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Evaluation of Renal Cortical Thickness in Hydronephrosis Patients on Ultrasound at Hayatabad Medical Complex Hospital Peshawar

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ABSTRACT

Background: Hydronephrosis is often provoked by a previous medical disease or risk factors such as congenital obstruction, unilateral obstructive uropathy, nephrolithiasis, urinary tract infections, tissue scarring, thrombosis, neuromuscular disorders, malignancy, benign prostatic hyperplasia, and pregnancy. The management of hydronephrosis has evolved significantly due to the frequent use of prenatal ultrasonography. **Material and method:** This cross-sectional descriptive research was performed at the Radiology Department of Hayatabad Medical Hospital Complex, Peshawar from July to December 2024, using a convenience sample method. Patients were chosen according to inclusion criteria that included all genders and ages referred for renal scans, whereas those with a history of renal surgery, transplantation, or trauma were excluded. **Results:** The study investigated 233 individuals with acute hydronephrosis using descriptive and inferential statistical techniques to evaluate renal cortical thickness and its correlation with demographic and clinical factors. Notable correlations were identified between weight and hydronephrosis grade ($p < 0.05$), with weight serving as a vigorous predictor of severity. Age exhibited a significant trend, indicating that older persons were more prone to markedly decreased renal cortical thickness, but statistical significance varied within categories ($p = 0.075$ for adults aged 41–60 years). Gender and residency exhibited relationships with hydronephrosis grade, although were not statistically significant ($p > 0.05$). The size of the kidney changed markedly with the severity of hydronephrosis, indicating its increasing effect. **Conclusion:** The research underscores the considerable influence of weight and age on renal cortical thickness and the severity of hydronephrosis, highlighting their contribution to disease development. These results highlight the need for focused treatments and more research to enhance diagnostic and therapeutic approaches for hydronephrosis.

INTRODUCTION

Hydronephrosis is the enlargement of the pelvicalyceal system due to the inability to excrete urine (1). The classification primarily consists of two subgroups: obstructive and non-obstructive hydronephrosis. Uremic obstruction is the presence of a blockage in the urinary system, which hinders the normal drainage of urine from the kidney to the bladder (2). The condition might be sudden, chronic, partial, entire, unilateral, or bilateral. Unilateral hydronephrosis affects one kidney. When both kidneys are affected, bilateral hydronephrosis occurs. The illness can cause mild to severe edema (3). All ages can develop hydronephrosis. About 1 in 100 people get the disorder. Newborns typically have prenatal hydronephrosis, a developmental limitation. About 1% of pregnancies have this issue. Before birth, it typically resolves spontaneously (4).

Obstructive hydronephrosis can cause permanent kidney damage if not addressed quickly (5). In hydronephrosis, renal cortex thickness is an important measure of kidney function. Chronic kidney disease and renal failure shrink the cortex, which contains most of the nephrons, which filter and perform other vital activities (6). Urinary stenting or nephrostomy improved kidney outcomes compared to prolonged occlusion, according to the research. The study emphasizes the importance of regular observation and aggressive hydronephrosis management to prevent kidney injury. To preserve kidney health and function, quick diagnosis and intervention are essential (7). Maternal sonography can detect hydronephrosis early and slow renal functional decline. However, renal function may deteriorate 50% before it becomes obvious. 3, 4 Despite its importance, little is known about the renal response to human obstructive uropathy and disease progression (8). Ultrasound, a non-invasive and cost-effective imaging

technique, is extensively used for the diagnosis and monitoring of hydronephrosis. By enabling the assessment of renal size, cortical thickness, and the extent of hydronephrosis, this technique offers vital data for making clinical decisions (9). Hydronephrosis can impair renal function and cause serious complications if left untreated. Urinary tract obstruction raises intracranial pressure, injuring kidney tissues and lowering GFR, possibly causing acute or chronic renal failure (10). Urinary tract infections can cause sudden or severe back or side discomfort, painful urination, hematuria, weakness, and pyrexia. Symptomatic or asymptomatic hydronephrosis. A common symptom is flank pain, which is pain and discomfort at the rear and side of the abdomen or groin (11).

