

The Role of Plain Radiograph and Ultrasound in the Diagnosis of Renal Tract Calculi

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ABSTRACT:

Introduction: Renal tract calculi is one of the most common problem among adults in Bangladesh. Plain radiograph and ultrasound both are the important tools for diagnosis of these calculi but efficacy may be varying due to different factors. **Objective:** To find out the effectiveness of plain radiograph and ultrasound to diagnose renal tract calculi. **Methodology:** This prospective observational study was done for the period of 24 months, from July 2013 to June 2015 in the department of radiology and imaging and department of urology at Dhaka medical College Hospital (DMCH) among 50 purposively selected patients. Data were collected by reviewing patients' record and face to face interview. Then data were analyzed and presented accordingly. **Results:** Mean age of the respondents was 43.70 ± 9.75 years and about 18(36.0%) of them belonged 41-50 years' age group. Most (46.0%) of the respondents were farmer. Regarding clinical feature 36(72.0%) had abdominal pain, 21(42%) had urinary tract infection and 9(18.0%) had hematuria. Sensitivity, specificity and accuracy of plain radiograph was 86.66%, 20.0% and 80.0% for diagnosing renal tract calculi. Sensitivity, specificity and accuracy of ultrasound and combination of both were 91.11%, 40.0%, 86.0% and 97.78%, 60.0% & 94.0% respectively. **Conclusion:** Ultrasound and plain radiograph both are cheap, easily available, non-invasive and useful methods for effectively diagnosis of renal tract calculi.

Key words: Plain radiograph, ultrasonography, renal tract calculi

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INTRODUCTION:

Renal tract calculi, also known as urolithiasis, refer to renal stone formation at any point along the renal tract (from kidneys to bladder and urethra). Renal tract calculi, are solid masses made of crystals. It usually originates in kidneys. However, they can develop anywhere along urinary tract.¹

Renal tract calculi commonly appear to be due to minerals crystallizing out of urine in a normal renal tract. There is a predictable increased risk of stone formation in condition where the urine contains a high concentration of minerals particularly calcium.

Spending time in hot climate and or in hot wave or becoming recurrently dehydrated have the strongest association with renal calculi formation. Some patient exhibit family tendency and a small but significant minority have a specific biochemical causes. Structural abnormalities predispose to stone formation particularly those involving urinary stasis.¹

Calculi are unilateral in about 80.0% of patients. The favored sites for their formation within the renal calyces and renal pelvis. These may have smooth contours or may take the form of an irregular jagged

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mass of spicules. Often many stones are found within one kidney. On occasion progressive accretion of salt leads to the development of branching structures known as staghorn calculi.²

Clinical features of renal tract calculi may vary according to size, shape, position of the stone and nature of underlying condition. Leading feature is pain in around 75% of patients, others are hematuria, urinary tract infection, nausea, vomiting etc. Sometimes even large staghorn calculi may be presented for years without giving rise to symptoms and may be discovered during radiological examination for another disorder.³

Plain radiograph, ultrasound, CT scan and IVU are the commonest method for diagnosing renal tract calculi. Among those plain radiograph and ultrasound are the cheap, simple easily available in all health setup. Over 90% of renal tract calculi are radiopaque so easily seen in radiograph but in some cases it may be overlooked due to its position and overlying bowel gases and feces.¹

Ultrasound and plain radiograph are the most commonly used methods of renal tract calculi diagnosis. Every single method may be useful and combined methods may give more perfect result but data regarding those investigations is scarce in our country, as far as we have searched the literature and web. So this study is very time bound and effective to know the sensitivity, specificity & accuracy of ultrasound and plain radiograph and combined methods. It will help physician to take decision regarding accurate diagnosis of renal tract calculi.

METHODS AND MATERIALS:

This prospective observational study was carried out in the department of radiology and imaging in collaboration with department of Urology, Dhaka Medical College and Hospital to find out the effectiveness of plain radiograph and ultrasound to diagnose renal tract calculi during the period of 24 months (July 2013 to June 2015). During this period 50 patients were selected purposively as sample, who undergo surgery for renal stone in the urology department. Socio-demographic data and were collected by face to face interview and through

questionnaire and all other information were collected by record review and from history sheet in respective department.

