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ORIGINAL ARTICLE

Ultrasonographic assessment of hydronephrosis in adults and children: Experience from a tertiary care hospital

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A B S T R A C T

Introduction: Hydronephrosis (HN) refers to the dilation of the pelvicalyceal system. It is prevalent in both pediatric and old age. The etiology of HN in adults differs from that in neonates and children. The current study aims to evaluate various presentations and causes of HN in children and adults with the help of ultrasound (US) as the primary diagnostic modality.

Methodology: This cross-sectional prospective study was conducted in a tertiary care hospital in Lahore, Pakistan on patients between 0-70 years of age, who were diagnosed with HN in the US. Data was collected on a self-designed proforma including gender, age, symptomatology, and anthropometry. Percentages and frequencies were calculated for categorical data. The chi-square test was applied to compare urinary calculi in gender, age, BMI, and side.

Results: The total number of patients was 73. The mean age was 31 years. Adults were 74% (54) while 26% (19) were of the pediatric age group. Males were 67.6% (50) and 31.5%(23) were females. Lumbar pain was the commonest presenting complaint. Hydronephrosis was bilateral in 20.5%(15), 43.8% (32) in the left and in the right kidney (35.6%) 26. In adult patients, renal calculi were the commonest cause of 69.9%(51) of HN. In the case of children, PUJ obstruction and renal calculi were equally common 31.6%(6) each. The ureter was the most common site of calculi 35.6% (26). A significant association was found between HN with side of involvement (p-value < 0.001) and age of the patient (0.041).

Conclusion: Ultrasound imaging is helpful in the diagnosis, determination of etiology, and grading of hydronephrosis. Ureteric calculi is the most frequent cause of hydronephrosis followed by pelvic ureteric junction obstruction.

Keywords: *Hydronephrosis, Etiology, Ultrasound, Renal calculi, Pediatric.*

Introduction

Hydronephrosis (HN) refers to the distension and dilation of the pelvicalyceal system. It is quite common in both pediatric and adult populations. The prevalence of HN from neonates to old age is 3.1%.[1] HN is reported in 2-2.5% of pediatric population.[1] Both acute and chronic forms of HN are observed. In most cases, HN is secondary to obstruction of urine flow but it can be seen even without any obstruction. The underlying cause of HN can vary according to the age of the patient. Congenital urinary tract abnormalities like posterior urethral valves, PUJ obstruction, stenosis at the ureterovesical junction, and ureteric strictures are frequently encountered etiology of HN in children.[2] Renal calculi are frequently seen in adolescents and young adults, while prostatic hypertrophy

or carcinoma, retroperitoneal or pelvic malignancies, and renal calculi are the primary causes in older patients.[3, 4] This condition is frequently encountered by urologists, emergency medicine specialists, and primary care physicians. HN has various clinical presentations. Quite a number present in ER with severe pain while many present in OPDs. Flank pain is the main symptom of HN. Other presentations include decreased urination, urinary incontinence, dysuria, increased frequency, fever, and nausea.

Presenting symptoms depend on the cause and severity of urinary obstruction.[5] Severity of HN in infants and adults is assessed through grading systems like Onen, AP diameter, SFU, radiology, and UTD.[6] All these systems are ultrasound-dependent. According to the Society of Fetal Urology (SFU) classification system, HN has four severity grades;

Grade 1; and dilation of the renal pelvis. Grade 2; dilation of the renal pelvis and major calyces. Grade 3; grade 2 + minor calyces' dilation. Grade 4; grade 3+ thinning of the renal parenchyma. Ultrasound(US) remains the first-line imaging modality for diagnosis and grading of HN. US imaging is a non-radiation and non-invasive modality that is widely accessible and cost-effective. It is also available in portable form in most healthcare setups.[6, 7] It not only determines the severity of HN promptly but also prompts the necessity of other diagnostics.[8] Ultrasound adds a functional evaluation of the urinary tract when combined with clinical findings. Adequate data about the etiology of HN in children and adolescents, in Pakistan, is lacking.

The current study aims to evaluate various presentations and etiology of HN in children and adults. This study will especially be of value for radiologists, urologists, pediatricians, and emergency practitioners who have to find out the cause of HN as a frequent and important problem corresponding to their daily work. Quick diagnosis will assist in prompt treatment of the underlying condition and will be beneficial for better patient outcomes.

