## Original Article

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*** Comparative study of Plain Radiograph and Ultrasound in the Diagnosis of Renal Tract Calculi**
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***Will be replaced by-***
***Plain Radiograph and Ultrasound are complementary in the Diagnosis of Renal Tract Calculi***
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# Plain Radiograph and Ultrasound are complementary in the Diagnosis of Renal Tract Calculi

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***ABSTRACT***

***Introduction:*** *In Bangladesh, renal calculi are one of the most prevalent health issues among adults. Plain radiography and ultrasonography are both essential diagnostic methods for calculi, although their efficacy varies depending on a number of circumstances.* ***Objective:*** *To find out the effectiveness of plain radiograph and ultrasound to diagnose renal tract calculi.* ***Methodology:*** *This prospective observational study was done on 70 patients at Sher E Bangla Medical College Hospital (SBMCH) in the departments of radiology and imaging over a period of 24 months, from January 2018 to December 2020. Data was gathered by reviewing patient records and speaking with them in person. The data was then examined and displayed correctly.* ***Results:*** *The mean age of the respondents was 43.70±9.75 years, and around 25 (36%) of them were within the age bracket of 41-50 years. The majority of responders (46.0%) were farmers. 50 (72%) reported stomach discomfort, 29 (42%) had an infection of the urinary system, and 13 (18%) had hematuria. For the diagnosis of renal tract calculi, the sensitivity, specificity, and accuracy of plain radiographs were 87.30%, 14.28%, and 80%, respectively. The sensitivity, specificity, and accuracy of ultrasound and their combination were 90.40%, 42.85%, 86.0% and 98.41%, 57.1%, and 98.41% respectively.* ***Conclusion:*** *Both ultrasound and plain radiographs are non-invasive, easy-to-use, inexpensive, and valuable diagnostic tools that can be used to make a correct diagnosis of renal tract calculi and complementary to each other.*

***Key words:*** *Plain radiograph, ultrasonography, renal tract calculi.*

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## INTRODUCTION

The deposition of renal stones at any point along the renal tract is referred to as urolithiasis, which is another name for renal tract calculi (from kidneys to bladder and urethra). Renal tract calculi are solid masses composed of crystals. Typically, kidneys are the source of the problem, but it can arise at any point along the urinary tract.[1]

Renal tract stone commonly develops due to minerals crystallizing out of urine in a normal renal tract. A condition in which the urine contains a high quantity of minerals, especially calcium, is associated with an increased risk of stone development. Time spent in a hot region or during a heat wave, as well as repeated dehydration, have the strongest relationship with renal calculi formation. Some patients have familial tendencies, whereas a few but important number have biochemical origins. Structural anomalies, especially those involving urinary stasis, predispose to stone development.[1]

Approximately 80% of patients have unilateral calculi. The renal calyces and renal pelvis are the most common locations for their development. This may have smooth outlines or resemble an uneven, jagged mass of spicules. Frequently, several kidney stones are detected. On occasion, progressive salt accumulation results in the formation of branching formations known as "staghorn calculi."[2]

Clinical characteristics of renal tract calculi might vary according to the size, shape, location, and underlying disease of the stone. In around 75% of patients, pain is the predominant symptom; additional symptoms include hematuria, urinary tract infection, nausea, and vomiting. Occasionally, even big staghorn calculi might be present for years without causing symptoms and may only be detected during a radiological screening for another reason.[3]

Renal calculi are often diagnosed using plain radiography, ultrasonography, CT scan, or intravenous urography. Standard radiology and ultrasound are two examples of low-cost, low-tech diagnostic tools that are standard in any healthcare facility. While radiographs can detect the majority of kidney stones because they are radiopaque, stones in the renal tract may be obscured by intestinal gases and feces.[1]

Diagnosing renal tract calculi often involves ultrasound or plain radiography. Although we have examined the literature and the internet for information on such studies, we have found that such data is rare in our nation. 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.

## MATERIALS AND METHODS

The purpose of this prospective observational study was to compare the diagnostic accuracy of plain radiographs and ultrasounds for renal tract calculi over a period of 24 months. The research was

conducted by the Department of Radiology and Imaging, Sher E Bangla Medical College Hospital (SBMCH) over a period of 24 months, from January 2018 to December 2020. 70 patients having renal stone surgery in the urology department were randomly selected to serve as a sample throughout this time period. We did in-person interviews and gave out questionnaires to get demographic data. For all the other data, we looked through records and personnel files.

**Technique of ultrasound:** Ultrasound device equipped with a 3.5 or 5 MHz sector probe was used. No preparation is required other than a full bladder. All patients were scanned in the prone, supine, right lateral, and left lateral positions. Both kidneys were scanned longitudinally and transversely. Both length and breadth were noted. There was evidence of cortical echo, sinus echo, and corticomedullary differentiation. If calculi were discovered, their size and location were recorded. Other images, such as those of PC dilatation, mass lesions, and cysts, were sought.

**Technique of radiograph:** The patient was positioned supine on the X-ray table with the body's median sagittal plane perpendicular to the table's midline. For the average adult, the 35x43 cm film was big enough to cover the region from above the upper poles of the kidneys to the pubic symphysis. The cassette was positioned within the Bucky tray so that the symphysis pubis appeared on the lowest portion of the film. The cassette's center was about at the level of the lower costal margin in the midaxillary line, and its upper border was at the level of the xiphisternum.

