task of managing them, given the significant load of asymptomatic abnormalities. Dilatation of the pelvicalyceal system, otherwise called hydronephrosis, is one of the most common anomalies detected in the antenatal scan (1). The question is what happens subsequently in the post-natal period to these children with hydronephrosis. As surgical problems need to be identified and taken up for early intervention, to achieve optimal results, the focus is on the need to effectively segregate these from the large pool of hydronephrosis. This review addresses the surgical problems in the child with antenatally detected hydronephrosis, specifically pelvi ureteric junction obstruction, which evolves as sequelae of the same.

Epidemiology

With regard to the rate of detection of the fetal anomalies, the Congenital Anomalies of the Kidney and Urinary Tract (CAKUT) are positioned after Cardiac and limb defects in the non-chromosomal anomalies group, with a prevalence of 3.1 per 1000 births (2). The most common of the CAKUT is hydronephrosis, accounting for about 51% (3). The incidence of fetal hydronephrosis has been put forth at 1-5% of pregnancies. Ultimately, the antenatal hydronephrosis leads onto detection of postnatal pelvi-ureteric junction obstruction in 0.2-0.4% cases (4, 5, 6). Mandell et al. have recorded the most common anomaly in the second trimester antenatal scan to be fetal hydronephrosis (7).

Definition

The presence of renal pelvic dilatation on antenatal sonography, quantified as equaling or more than 4mm in the second trimester, or, equaling or more than 7mm in the third trimester qualifies for consideration as Antenatal hydronephrosis (8).

Differential diagnosis

The various causes for Fetal hydronephrosis include Pelvi Ureteric Junction obstruction (PUJO), Vesico Ureteric Reflux (VUR), Posterior Urethral Valves (PUV), Vesico Ureteric Junction obstruction (VUJO), Duplex system, Multi Cystic Dysplastic Kidney (MCDK), and uncommon anomalies such as cystic renal disease , Prune belly syndrome (9). With the aid of post-natal investigations (including, but not only sonography), most of these conditions can be satisfactorily ruled out, narrowing down to PUJO. Evidence of multiple but uniformly dilated calyces in communication with a distended renal pelvis and abrupt tapering at the pelvi-ureteric junction with normal caliber ureter below, with or without parenchymal thinning is highly suggestive of PUJO, on sonography (10).

Transient Hydronephrosis

It is noteworthy that a majority of hydronephrosis, to the tune of 40-88%, diagnosed in the antenatal period undergo spontaneous resolution during follow-up (8,9). It has been found that this could happen due to a variety of reasons. Renal immaturity in the fetus, as evidenced by alterations in renovascular resistance, concentrating ability and glomerular filtration rate contributes to a high flow of urine, as much as 4-6 times, leading to dilatation of the pelvicalyceal system (11). Also, the smooth muscle of the renal pelvis, due to its immaturity, has been blamed for being the culprit behind peristalsis which is not effectively co-ordinated across the pelvi-ureteric junction, resulting in improper emptying, stasis and ultimately dilation of the pelvicalyceal system (12). Although most resolve in the initial years of life, it is the milder grades of hydronephrosis (SFU grades 1&2) which have been shown to normalize by 18 months of age (13).

Investigations

Sonography

In its ability to provide required information on hydronephrosis readily, with no risk of radiation, easy availability bedside, reasonable anatomic resolution, sonography is usually the most common and the initial investigation of choice in the post-natal period (14). Also, in almost all cases, serial follow-up would be required, making sonography an important tool in the management of hydronephrosis. Based on the findings obtained on sonography, further investigations can be planned.

In the antenatal period, evaluation parameters include renal size, degree of dilatation of hydronephrosis measured by anteroposterior diameter (APD) of the renal pelvis at the renal hilum, corticomedullary differentiation, renal echogenicity, presence of cortical cysts, ureteric dimension if dilated, bladder wall thickness and amniotic fluid volume in addition to other systemic anomalies screening. The society for fetal urology (SFU) grading can help to categorize the hydronephrosis, although it is more qualitative and less objective (figure 1). To overcome this shortfall, studies have used grading of caliectasis and pelviectasis and demonstrated superior results (15, 16). Recently, Santos et al. (17) have shown that incorporation of both APD and caliectasis significantly improves the prediction of at risk for surgery in the antenatal hydronephrosis group.