Methodology

This cross-sectional prospective study (IRB number 00-18-21) was conducted in the radiology Department of Lahore General Hospital Pakistan. Patients between 0-70 years of age, who were diagnosed as having HN based on US were included in the study, after taking verbal informed consent. Patients with prenatal HN were excluded. Standard protocol for ultrasound imaging of kidneys was followed. A 3.5 MHz curved transducer of Medison, Sono ex-model six color Doppler machine was used to perform ultrasound of study participants. Patients were scanned by the same highly experienced radiologist following the protocol of ultrasound imaging of the kidneys. Longitudinal and transverse sections of each kidney were acquired in supine, lateral, and prone positions.

Demographic data was collected on a self-designed proforma including gender, age, and symptomatology. Anthropometric measurements were recorded. Data was analyzed using SPSS version 23. Percentages and frequencies were calculated for categorical data. The chi-square test was applied to see the association of urinary calculi with gender, age, BMI, and side. A P <0.05 was taken as significant.

Results

The study involved 73 patients who were diagnosed as having HN based on abdominal ultrasound imaging. The mean age was 31 years (range was 4 months to 81 years). Adults were 74% (54) while 26% (19) were < 18 years of age. Males were 67.6% (50) and 31.5%(23) were females (Table 1).

Table 1: Symptomatology of Hydronephrosis

Symptom	Frequency n =73	Percentage
Bilateral lumbar pain	17	23.3
Right lumbar pain	18	24.7
Left lumber pain	22	30.1
Groin pains	6	8.2
Recurrent UTIs	3	4.1
others	7	9.8

HN was bilateral in (20.5%) 15, (43.8%) 32 in the left and in the right kidney (35.6%) 26. Regarding the BMI of our patients, 63% were healthy, 11% were underweight, 20.5 % were overweight and 3% were obese. Table 2

shows a significant association between HN with a side of involvement ($p < 0.001$) and the age of the patient (0.041) but no significant association with gender and BMI.

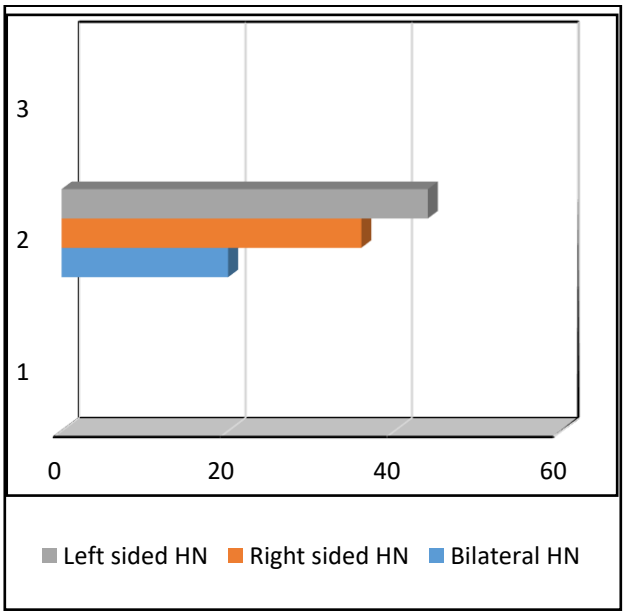

Figure 1: Kidney involvement with hydronephrosis

Table 2: Association of HN with a side of involvement, gender, and BMI

Values	Category	Number	%age	p -value
Gender	Male Female	50 23	67.6 31.5	0.651
Kidney	Unilateral Bilateral	58 15	79.4 20.5	0.651
Age	Child Adult	19 54	26 74	0.041
BMI	healthy Overweig ht/obese	45 19	63 23.5	0.273
Side	Right left bilateral	26 32 15	35.6 43.8 20.5	0.000

Regarding the severity of HN, the mild (Grade 2) form of Hn was the commonest 38 (52%), followed by moderate (Grade 3) HN 26 (36%) and gross (Grade 4) HN 9 (12%). We did not find any case of minimal HN (Figure 3). Renal calculi were the cause of HN in 69.9%(51) cases and pelvic ureteric junction obstruction was seen in 16.4% (12) cases, Table 4. In the case of children, PUJ obstruction and renal calculi were causing HN in an equal number of cases i.e. 6 (31.6%). Other causes are mentioned in Table 3.