Hydronephrosis and hydroureters occur over 80% of the time during pregnancy, with primigravida having a higher incidence and severity. Second-trimester dilatation affects the right side. It only appears above the linea terminalis and dissolves within weeks of birth (12). To prevent kidney injury, acute hydronephrosis must be diagnosed and treated immediately. However, if the issue is ignored or rehabilitation is delayed, this might lead to kidney damage, diminished renal function, and the need for more invasive operations. Such patients may need long-term dialysis or kidney transplants (13).

Urinary blockage causes hydronephrosis. Multiple factors can cause this. Many illnesses can induce adult hydronephrosis. Calcium and oxalate kidney stones block kidneys and bladders. Urine flow can be blocked by bladder, prostate, uterine, or other organ malignancies. Benign prostatic hyperplasia (BPH) pushes on the urethra and hinders urinating (14). Hydronephrosis affects 1-5% of Americans. Urolithiasis and congenital abnormalities cause hydronephrosis in 10% of Indians (15).

Prior investigations have shown that surgical intervention should be performed promptly after the onset of acute hydronephrosis in the kidney (16). People at risk need regular medical exams to detect and cure blockages. Lifestyle adjustments like eating a balanced diet full of fruits and vegetables and avoiding salt may also improve kidney function. Hydronephrosis prophylaxis requires early detection and treatment of structural defects that might cause obstruction, such as strictures or tumors (17). Accurate identification of hydronephrosis is crucial since hydronephrosis may lead to chronic renal impairment (18). US (ultrasound) examination might give more precise information that can alter clinical care and enhance the long-term prognosis in subtle ways. Various studies demonstrate that ultrasonography is a prompt and non-intrusive diagnostic technique for renal disorders, and it is also the primary approach preferred for screening and monitoring of patients and individuals in good health (19)

MATERIALS AND METHODS

The research was preceded by approval from the Clinical Research Ethics Committee of the Institute of Paramedical Sciences, Khyber Medical University, and Peshawar. Ethical board committee of Hayatabad Medical Complex Peshawar granted consent for data collection. The sampling method used was non-probability convenience sampling and data were collected from July to December 2024. This research used a predesigned semi-structured questionnaire to perform a descriptive cross-sectional analysis. We have assessed 233 patients having hydronephrosis and Rao-soft Sample Size online Calculator was used for sample size calculation, by putting variable. The confidence level taken is 95%, With p= 30% prevalence and MOE = Margin of Error (6%) (20).

Inclusion criteria were all patients refer for renal scan to radiology department with diagnosed acute hydronephrosis were included in this study irrespective of gender and age. Exclusion criteria all patient having renal surgery, renal transplant and renal trauma were excluded from this study.

Ultrasound imaging is noninvasive, inexpensive, and accessible. Despite radiation, it can accurately diagnose most acute and chronic renal blockages. Ureteric stones can be detected 57.3% without hydronephrosis and 81.3% with it. Ultrasound is the preferred imaging technique for ureteric stones in pregnant and pediatric patients, despite being less sensitive than CT (21).

The Society of Fetal Urology (SFU) grading system is widely used to establish the severity of hydronephrosis across all age groups. The hierarchical method enables physicians to evaluate the extent of the disease and direct suitable therapeutic approaches (22). Hydronephrosis has four severity degrees. Minor renal pelvis enlargement without functional impairment or calyceal involvement is grade 1 (Mild). Grade 2 (Moderate) shows increased renal pelvis dilatation with little calyceal extension, although renal parenchyma is intact and function is barely affected. Grade 3 (Moderate to Severe) has renal pelvis and calyces dilatation, cortical thinning, and potential functional impairment. The kidney often looks balloon-like due to grade 4 (severe) renal pelvis and calyceal enlargement, parenchymal thinning, and functional impairment (23).