Technique of ultrasound: Real time ultrasound machine fitted with 3.5 or 5 MHz sector probe. No preparation is needed except optimally filled urinary bladder. All the patients were scanned in supine, right lateral, left lateral and prone position. Longitudinal and transverse scan of both kidney were performed. Length and width were recorded. Cortical echo, sinus echo and corticomedullary differentiation were observed. If any calculi were found size and location were noted. Any other photograph such as PC dilatation, mass lesion or cyst were looked for.

Technique of radiograph: The patient was positioned supine on the X-ray table with the median sagittal plane of the body at right angles to and the midline of the table. The size of film was large enough to cover the region from above the upper poles of the kidneys to the symphysis pubis, for the average adult that was a 35x43 cm film. The cassette was placed in the Bucky tray and positioned so that the symphysis pubis was included on the lower part of the film. The center of the cassette was about at the level of the lower costal margin in the mid axillary line and the upper edge of the cassette at the level of the xiphisternum.

The vertical central ray was directed to the center of the film. The x-ray beam was collimated to just within the margins of the film. Using high mA and short exposure time, the exposure was made on arrested respiration after full expiration.

Small opacities overlies the kidney may be inside or the outside the kidney substance. A further radiograph taken on arrested respiration after full inspiration might show a difference in extent and direction of movement and kidney and calcification lying outside the kidney.

All the data were recorded in a predesigned questionnaire. Data were analyzed by computer software for windows SPSS version 15. Ethical clearance for the study was obtained from IRB of DMCH.

RESULTS:

Total 50 cases enrolled purposively.

Table-I: Distribution of the respondents according to age (n=50)

Age group (Years)	Frequency	Percentage
Up to 30	5	10.0
31- 40	13	26.0
41- 50	18	36.0
51- 60	14	28.0
Total	50	100.0

Most (36%) of the respondents were 41-50 years' age group and mean age was 43.70±9.75 years.

Table-II: Distribution of the respondents according to occupation (n=50)

Occupation	Frequency	Percentage
Farmer	23	46.0
Business	4	8.0
Service holder	10	20.0
Housewife	6	12.0
Garments worker	2	4.0
Day labour	4	8.0

Others	1	2.0
Total	50	100.0

Most (46.0%) of the cases were farmer about 10 (20.0%) were service holder, 4(8.0%) were day labour and 6(12.0%) were house wife.

Table-III: Distribution of the respondents according to clinical features (n=50^s)

Clinical features	Frequency	Percentage
Urinary tract infection	21	42.0
Abdominal pain	36	72.0
Nausea	5	10.0
Vomiting	4	8.0
Hematuria	9	18.0
Others	2	4.0

^sMultiple answer

Most of the respondents 72.0% (36) were presented with abdominal pain, followed by UTI (42.0%), hematuria (18.0%), nausea (10.0%) and only 2(4.9%) had some other symptoms.

Table-IV: Sensitivity, specificity and accuracy of plain radiograph in the diagnosis of renal tract calculi

Investigation	Findings	Operational findings		Total
		Positive	Negative	
Plain radiograph	Positive	39 (a)	4 (b)	43 (a+b)
	Negative	6 (c)	1 (d)	7 (c+d)
	Total	45 (a+c)	5 (b+d)	50
Calculation of Sensitivity, Specificity and Accuracy				
Sensitivity	$= \frac{a}{a+c} = \frac{39}{39+6} = \frac{39}{45} = 0.8666 = 86.66\%$			
Specificity	$= \frac{d}{b+d} = \frac{1}{1+4} = \frac{1}{5} = 0.20 = 20.0\%$			
Accuracy	$= \frac{a+d}{a+b+c+d} = \frac{39+1}{39+4+6+1} = \frac{40}{50} = 0.80 = 80.0\%$			

Table-IV shows that sensitivity, specificity and accuracy of plain radiograph in diagnosis of renal tract calculi is 86.66%, 20.0% and 80.0% respectively.

