https://doi.org/10.29309/TPMJ/2024.31.01.7746

The Professional Medical Journal
www.theprofesional.com
2024, Volume, 31 Issue, 01

ORIGINAL ARTICLE

Sonographic determination of the association between grades of hydronephrosis and detection of kidney and ureteric calculi.

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Article Citation: Mahmud M, Pervaiz M, Akhtar N, Awan MFA, Anwar M, Turabi A. Sonographic determination of the association between grades of hydronephrosis and detection of kidney and ureteric calculi. Professional Med J 2024; 31(01):12-17. https://doi.org/10.29309/TPMJ/2024.31.01.7746

ABSTRACT… Objective: To correlate the grades of hydronephrosis and the detection of urinary stones by ultrasound imaging. **Study Design:** Cross-sectional, Retrospective study. **Setting:** Watim General Hospital, Rawat. **Period:** Jan 1, 2023 and Mar 31, 2023. **Material & Methods:** All patients on whom a renal sonogram showed hydronephrosis and nephrolithiasis between Jan-Mar 2023 > 18 years of age and < 70 years of age were included. The data were obtained retrospectively from the ultrasound department records. All patients were scanned while lying flat on their backs. Data regarding hydronephrosis grades and the presence of nephrolithiasis was obtained. **Results:** There were 248 individuals with hydronephrosis due to nephrolithiasis whose ultrasounds were included in this investigation. All patients had urinary stones and as hydronephrosis progressed from grade 1 to 3, the detection rate of stones increased, before declining in grade 4. Patients with grade 3 hydronephrosis had four times the risk of having urinary stones as grade 4 patients (Odds Ratio = 5.675, 95% Confidence Interval [CI]=3.345-4.648). **Conclusion:** The sensitivity of sonography to identify grades of hydronephrosis and identify their underlying causes is of diagnostic importance. Hydronephrosis is often brought on by kidney stones or ureteric calculi, and a higher grade should raise clinical suspicion for the presence of renal calculi.

Key words: Hydronephrosis, Renal Stone, Ultrasound.

INTRODUCTION

Patients often complain of sudden, severe flank discomfort as a result of kidney stones when they visit emergency rooms.[1] The importance of radiology in the diagnosis of such individuals is crucial. Ultrasonography (US), computed tomography (CT), conventional radiography, and intravenous urography (IVU) are all valid imaging modalities that may be employed.[2] Acute stomach discomfort is often brought on by renal or ureteric colic, the most common urologic emergency. Those who seek medical attention for renal stones are often range in the age range from 30 to 60 years. Men are three times as likely as women to get the condition.[3] Renal colic is characterized by sudden onset of unilateral flank discomfort that spreads to the groin, along with dysuria and hematuria; the blockage in the ureter causes an increase in tension in the urinary tract wall, stimulating the synthesis of prostaglandins, causing vasodilatation and ureteral spasm.[4] When a concentrated region of echogenicity and acoustic shadowing is seen in the renal collecting system, ultrasound may be utilized to make the diagnosis of a stone.[5]

Ultrasound is excellent at showing the secondary symptom of hydronephrosis caused by renal stone obstruction of the ureter.[6] Most ureteral stones are often masked by overlaying bowel gas, although US may reveal renal stones placed at the upper ureter or distally at the ureterovesical junction that induce hydronephrosis.[2] When hydronephrosis was added as a positive indicator for a ureteral stone, US's sensitivity climbed to 74%, up from a low of 37% for direct ureteral stone detection.[7] A recent paper found that up to 11% of patients with renal stones and colic

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Article received on: 07/08/2023
Accepted for publication: 10/10/2023

may not have hydronephrosis, and that in up to 71% of cases, only moderate hydronephrosis is present.[5] Renal stones were revealed to be the leading reason for hydronephrosis in a recent research conducted in Pakistan.[8] Detection rates for stones rose from first through third grade, then fell in fourth, according to this and other studies. These findings in hydronephrosis grades 1, 2, and 3 are quite similar to those of a prior research by Ozden E et al. (2002).[9]

However, several other factors were also shown to contribute to hydronephrosis. The two main types are intrinsic compression and extrinsic compression.[10] The definition of hydronephrosis is the distension and dilation of the collecting system of either or both of the kidneys due to urine outflow obstruction after the renal pelvis (i.e., ureter, urinary bladder, and urethra).[11] Renal stones, malignancy, ureteral strictures due to inflammation, stenosis of the ureteropelvic junction, posterior urethral valves, renal inflammation, renal cysts, and neurogenic bladder are all potential causes of intrinsic obstruction.[11] Extrinsic compression may result from a number of different conditions, such as retrocaval ureter, malignancy, peripelvic cysts, retroperitoneal fibrosis, trauma, and abscess of the prostate gland. Most occurrences in children are caused by anatomical defects. Urethral strictures and valves, as well as ureterovesical and ureteropelvic junction stenosis, are examples.[11] Stenosis of the pelviureteric junction (PUJ) stenosis, renal calculi, and bladder outlet obstruction are among the most prevalent causes.[8] These potential causes of hydronephrosis may be ruled out using various diagnostic approaches.[12] For instance, a voiding cystourethrogram may detect vesicoureteral reflux in infants with congenital hydroureteronephrosis.[13]