The vertical central ray was aimed at the film's center. The x-ray beam was collimated to fall precisely within the film's boundaries. Using a high mA current and a brief exposure duration, the exposure was performed during paused respiration following complete expiration.

Small opacities that cover the kidney's material may be internal or external. A second radiograph obtained with the patient's breathing halted after complete inspiration may reveal a difference in the kidney's extent and direction of movement, as well as calcifications outside the kidney, if there is one.

All of the information was contained in a predesigned questionnaire. Data were analyzed using Windows SPSS version 15 software. IRB of DMCH granted ethical approval for the investigation.

## RESULTS

Total 70 cases enrolled purposively.

**Table-I: Distribution of the respondents according to age (n=70)**

| Age group (Years) | Frequency | Percentage |
|---|---|---|
| Up to 30 | 7 | 10.0 |
| 31- 40 | 18 | 26.0 |
| 41- 50 | 25 | 36.0 |
| 51- 60 | 20 | 28.0 |
| **Total** | **70** | **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=70)**

| Occupation | Frequency | Percentage |
|---|---|---|
| Farmer | 32 | 46.0 |
| Business | 6 | 8.0 |
| Service holder | 14 | 20.0 |
| Housewife | 8 | 12.0 |
| Garments worker | 3 | 4.0 |
| Day labour | 6 | 8.0 |
| Others | 1 | 2.0 |
| **Total** | **70** | **100.0** |

Most (46.0%) of the cases were farmer about, 14 (20.0%) were service holder, 6(8.0%) were day labour and 8(12.0%) were house wife.

**Table-III: Distribution of the respondents according to clinical features (n=70[$])**

| Clinical features | Percentage |
|---|---|
| Urinary tract infection | 42.0 |
| Abdominal pain | 72.0 |
| Nausea | 10.0 |
| Vomiting | 8.0 |
| Hematuria | 18.0 |
| Others | 4.0 |

[$]Multiple answer

Most of the respondents 72.0% were presented with abdominal pain, followed by UTI (42.0%), hematuria (18.0%), nausea (10.0%) and only (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 | 55 (a) | 6 (b) | 61 (a+b) |
| | Negative | 8 (c) | 1 (d) | 9 (c+d) |
| | Total | 63 (a+c) | 7 (b+d) | 70 |
| **Calculation of Sensitivity, Specificity and Accuracy** | | | | |
| Sensitivity | $= \frac{a}{a+c} = \frac{55}{55+8} = \frac{55}{63} = 0.873 = 87.30\%$ | | | |
| Specificity | $= \frac{d}{b+d} = \frac{1}{1+6} = \frac{1}{7} = 0.14 = 14.28\%$ | | | |
| Accuracy | $= \frac{a+d}{a+b+c+d} = \frac{55+1}{55+6+8+1} = \frac{56}{70} = 0.80 = 80.0\%$ | | | |

Table-IV shows that sensitivity, specificity and accuracy of plain radiograph in diagnosis of renal tract calculi is 87.30%, 14.28% 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 | 57 (a) | 4 (b) | 61 (a+b) |
| | Negative | 6 (c) | 3 (d) | 9 (c+d) |
| | Total | 63 (a+c) | 7 (b+d) | 70 |
| **Calculation of Sensitivity, Specificity and Accuracy** | | | | |
| Sensitivity | $= \frac{a}{a+c} = \frac{57}{57+6} = \frac{57}{63} = 0.904 = 90.40\%$ | | | |
| Specificity | $= \frac{d}{b+d} = \frac{3}{3+4} = \frac{3}{7} = 0.42 = 42.85\%$ | | | |
| Accuracy | $= \frac{a+d}{a+b+c+d} = \frac{57+3}{57+6+4+3} = \frac{60}{70} = 0.86 = 86.0\%$ | | | |

Table-V shows that sensitivity, specificity and accuracy of ultrasound in diagnosis of renal tract calculi is 90.40%, 42.85% 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 | 62 (a) | 3 (b) | 65 (a+b) |
| | Negative | 1 (c) | 4 (d) | 5 (c+d) |
| | Total | 63 (a+c) | 7 (b+d) | 70 |
| **Calculation of Sensitivity, Specificity and Accuracy** | | | | |
| Sensitivity | $= \frac{a}{a+c} = \frac{62}{62+1} = \frac{62}{63} = 0.98 = 98.41\%$ | | | |
| Specificity | $= \frac{d}{b+d} = \frac{4}{3+4} = \frac{4}{7} = 0.57 = 57.1\%$ | | | |
| Accuracy | $= \frac{a+d}{a+b+c+d} = \frac{62+4}{62+3+1+4} = \frac{65}{70} = 0.928 = 92.8\%$ | | | |

Table-VI shows that sensitivity, specificity and accuracy of combined radiograph & ultrasound in diagnosis of renal tract calculi is 98.41%, 57.1% and 92.8% respectively.

## DISCUSSION

In this study, 70 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 87.30% and a similar result was found by Middletone 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 90.40% and Middletone 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 (98.41%) 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

Ultrasound and plain radiography are readily available and inexpensive diagnostic methods for reliably diagnosing renal tract calculi; a combination of the two is more sensitive than each test alone. To figure out what role ultrasonography and plain radiography play in diagnosing kidney stones, more research needs to be done.

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