Table-V: Sensitivity, specificity and accuracy of ultrasound in the diagnosis of renal tract calculi

Investigation	Findings	Operational findings		Total
		Positive	Negative	
Ultrasound	Positive	41 (a)	3 (b)	44 (a+b)
	Negative	4 (c)	2 (d)	6 (c+d)

	Total	45 (a+c)	5 (b+d)	50
Calculation of Sensitivity, Specificity and Accuracy				
Sensitivity	$= \frac{a}{a+c} = \frac{41}{41+4} = \frac{41}{45} = 0.9111 = 91.11\%$			
Specificity	$= \frac{d}{b+d} = \frac{2}{3+2} = \frac{2}{5} = 0.40 = 40.0\%$			
Accuracy	$= \frac{a+d}{a+b+c+d} = \frac{41+2}{41+3+4+2} = \frac{43}{50} = 0.86 = 86.0\%$			

Table-V shows that sensitivity, specificity and accuracy of ultrasound in diagnosis of renal tract calculi is 91.11%, 40.0% and 86.0% respectively.

Table-VI: Sensitivity, specificity and accuracy of combined radiograph & ultrasound in the diagnosis of renal tract calculi

Investigation	Findings	Operational findings		Total
		Positive	Negative	
Combined Radiograph & Ultrasound	Positive	44 (a)	2 (b)	46 (a+b)
	Negative	1 (c)	3 (d)	4 (c+d)
	Total	45 (a+c)	5 (b+d)	50
Calculation of Sensitivity, Specificity and Accuracy				
Sensitivity	$= \frac{a}{a+c} = \frac{44}{44+1} = \frac{44}{45} = 0.9777 = 97.77\%$			
Specificity	$= \frac{d}{b+d} = \frac{3}{3+2} = \frac{3}{5} = 0.60 = 60.0\%$			
Accuracy	$= \frac{a+d}{a+b+c+d} = \frac{44+3}{44+2+1+3} = \frac{47}{50} = 0.94 = 94.0\%$			

Table-VI shows that sensitivity, specificity and accuracy of combined radiograph & ultrasound in diagnosis of renal tract calculi is 97.77%, 60.0% and 94.0% respectively.

DISCUSSION:

In this study, 50 patients were selected purposively as sample, who undergo surgery for renal stone in the urology department of DMCH. Mean age of respondents was 43.75±9.75 years and majority (36%) were within 30 to 50 years of age. In a study done by Khan I.F., found that peak age of incidence occurs in the third to fifth decade.⁴

Farmer is the single most (46.0%) majority in the occupation and it may be due to they are always work in hot climate in hot wave and more chance of becoming dehydrated which were the probable cause of renal tract calculi. This finding is similar to another study done by Kabala *et al*¹

Among the respondents about 72.0% gave the history of abdominal pain in the form of renal colic or fixed abdominal pain. Studies found that renal pain is the leading symptom in 75.0% of the renal calculi patient. Presence of infection is also a common symptom. In a study conducted by kenny

I.J., on 683 patients showed that urinary tract infection is a common symptom of renal tract colic.^{1,5,6}

In this study, we found that sensitivity of plain radiograph was 86.66% and a similar result was found by Middleton W.D. but different finding was found by Nimkin K. *et al*, (only 57.0%) and most probably it may be due to the study population. Most of their respondent were less than 20 years of age.^{7,8}

The sensitivity of ultrasound was 91.11% and Middleton W.D., found it as 96.0%. In that study ureteric colic was not included. But some other studies Vrtiska T.J *et al* Diament M.J., *et al* found similar findings.^{7,9,10}

In this study it also revealed that combined plain radiograph and ultrasound was more sensitive (97.77%) than any single test. Different studies found the similar result. Nimkin K *et al*, Diament M.J. *et al*, and Hill M.C *et al*, conducted three

different study in different time but found that combined plain radiograph and ultrasound showed more sensitivity and accuracy than any single test.^{8,10,11}

CONCLUSION:

It is clear that ultrasound and plain radiograph are easily available and cheap diagnostic tools to accurately diagnose renal tract calculi but it can be concluded that combined ultrasound and plain radiograph are more sensitive than the single one test. Further study will be more helpful to evaluate the role of ultrasound and plain radiograph in the diagnosis of renal tract calculi.

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