RESULTS

The table (4.1) shows N=233 hydronephrotic patients at Hayatabad Medical Complex Hospital in Peshawar, comprising male and female patients of various ages who met inclusion criteria. Male participants made up n=125 (54%), while females made up n=108 (46%). Hydronephrotic individuals were variable in age. The majority of participants, n=76 (32.6%), were aged 21-40, with a mean and SD of 32±5, showing influence on young and middle-aged individuals. The demographic

features of the participants are shown in Table 4.1.

Table 1

The demographic features of the participants are shown in Table 4.1.

Variables		Frequency (F)	Percentage (%)
Age of individual	1-20 Years	72	30.9
	21-40 Years	76	32.6
	41-60 Years	65	27.9
	61-80 Years	18	7.7
Gender-wise distribution	Male	125	54
	Female	108	46
Marital status of the participants	Married	132	56.65
	Unmarried	101	43.34
Weight	1 to 20 Kg	13	5.6
	21 to 40 Kg	19	8.2
	41 to 60 Kg	91	39.1
	61 to 80 Kg	54	23.2
	Above 80 Kg	56	24

Table 2

Ultrasound Evaluation & participants related variables

Variable		Frequency (F)	Percentage (P)
Renal cortical thickness	Normal (5-10 mm)	133	57.3
	Mildly Reduced (3-5 mm)	63	27.2
	Severely Reduced or Gross (Less than 3 mm)	37	15.5
Grading of hydronephrosis	Grade0 (No Hydronephrosis)	0	0
	Grade1 (Mild Hydronephrosis)	92	39.5
	Grade 2 (Moderate Hydronephrosis)	46	19.7
	Grade 3(Severe Hydronephrosis)	45	19.3
	Grade 4 (Gross Hydronephrosis)	50	21.5
Size of affected kidney	Normal Size	87	37.3
	Slightly Enlarged	58	25
	Moderately Enlarged	37	16
	Severely Enlarged	47	20
	Reduced Size (if applicable)	4	1.7

Figure 1: *The sonographic view of the measurement of renal cortical thickness*

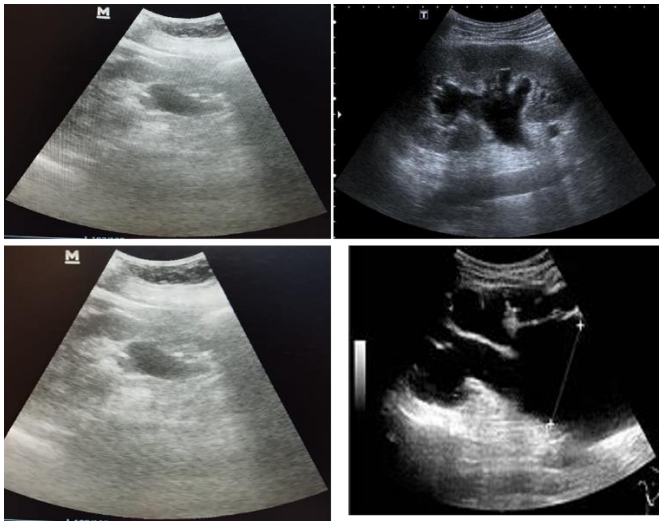


Table 3

Age depended renal cortical thickness (RCT) in millimeters RCT

Age-Depended Renal Cortical Thickness (RCT)		Frequency (F)	Percentage (P)
Children (0-12 years)	Normal 8 to 12 mm	12	44.4
	Less than 8 mm	13	48.1
	Above 12 mm	2	7.4
Adolescents (13-18 years)	Normal 7 to 11 mm	13	36.1
	Less than 7 mm	22	61.1
	Above 11 mm	1	2.8
Young Adults (19-30 years)	Normal=8-12 mm	17	34.7
	Less than 8 mm	30	61.2
	Above 12 mm	2	4.1
Adults (31-50 years)	Normal 7 to 11 mm	23	39.7
	Less than 7 mm	34	58.6
	Above 11 mm	1	1.7
Older (51yrs & above)	Normal 5 to 9 mm	38	61.3
	Less than 5mm	20	32.3
	Above than 9 mm	4	6.5