Adult patients need a urinalysis and a basic metabolic panel to assess kidney health and additional imaging if their medical history requires it. A renal ultrasound is very sensitive and specific for renal obstruction caused either by extrinsic compression or nephrolithiasis. Renal sonographic imaging is used commonly, noninvasive, universally available and a modality with no risks of ionizing radiation. It is highly valuable in diagnosing, excluding extrinsic causes, and grading of hydronephrosis.[14] In addition, ultrasound is an excellent modality for determining the source of additional acute severe flank discomfort.[11] Ultrasound is adequate for evaluating hydronephrosis in individuals with a history of recurrent kidney stone episodes and symptoms typical of these episodes.[15] Individuals with hydronephrosis also benefit from ultrasound as their primary imaging modality.[11] The importance of this technique and the association between hydronephrosis grades and detection of kidney and ureteric calculi is not well-studied in Pakistan. Therefore, we designed this study to see the association between the grades of hydronephrosis and the detection rate of urinary stones by ultrasound imaging.

MATERIAL & METHODS

Study Design and Setting

This cross-sectional, retrospective study was conducted at Watim General Hospital, Rawat between Jan 1, 2023 and Mar 31, 2023 after approval from the hospital Ethics Committee. The records of all adult patients who underwent ultrasound imaging for acute lumbar pain were included. The hospital's Ethics Committee gave ethical approval for the study (WMDCR/ERB/2023/41).

Sample Size

By using WHO calculator, the sample size was determined to be 250 for the study with a level of significance of 5%, power of test 90%, based on the prevalence of kidney stone disease i.e., 16%.[5]

Inclusion and Exclusion Criteria

All patients on whom a renal sonogram was done for acute flank pain, and were found to have hydronephrosis and nephrolithiasis, between Jan-Mar 2023 and were > 18 years of age and < 70 years of age were included in the study.

Patients with hydronephrosis secondary to pregnancy, bladder outlet obstruction and congenital renal anomalies were excluded from the study.

Data Collection Procedure

The data was obtained retrospectively from the ultrasound department records. All patients had been scanned while lying flat on their backs, and a curved 3.5 MHz transducer was used. Longitudinal and transverse slices through the kidneys revealed the renal pelvis, calyces and ureters ere also imaged. Hydronephrosis was easily identifiable by the dilatation of the renal pelvis and calyces. To eliminate potential for bias, it was confirmed that the ultrasound scans on all patients had been performed using the same procedure and same transducer. The Society of Fetal Urology (SFU) classification system was used for grading hydronephrosis: Grade-1; renal pelvis dilatation only. Grade-2; dilatation of the renal pelvis and major calyces dilatation. Grade-3; renal pelvis and major and minor calyces dilatation. Grade-4; renal pelvis and all calyces' dilatation with thinning of the renal parenchyma. The SFU classification system is used also in adults.[16]

Statistical Analysis

Data was entered and analyzed by using the Statistical Package for the Social Sciences (SPSS), version 20, and descriptive analysis was used for categorical data analysis. However, for the level of significance, the Chi-square test and simple logistic regression was performed. Statistically significant difference was assumed for P-value ≤0.05.

RESULTS

In Table-I there were 248 individuals with hydronephrosis due to nephrolithiasis whose ultrasounds were included in this investigation. In this study 58.4% were males and 41.5% were females. The majority of patients were from the very low income category.

Variables	N (%)
Gender	
Males	145 (58.4%)
Females	103 (41.5%)
Socio economic Status	
Very Low-income status (<20K/month)	97 (39.1%)
Low Income status (20-50 K/month)	75 (30.2%)
Middle Income status (50-100K/month)	58 (23.3%)
High Income status (>100K / month)	18 (7.2%)

Table-I. Demographic details of included patients

Unilateral hydronephrosis was seen in 93.6% of cases. There were 6-8 % more cases in the right kidney than the left. Hydronephrosis was found in the sample to vary in severity from mild (grade 1) 18% to severe (grade 4) 17.7%.

Amongst all cases the 248 cases with kidney and ureteric calculi had the underlying cause of their hydronephrosis identified with B-mode ultrasound imaging. All patients had urinary stones as hydronephrosis progressed from grade 1 to 3, the detection rate of stones increased but decreased in grade 4.

The majority of patients were from the very low income and low income status, and this will be discussed further.