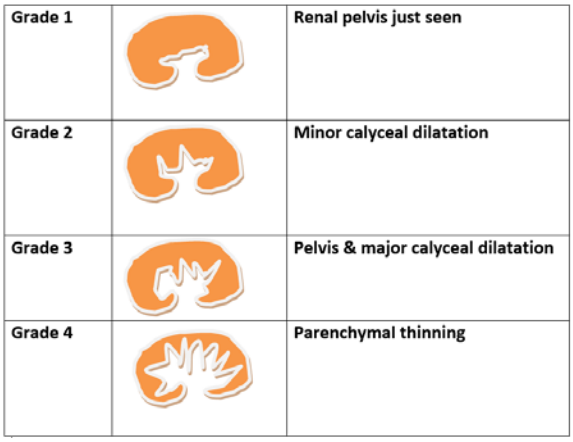

Figure 1. SFU grading

Overall, almost all of the SFU grade 4 hydronephrotic units require surgical correction. Concerning SFU grade 3, about 27-89 % undergo resolution or remain stable, without the need for surgery. In SFU grade 2, surgical intervention may not be needed in 42-100%. Remarkably SFU grade 1 hydronephrotic units escape surgery in almost 98% of the time (18).

The problem with the APD is that it does not provide an accurate reflection of the severity of hydronephrosis as other parameters such as caliectasis and parenchymal thinning. This would mean that at times, the APD may not be increasing over a period of time, whereas the renal parenchyma can be thinned out with the calyces getting dilated

as well, bearing the brunt of the hydronephrosis of the renal unit. Hence caution is to be exercised when decision making is planned, though such instances are uncommon (19). Reliability of APD, at a cut-off of 24mm, has been shown to be a useful tool in the ability to predict the likelihood of surgery with greater sensitivity and specificity (20).

Post- natal sonography is recommended on day 4 of life as fetal diuresis, decreased glomerular filtration rate and relative dehydration may cause false negative report in the immediate postnatal period. The exception to this may be made in special cases such as bilateral hydronephrosis, solitary kidney and probable posterior urethral valves (21, 22, 23).

Renal resistive index (RRI), though less specific for PUJO, can be helpful as an adjunct in sonographic evaluation for hydronephrosis. As a reflection of the reduced diastolic arterial flow velocity due to renin-angiotensin interplay in the background of an obstructive hydronephrosis, RRI has been utilized in identifying PUJO. When the RRI is more than 0.7 or the difference between the sides is more than 0.1, chances of obstructive etiology is likely in a given case of hydronephrosis (24,25,26).

Recent studies also quote other novel techniques such as the study of urine jets at the ureteric orifices, three-dimensional measurement of renal volume and elastography in the detailed sonographic assessment of hydronephrosis (27,28), which are not commonly used.

Radionuclide Scintigraphy/Diuretic Renography

Diuretic renogram is touted to be diagnostic of obstruction in the management of hydronephrosis due to pelvi-ureteric junction obstruction. As a functional study it scores over sonography and its ability to discern obstruction, and further quantify the degree of functional impairment makes it assume a prominent position in the management of hydronephrosis (29).

MAG3 (Mercato Acetyl triGlycine) & EC (Ethylene diCysteine) are preferred radiotracers in children, given their high extraction ratio and less background activity. The preferred time is 6-8 weeks in the postnatal life to have an optimal evaluation of relatively 'mature' renal systems by radionuclide study. An up-going curve, with failure to empty by the end of the study at 20 min is highly suggestive of obstruction (30). Also, if the relative renal function of the hydronephrotic unit is less than 40% or exceptionally supra-normal (31), then the obstructed hydronephrotic unit qualifies for surgical intervention. During the follow-up, when the relative renal function compared to its previous study demonstrates a 10 % difference, again renal impairment is underlined, with a need for surgery (1).

Alterations in renal blood flow and renin-angiotensin system account for the unique case of supra-normal function, which can occur in up to 22%, on the hydronephrotic side. Of note is the finding that the contralateral normal kidney to be borderline hypo-functioning as per the decreased glomerular filtration rate documented in the study (31).

Adequate oral hydration, bladder emptying, the positioning of the child are essential pre-requisites for a satisfactory scintigraphic study and obtaining effective isotope washout at the end of the study. Also, size and compliance of the collecting system influence the isotope clearance, and at times presence of a large dilated renal pelvis although unobstructed, can result in an obstructed pattern (figure 2). Hence more weight is given to the relative or differential or split renal function than the clearance curve pattern (32-35).

