# Comparison of ultrasonography and computed tomography in detecting urolithiasis in a teaching hospital of Kaski district

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**ABSTRACT**

**Introduction:** Urolithiasis is an increasing health problem worldwide including developing countries like Nepal. Ultrasonography and computed tomography of kidney, ureter and urinary bladder imaging modalities are used in detection of urolithiasis. This study was done to compare ultrasonography and computed tomography of kidney, ureter and urinary bladder findings for detection of urolithiasis. Methods: A cross-sectional study was conducted in Department of Radiology, Gandaki Medical College, Pokhara, Nepal from July to October, 2021 after obtaining ethical clearance from Institutional Review Committee of Gandaki Medical College. Total 92 patients who had urolithiasis in computed tomography and had ultrasound report available within one week were selected for the study. Demographic data of patients, location and side of calculi were recorded. The findings of ultrasonography and computed tomography were then compared. Similarly, sensitivity and specificity of ultrasonography were calculated. Results: Urolithiasis was more common in middle age groups i.e. 20 to 40 years (n= 57, 62.0%) and in males (n=56, 60.9%). Kidney was the commonest location detected by both ultrasonography (n=45, 48.9%) and computed tomography (n=44, 47.8%) with predominance in right side. Some of the calculi that were undetected by ultrasonography were easily confirmed by computed tomography in various locations. This was found to be statistically significant ($p<0.05$). The sensitivity and specificity of ultrasonography in compared to computed tomography was 83.7% and 100% respectively. Conclusions: Ultrasonography has poor sensitivity and high specificity for detecting urolithiasis. Thus, computed tomography can be considered as better imaging modality as compared to ultrasonography for diagnosis of urolithiaisis.

**Keywords:** Computed tomography, location, side, ultrasonography, urolithiasis.

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## INTRODUCTION

Urolithiasis is a very common problem worldwide with incidence of 12%.[1] It may cause longstanding obstruction and infection, ultimately leading to renal failure. Thus, early accurate diagnosis with appropriate treatment is paramount for prevention of complications and maintenance of renal function.[2]Imaging techniques play a critical role in the initial diagnosis, treatment plan and post-treatment follow-up of urolithiasis. Plain radiographs, intravenous urography, ultrasonography (USG) and computed tomography (CT) are widely used imaging modalities.[3]

Among these, USG is commonly used first investigation for diagnosis of urolithiasis which is safe, inexpensive, portable and bears no risk of radiation.[3–5] But its sensitivity is modest and hugely dependent on operator and body habitus of the patient.[3] Additionally, sensitivity of USG is low in calculi with low grade hydronephrosis or hydrocalyces and small calculi (<3 mm).[6] Computed tomography of kidney, ureter and bladder (CT KUB) is another emerging imaging modalities for patients with urolithiasis.[7] It not only detects the calculi but also

determine its size, number, location and even density.[7,8] Moreover, it allows rapid diagnosis and aid in diagnosis of pathologies other than urinary tract calculi.[3] However, high radiation dose and high cost are its limitations.[8]

Many studies were conducted comparing USG and CT KUB for detection of urolithiasis.[5] However, limited literatures are available in Nepal. Thus, this study was carried out to compare diagnostic efficiency between USG and CT KUB for detection of urolithiasis.

## METHODS

This prospective cross-sectional study was conducted from July to October, 2021 in Department of Radiology, Gandaki Medical College Teaching Hospital & Research center, Pokhara, Nepal. Convenience sampling method was used. Based on the study by Sharma et al., at 95% confidence interval and prevalence of 60.62%, using formula , sample size of 92 was calculated.[5] Ethical clearance was obtained from Institutional Review Committee of Gandaki Medical College (Reference No. 09/078/07). A written consent was taken from the patients prior to data collection.

Patient who had urolithiasis in CT KUB and had ultrasound reports done within one week were included in the study. Postoperative patients, patients with ureteric obstruction caused by other factors like retroperitoneal masses and pregnant women were excluded from the study. Data were collected and recorded in a proforma by a single radiologist.

The study parameters included demographic data, location and side of the urolithiaisis. The location included kidney (K), proximal ureter (PU), mid ureter (MU), distal ureter (DU), pelviureteric junction (PUJ), vesicoureteric junction (VUJ) and urinary bladder (UB). The side included right, left and both. CT KUB was performed on 160 slice Multidetector Canon Prime SP Aquilion CT Scanner. The scan ranged from diaphragm to ischium with patients lying in supine position. The exposure parameters were 120 kvp, 200-250 mAs, 750ms and 0.5 mm slice thickness. Three-dimensional reconstruction of the unenhanced CT image was reformed in coronal and sagittal projection and determination of location and side of urolithiasis was done. (Figure 1). Similarly, determination of side and location of urolithiasis was done from previous USG reports and recorded in proforma. (Figure 2)