Chi-square (X^2) and p-value results indicating the correlation between frequency of Renal Cortical Thickness and age groups. Significant associations ($p<0.05$) were observed for Children (0-12 years), Adolescents (13-18 years), Adults (31-50 years), and Older Adults (51 years and above), suggesting a strong relationship between renal cortical thickness and these age categories. However, the Young Adults (19-30 years) group showed no significant correlation ($p>0.05$) shown in the table 4.4.

Table 4

Age depended. Table 4.4 shows chi square and p values.

Variables	Frequency of Renal Cortical Thickness (n=233)	X^2	P
Children (0-12 years)	25	10.52	0.005
Adolescents (13-18 years)	36	8.32	0.015
Young Adults (19-30 years)	49	5.76	0.055
Adults (31-50 years)	58	7.45	0.024
Older Adults (51yrs & above)	65	9.12	0.010

A paired sample t-test indicates the relationship between demographic and clinical factors and Hydronephrosis Grade in Table 4.5. Gender negatively correlated with hydronephrosis grade (OR = -0.74, p = 0.005), suggesting masculine patients had lower grades. Significant association exists between weight and Hydronephrosis Grade (OR = 1.29, p < 0.001), suggesting that heavier individuals have more severe cases. Age did not significantly affect hydronephrosis grade (OR = -0.11, p = 0.26). Residence showed a borderline significant negative connection (OR = -0.16, p = 0.05), suggesting rural patients may have lower Hydronephrosis Grades.

Most patients were male (1.48, SD = 0.518). The sample showed mild hydronephrosis, with a mean of 2.227 (SD = 1.1835). The sample's mean age was 2.116 (SD =

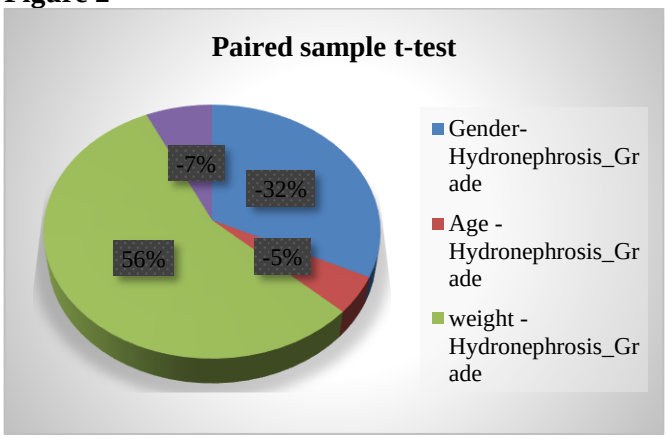
0.9466), with most patients in the middle age range. Weight has a mean of 3.519 (SD = 1.1106), showing a wide range of body weights, with a higher concentration in heavier weight categories.

Table 5

Paired Sample t-test Between Various Variables and Hydronephrosis Grade

Variables	OR	95%C.I for OR		p-value
		Lower	Upper	
Gender- Hydronephrosis Grade	-0.74	-0.91	-0.58	0.005
Age - Hydronephrosis_Grade	-0.11	-0.30	0.086	0.26
weight - Hydronephrosis_Grade	1.29	1.08	1.50	0.000
Residence - Hydronephrosis_Grade	-0.16	-0.34	0.018	0.05

Figure 2



The multinomial logistic regression analysis (Table 4.6) show the relationship between many covariates and categories of Renal Cortical Thickness.