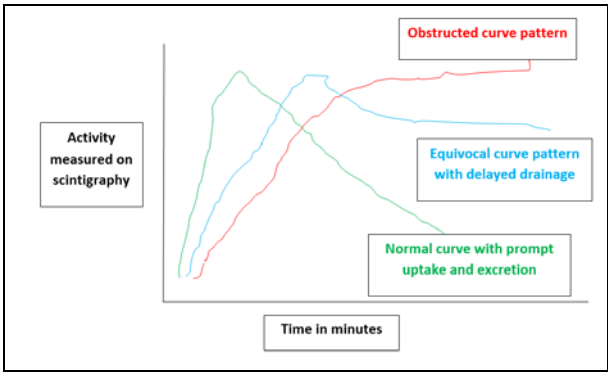

Figure 2. Diuretic Renogram curves

Improvisation in nuclear scintigraphic techniques has led to the suggestion of better objective parameters such as normalized residual activity & cortical transit time to improve the accuracy and reliability of the study (14, 36).

Alternative view regarding Scinitgraphy usage has been put forth. As sonography can consistently identify critical changes in a hydronephrotic renal unit, Nuclear Scintigraphy is to be reserved for selective rather than regular usage. This is in

concordance with the finding of preservation of renal function when the APD was less than 20 mm without calyceal dilatation. But, scintigraphy is undertaken when the APD was more than 20 mm during sonographic follow up.
The study by Burgu et al supports the recommendation of judicious use of Scinitigraphy during follow up of hydronephrosis (37).

Others
MR urography has been proposed as an alternative, given the better tissue contrast and resolution, anatomic and functional study capabilities in the absence of ionizing radiation. However, cost and the need for sedation are limiting factors for its wider usage (38, 39).
Urinary biomarkers such as monocyte chemoattractant protein 1 appear promising as a novel noninvasive way of assessing obstruction in hydronephrotic units before and after surgery, quantifying the relief of obstruction. The extent to which these biomarkers would be useful, in actually diagnosing obstruction, and, further be helpful in decision making in the management of hydronephrosis is not clear yet (40).

Special cases

Bilateral Hydronephrosis
In the event of bilateral hydronephrosis, the follow-up needs to be more intensive.
As a general rule, the worst of the sides requires to be operated first, provided the sonographic and scintigraphic parameters match the criteria for obstruction. Of note, in the case of bilateral severe grade hydronephrosis, the differential renal function by scintigraphy may not accurately point to the unit with worst function, as both units may be equally impaired. Parenchymal thinning and worsening dilatation on sonography can help to provide vital information on surgical decision-making (21).

Solitary Kidney with Hydronephrosis
Special instances of the solitary kidney with hydronephrosis require more attention, as the sole functioning unit to be taken care and preserved at any cost. Surgical indications although standard for an obstructed unit with hydronephrosis, may need to be individualized as there is no comparison available for noting functional deterioration (21).

When to operate
Hydronephrosis indicates only distension or dilatation of the pelvi-calyceal system and per se does not translate into an obstructive pathology requiring surgical correction. Hence, the need for surgery requires careful evaluation before reaching the decision to undertake surgery. Obvious indications for pyeloplasty include palpable lump, urinary tract infection, hematuria, stone and pain in older children. It has been noted that about 15-30 % of children with pelvi-ureteric junction obstruction ultimately require surgical intervention (41-44).
In the asymptomatic children with antenatal hydronephrosis, the following criteria have been accepted as surgical indications, namely APD more than 3.5 cm, differential renal function less than 40%, drop in function during follow-up of more than 10% and an obstructive curve pattern (45).

Is Non-operative management justified?
Based on a prolonged follow-up of 16 years, Dhillon et al reliably put forth that the need for surgical intervention in hydronephrosis is nil when the post-natal APD is less than 15 mm, without calyceal dilatation and split function by diuretic renogram is falling within normal limits (45).

Long-term outcome
Excellent results have been documented in the literature as far as Pyeloplasty is concerned. Long term follow-up of 10 years beyond surgical correction of PUJO revealed recurrence rates as low as 1.6% (46). Persistent hydronephrosis, not requiring surgical intervention needs to be on protracted surveillance, as studies have demonstrated deterioration of these renal units, estimated to be around 1-5%., which could happen at any time from few months to as long as 6 years. The worsening can involve all grades of hydronephrosis and it is important to note that most of the worsened renal units would end up with high-grade hydronephrosis, laying emphasis on the issue of long-term follow-up (12, 47-49).