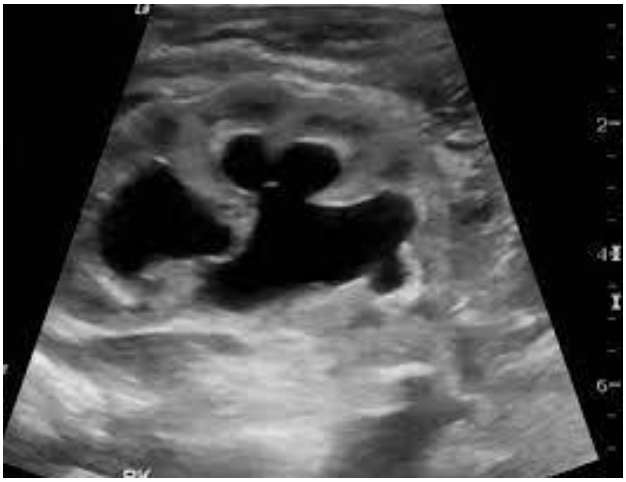

Figure 2: Ultrasound image of HN in children

Grade-1: (Minimal) Dilation of the renal pelvis.
Grade-2: (Mild) Grade-1+ dilation of major calyces.
Grade-3: (Moderate) Grade-2+ dilation of all calyces.
Grade-4: (Gross) Grade-3+ thinning of renal parenchyma

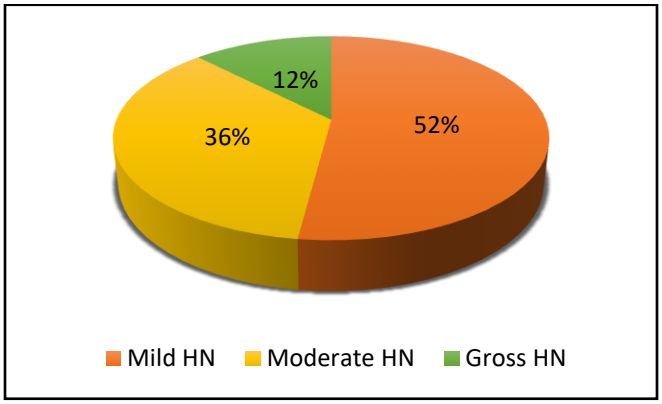

Figure 3: Percentage distribution of severity of HN

Renal Calculi were found throughout the renal tract. Calculi were found in Renal Pelvis in 21 (28.8%) cases. All parts of the ureter were found to have calculi. Lower ureter being the commonest site 18 (24.7%). Overall ureter was the site where calculi were most commonly found 26 (35.6%) Table 4.

Table 3: Causes of HN with division of age

Causes	Number /Percentage 73	N /%	
		<18 yrs. 19(26%)	>18yrs 54(74%)
Renal Calculi	51(69.9%)	6(31.5%)	45(83.3%)
PUJ obstruction	12(16.4%)	6(31.5%)	6(11.11%)
VUR	6(8.2%)	5(26.31%)	1(1.85%)
Prune belly syndrome	1(1.9%)	1(5.26%)	0
ureterocele	1(1.9%)	1(5.26%)	0
Ureteric stricture	1(1.9%)	0	1(1.85%)
Compression of the ureter by external LN	1(1.9%)	0	1(1.85%)

Table 4: Sites of Calculi causing HN

Categories	Numbers	Percentages
Renal pelvis	21	28.8
Upper ureter	5	6.8
Mid ureter	3	4.1
Lower ureter	18	24.7
Multiple sites	4	5.5
U Bladder	4	5.5

Discussion

Acute flank pain is a frequently encountered clinical scenario presenting in any emergency care facility. Ultrasound is the first diagnostic modality for instant and precise diagnosis in these cases. Incorporating renal ultrasound in emergency health care setups, can quicken the case management and shorten the hospital stay. As per our analysis, males (67.6%) were found to have HN more than females (31.5%). Akash et al report similar findings, female patients with 30% of and 70% of males with HN.[9] Sultan et al also have similar observations .[2]In contrast It is observed in certain studies that females are more likely than males to develop hydronephrosis (56%) because they have a lower threshold for renal effects.[3]

Literature reports that females of age 20-60 years, experience hydronephrosis more frequently. This is due to pregnancy or other gynecological problems.[10] In our cohort we did not have any females with pregnancy or gynecological malignancy. The pediatric age group was 26% while adults were 74% in our study. HN has a significant association with the age of the patient (p=0.041). Limited studies are comparing the effect of age on the incidence of HN.