Table 6

Multinomial Logistic Regression

Variable	OR	95% C.I for OR		P-value
		Lower	Upper	
Renal cortical thickness = normal 5 to 10	-0.051	-3.29	3.19	0.976
Renal cortical thickness= Mildly reduced 3 to 5	1.465	-1.78	4.71	0.376
Male	-0.191	-3.08	2.71	0.897
Female	-0.45	-3.27	2.37	0.754
Age = 1-20 Years	0.434	-0.939	1.808	0.535
Age = 21-40 Years	0.145	-0.980	1.269	0.801
Age = 41-60 Years	-0.936	-1.965	0.093	0.075
Weight = 1 to 20 Kg	0.316	-1.078	1.709	0.657
Weight = 21 to 40 Kg	-0.520	-1.855	0.815	0.445
Weight = 41 to 60 Kg	-0.813	-1.696	0.070	0.071
Weight = 61 to 80 Kg	-0.218	-1.028	0.591	0.597
Teacher	0.277	-0.844	1.398	0.628
Student	0.480	-0.859	1.819	0.482
House wife	0.651	-0.640	1.943	0.323
Labour	0.328	-0.808	1.464	0.572
Engineer	-0.966	-2.458	0.526	0.204
Rural	0.721	-0.059	1.501	0.070
Urban	0.630	-0.016	1.276	0.056

Figure 3

Right Kidney of Patients Showing Different Grades of Hydronephrosis

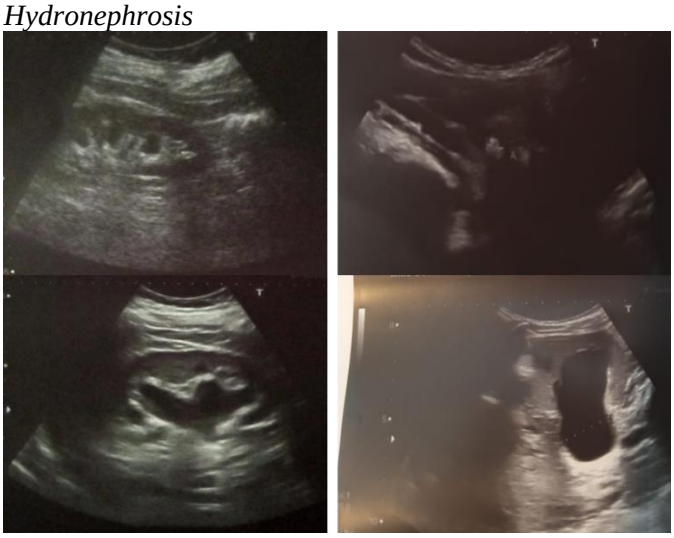
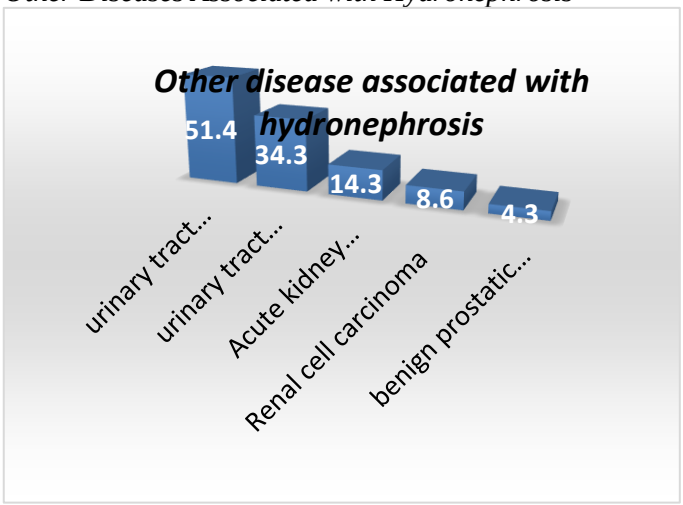