Early vs late intervention
Conservative management of antenatally detected hydronephrosis is one extreme swing of the pendulum based on the dictum that only a minority require surgical intervention. This has been exemplified by the long term follow-up studies such as Ulman et al. (50), wherein they concluded that

only 22% require surgery. Similar results have been shown by other studies (51). Further to this, Chertin et al. have established that conservative management avoided 'unnecessary' surgery.

To add to this, Chertin et al emphasized that conservative management avoided surgical intervention, when the same was actually not indicated. It was shown that the recovery after surgery was to the pre –operative functional level without functional impairment. This is in agreement with the conservative school of thought (52).

Early surgery was advocated given the presumption that obstruction at the pelvi-ureteric junction in hydronephrosis, caused significant renal impairment and immediate surgery restored the renal function completely without any compromise (53). Late surgery in antenatally detected hydronephrosis was shown to be fraught with complications of poor function post-surgery or unsatisfactory improvement (54, 55).

Safe discharge

Based on a retrospective review, children with postnatal APD less than 10mm and SFU grade 1-2, were deemed to be fit for release from close follow up due to their negligible risk for surgical requirement. On the contrary, those with postnatal APD more than 10 mm and SFU grades 3-4 were to be subjected to a regular review, in order to watch for likely complications (56).

Future prospects

The etiology of the hydronephrosis evolving into pelvi ureteric junction obstruction is still unclear, which might pave the way for therapeutic targeting. The ability of the urinary biomarkers to detect hydronephrosis requiring surgical intervention is under scrutiny (57). Limitation of investigations to reduce cost and allay unnecessary parental anxiety is being widely advocated. Unfortunately, an appropriate and well established risk stratification of children requiring investigations is lacking (58-60).

As age-related renal maturity leads onto reaching the adult values of glomerular filtration rate by 2 years of age, the improvement in renal function in an infant, noted as per diuretic renography, after surgery in pelvi-ureteric junction obstruction should be carefully reviewed. Caution is to be exercised in accepting it solely as a direct result of surgery rather than the physiological improvement in renal maturity (11). Hence, close observation of children with antenatal detection of hydronephrosis with a view to intervening when needed, based on sonography and diuretic renography in addition to clinical review would be a balanced stand without leaning onto overt conservation or aggressive surgery (figure 3).

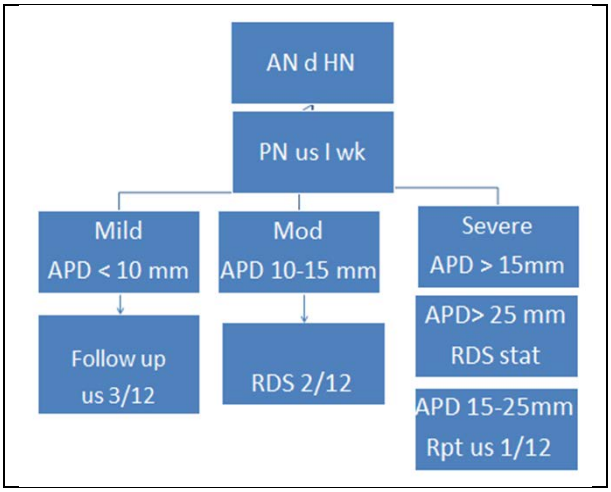

Figure 3. Management algorithm for Antenatally detected hydronephrosis

AN d HN - AnteNatally detected HydroNephrosis
PN us - Post Natal ultrasonography
APD - AnteroPosterior Diameter
RDS - Renal Diuretic Scintigraphy

Conclusion

The presence of renal pelvi-calyceal dilatation or hydronephrosis per se does not permit labeling as evidence of obstruction requiring surgical intervention. Although composite input of investigations can lead to identifying obstructive hydronephrosis, no single investigation at one point of time can reliably prognosticate the need for surgery. Sonography is vital both in the antenatal and postnatal period, to effectively monitor, plan further management and allay parental anxiety. Complimentary to this is the nuclear scintigraphy which further evaluates renal function. Adherence to protocols ensures a smooth transition from diagnosis to management, with optimal outcome in a timely fashion. As only a minority require surgery, timely decision making and prolonged follow-up are essential to the optimal outcome of antenatal hydronephrosis.

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Conflict of Interest
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Authors Contributions
Krishna Kumar Govindarajan drafted, reviewed and finalized the manuscript.

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