In our cohort we had 23.5% obese /overweight patients having HN, which is a documented risk factor for renal calculi.[11] Others have reported even a higher figure in the adult population.[12] Obesity is linked with several risk characteristics contributing to the frequent occurrence of renal calculi. It is described in the literature that high body weight for age is related to low urinary pH and escalated excretion of uric acid, oxalate, and phosphate via the kidneys.[13,14]

It is crucial to point out and control the risk factors for the development of renal calculi because nephrolithiasis along with hydronephrosis increases the risk of acute kidney injury in patients having urinary tract infections (p=0.025).[15] Hydronephrosis can present with various symptoms. Pain was the most common presenting symptom in our cohort of patients. Similar to Marium et al in the adult population .[3]Others have observed hematuria and recurrent UTIs as one of the leading symptoms, in addition to pain.[5,16] Although in some cases it is completely asymptomatic without any significant complaints.[2] The severity of the presenting symptoms depends on the grade of HN and the underlying cause.

According to our results, Unilateral HN (79.4%) is commoner than bilateral HN (20.5%). We found left-sided HN to be more common than right-sided one. (43.8% Vs 35.6%. Similar findings are shared by Musab et al. They found left-sided HN in 42/71 cases.[17] Common occurrences of right-sided HN are also reported in the literature.[2] In the current study, mild and moderate HN were most commonly seen (Figure 3). Stephanie et al also have reported similar findings.[18] others also report similar findings HN 48.5% and 16.2%.[19] Gross HN was seen in 12% of our cohort and 4% is reported in the literature.[20]

Renal Calculi were the commonest cause of HN in adults (83.3%) as well as children (31.5%) Table 4. Renal calculi cause HN irrespective of its location. Literature supports our findings (Renal calculi p=0.0001) .[16]Ureteral stones (35.6%) are the commonest site of renal calculi observed as per our results followed by renal calculi

(28.8%) Table 5. Others have found the renal pelvis as the commonest site of calculi in adults.[16] There are scenarios where renal calculi do not cause HN at all. According to researchers, 11% of ureteric stones present without hydronephrosis, and 71% exhibit only mild hydronephrosis.[19]

In contrast to our results, Shafique et al report only 4.9% renal calculi in the pediatric population, in their study.[21] This difference might be due to our small sample size. In our cohort of children, PUJ obstruction along with renal calculi, (31.5% each) was found to be the most frequent determinant of hydronephrosis. PUJ obstruction can both be congenital and acquired in the pediatric age group. Without intervention, it can lead to irreversible renal damage. Rehman et al report 40.1% of cases of HN in children due to PUJ obstruction.[22] Regarding renal calculi, Literature reports renal calculi (69.1%) as the most common cause of acquired HN in children.[21]

Our study has certain limitations. First, it was a single-center study with a relatively small sample size. Secondly, we did not have a record of medical history so the data regarding underlying chronic medical conditions was lacking which could have given valuable information regarding the etiology of renal calculi. Third, we cannot comment on neonatal causes of HN as neonates were excluded from the study. Fourth, follow-up of the study participants was not done regarding the record of any further urographic studies performed. Furthermore, the sensitivity and specificity of ultrasound could not be calculated due to the limited availability of CT scan KUB in our center. Further research with a larger sample size, more elaborate medical history, and post-procedure follow-up of patients can give better results.

Conclusion

Ultrasound imaging is helpful in the diagnosis, determination of etiology, and grading of hydronephrosis. Ureteric calculi are the most frequent cause of hydronephrosis followed by pelvic ureteric junction obstruction. Ultrasound should routinely be used as a screening tool followed by other diagnostics, for patients with suspected HN.

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