SFU Grading System of Hydronephrosis		N	%
Grade 1	Dilated only renal pelvis	45	18.3
Grade 2	1 + dilated few calyces	60	24.2
Grade 3	2 + dilated all calyces	99	39.8
Grade 4	3 + thinning of the renal parenchyma	44	17.7

Table-II. Detected stones in different grades of hydronephrosis.

Patients with grade 3 hydronephrosis had four times the risk of having urinary stones as patients with grade 4 hydronephrosis (Odds Ratio = 5.337, 95% confidence interval [CI]=2.0379-4.6566), as shown in Table-III. Stones were found in the following locations: ureterovesical junction (26.2%), renal pelvis (33%), ureteropelvic junction (17.4%), upper ureter (13.9%), lower ureter (4.7%), and mid ureter (4.8%).

Grades[a]	Odds Ratio (OR)	95% CI (Lower - Upper)		P-Value
1.00	1.0278	0.6496	1.6260	.9068
2.00	1.4797*	0.9562	2.2897	.00786
3.00	5.337*	2.0379	4.6566	.0001
The reference category is: hydronephrosis grade 4				

Table-III. Comparison between detection and the grades of hydronephrosis.

DISCUSSION

Hydronephrosis has been diagnosed more often in recent decades due to the widespread use of

ultrasound imaging for the identification of renal diseases. We investigated the use of ultrasound imaging in identifying urinary tract stones with varying hydronephrosis severity levels. The severity of hydronephrosis was shown to be correlated with the presence of detected stones. This was consistent with a recent research by Suzan et al. who found that renal stones were the cause of hydronephrosis in 54% of adult patients[17] 58.4% of the patients in this research were male, whereas 41.5% were female. Renal calculi were more common in men as they were in women, which is consistent with findings from prior research by Nuraj P et al.[18]

The distribution of hydronephrosis grades in this research is comparable to that reported by Nuraj P et al.[6] who found a prevalence of 48% for grade 2, 22.8% for grade 1, 16.2% for grade 3, and 12.5% for grade 4, and that by Alshoabi[8] as well. Hydronephrosis severity was shown to be significantly correlated with stone length and position, but not with patient gender in this investigation. The length of the stone and the gender of the patient followed with a prior research by Song Y et al., however the position of the stone did not.[11] There was an uptick in stone detection between grades 1 and 3, followed by a decline in grade 4.[5,18] In grades 1-3, these findings are quite similar to those of a prior research by Ozden E et al., although in grade 4, there is some inconsistency. The decline in fourth-grade hydronephrosis stone detection may be due to other chronic causes rather than stones themselves.[9]

These findings provide credence to research by Goertz and Lotterman., who found that the severity of hydronephrosis might also be used as a predictor of stone size.[13] Stones were found in all segments of the ureter, however the middle segment was the least prevalent (4.8%). This finding is consistent with the findings of Hansen KL et al., who found that ultrasound imaging of the ureter is not always successful in detecting stones because of the presence of bowel gases, which obscure the insonation window.[19] Hydronephrosis severity was not examined in connection to the size of urinary stones in our study. Previous research by Riddell et al. shown that the sensitivity of ultrasonic imaging for detecting hydronephrosis increased from 75% for stones 6 mm to 90% for stones >6 mm.[20] This research showed that the most common causes of hydronephrosis were stones (75%), masses (20%), and infections (5%).[21] Another research by Suzan Omer Abdelmaboud et al. found that 53% of Khartoum residents with hydronephrosis had only mild symptoms, whereas 30% had moderate symptoms, and 13% had severe symptoms, based on ultrasound evaluations, and therefore it may be prudent to screen all patients with even mild symptoms for the presence of renal and ureteric stones.[17]

The majority of patients were from the very low and low income status, and a study showed that patients with lower education levels and from regions of lower mean income were found to be more likely to present to our tertiary care center with a greater stone burden, and the majority of patients in our study had grade 3 hydronephrosis.[22]

However, in certain situations, a more thorough diagnosis may need the use of additional imaging modalities, such as CT or MRI.[17,21] Moreover, this was a single centre study, which is a limitation. Hydronephrosis is most often caused by kidney stones or ureteral stones, and the detection rate increases as the grade of hydronephrosis increases upto grade 3. The association between grades of hydronephrosis and kidney stone detection rate has not been well-studied in Pakistan, and this research will be of benefit to nephrologists and urologists who see patients with kidney stones very often in the outpatient setting.

CONCLUSION

The sensitivity of the renal ultrasound to rule out hydronephrosis grades and identify their underlying causes is of diagnostic importance, as it is inexpensive, readily available and free of radiation. Hydronephrosis is most often caused by kidney stones or ureteral stones, and the detection rate increases as the grade of hydronephrosis increases upto grade 3, which

should alert clinicians and sonologists as renal stones are a significant cause of morbidity in our country.

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