Figure 4

Other Diseases Associated with Hydronephrosis



DISCUSSION

We examined the RCT in people without renal diseases and its relationship to numerous characteristics to acquire first population data. The age-wise frequency distribution reveals that renal cortical thickness shows considerable variance across various age groups, with the greatest occurrence seen in older individuals. Analyses of hydronephrosis grading by gender and weight indicate unique patterns, with certain demographic and physical traits correlating with either elevated or diminished grades of hydronephrosis. The influence of residency on the grading of hydronephrosis is apparent, since people from rural areas have differing degrees of vulnerability (24). With similarly study Findings and hydronephrotic renal function. Nitzsche et al. examined 142 hydronephrotic kidneys and discovered that less than 10% had less than 40% function, all of which presented with cortical atrophy (25).

Logistic regression identifies weight as a significant determinant of hydronephrosis grade, exhibiting a robust

positive correlation, while gender and residency have lesser although noteworthy associations. These results highlight the interaction of demographic and clinical variables in influencing renal health outcomes (26). In the two additional investigations using arteriography, the typical RCT has been documented as 5–12 mm in one (27) study and 5–8 mm in another (28). In a separate investigation, Doppler ultrasonography indicated that the typical RCT measures 10–15 mm (29). The RCT was derived using two measurements taken at the upper and lower poles of the kidney; hence, varying results may be anticipated. Buchholz et al. at Karachi University, Pakistan, reported a mean ± SD RCT of 16 ± 2 mm, which significantly differs from our data; however, this may pertain to the determination of mean parenchymal thickness (30). If this represents the average RCT, given that Pakistan is one of our neighboring countries, more regional research are necessary. The disparity in cortical thickness reflects the extensive diversity in renal size and the morphology of the collecting system. In kidneys with short and robust infundibula, the cortex seems more substantial than in those with elongated, slender infundibula (31). The findings of the multivariate regression indicate that weight is a significant determinant of hydronephrosis grade, whereas gender and residency exhibit smaller nevertheless noteworthy correlations. Other study reported that Grade IVB hydronephrosis requires continuous monitoring, since early intervention may be necessary to prevent increasing renal function degradation. Hydronephrosis with diffuse cortical thinning (IVB) exhibit a substantial reduction in differential renal function relative to a hydronephrotic kidney with segmental parenchymal loss (IVA) (32). The chi-square analysis of renal cortical thickness across age groups indicates statistically significant variations, especially among children, adolescents, and older individuals, suggesting an age-dependent decline in renal health (26). Another research demonstrated that RCT has a slight positive connection with renal length. Moreover, several sources indicate a correlation between the individual's height and renal length. Consequently, relationship between the subject's height and RCT—was anticipated (32, 33). Renal length, cortical thickness, and parenchymal thickness are associated with diminished renal function. The medullary thickness exhibited no variations across groups 1 to 3. Multiple linear regression study including sex, age, and renal ultrasound measurements indicated that only renal length served as an independent predictor of renal function (34). Cortical thickness was the strongest associated parameter. Lower cortical left/right ratio (left cortical thickness/right cortical thickness) showed a stepwise association with a decrease in renal function (35).

CONCLUSION

This study shows that demographic, clinical and lifestyle factors interact to alter renal cortical thickness and hydronephrosis classification. Renal cortical thickness decreases with age, especially in adolescents, young adults, and older people, underscoring the need for age-specific renal health initiatives. Weight is a key component in hydronephrosis severity, suggesting lifestyle and diet may affect renal disease progression. Gender and residency also correlated differently with renal outcomes, highlighting the importance of social and environmental factors in renal illness. Older persons had a higher rate of decreasing renal cortical thickness, indicating age-related kidney structural changes. Hydronephrosis ranged from moderate to severe, closely linked to weight and residency. In late-stage hydronephrosis, moderate and severe kidney enlargement was more common. These findings demonstrate the complex link between age-related physiological changes, disease severity and renal morphology.

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