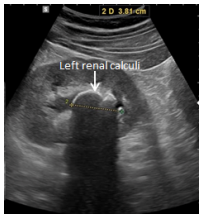


Figure 1: USG showing urolithiasis in left kidney

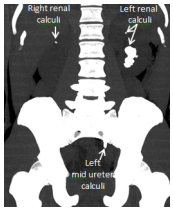


Figure 2: CT KUB (coronal section) of same patient showing urolithiasis in both kidney and left mid ureter

The data were entered into the excel sheet and was analyzed using statistical package for the social sciences version 16.0. Univariate analysis including frequencies and percentage of demographic data, location and side of urolithiasis in USG and CT KUB were calculated. Pearson Chi-square analysis test was used to determine the association between location of urolithiasis in USG and CT KUB where p-value <0.05 was considered statistically significant. The diagnostic accuracy of USG was determined by calculating sensitivity and specificity.

## RESULTS

A total of 92 patients with urolithiasis were evaluated with USG and CT KUB. Demographic data of the patients is shown in table 1. Urolithiasis was most common in 20 to 40 years (n=57, 62.0%) and least in >80 years (n=1, 1.1%). The proportion of male (n=56, 60.9%) were more than females (n=36, 39.1%).

**Table 1:** Demographic data of the patients

| Demographic data | Frequency (%) |
|---|---|
| **Age groups** | |
| 20-40 years | 57(62.0) |
| 41-60 years | 30(32.6) |
| 61-80 years | 4(4.3) |
| >80 years | 1(1.1) |
| **Sex** | |
| Female | 36(39.1) |
| Male | 56(60.9) |
| Total | 92(100) |

Urolithiasis was detected more commonly on kidney by both USG (n=45, 48.9%) and CT KUB (n=44, 47.8%). Some of the calculi that were undetected by USG were easily confirmed by CT KUB in various locations. This was found to be statistically significant (p<0.05) as shown in table 2.

**Table 2:** Location of urolithiasis in USG and CT KUB

| Location | USG n (%) | CT KUB n (%) | p-value |
|---|---|---|---|
| Absent | 18(19.6) | 0 | |
| K | 45(48.9) | 44(47.8) | |
| PU | 6(6.5) | 9(9.8) | |
| MU | 1(1.1) | 3(3.3) | |
| DU | 4(4.3) | 5(5.4) | |
| PUJ | 3(3.3) | 4(4.3) | |
| VUJ | 7(7.6) | 8(8.7) | |
| K+PU | 1(1.1) | 4(4.3) | |
| K+DU | 0 | 2(2.2) | |
| PUJ+VUJ | 2(2.2) | 2(2.2) | |
| K+PUJ | 2(2.2) | 4(4.3) | <0.001* |
| K+VUJ | 1(1.1) | 3(3.3) | |
| K+VUJ+PUJ | 0 | 1(1.1) | |
| K+PU+PUJ | 1(1.1) | 1(1.1) | |
| MU+VUJ | 1(1.1) | 0 | |

*Statistically significant

K=kidney, PU= Proximal ureter, MU= Mid ureter, DU= Distal ureter, PUJ= Pelviuteric junction, VUJ= Vesicoureteric junction

Urolithiasis was more common on right side in both USG (n=40, 43.5%) and CT KUB (44, 47.8%) followed by left side in USG (n=21, 22.8%) and bilateral in CT KUB (n=26, 28.3%) as shown in table 3. Furthermore, sensitivity of USG compared to CT KUB was 83.7% and specificity of 100% respectively.

**Table 3:** Side of Urolithiasis in USG and CT

| Side | USG, n (%) | CT KUB n (%) |
|---|---|---|
| No | 18(19.6) | 0 |
| Right | 40(43.5) | 44(47.8) |
| Left | 21(22.8) | 22(23.9) |
| Both | 13(14.1) | 26(28.3) |

## DISCUSSION

Urolithiasis is one of the major diseases of the urinary tract. It may cause urinary tract obstruction, infection, sepsis and even leads to renal failure. Thus, timely diagnosis and treatment is important to override the complications and maintenance of renal function. Imaging techniques play an imperative role in the initial diagnosis, treatment planning and in post-treatment follow-up. The emerging diagnostic innovations like USG and CT KUB are connecting the breach between radiologist and urologist. Thus, this study was carried out to compare diagnostic efficiency between USG and CT KUB for detection of urolithiasis.

Our study showed that urolithiasis was more common in 20 to 40 years of age group. This result takes support from previous studies who had reported that the renal stones were most common in middle aged people.[9–13] This can be explained as people from this age group are engaged more in laborious work, resulting in less fluid intake and subsequently higher rate of dehydration. Further, occupational stress, unhealthy lifestyle and changes of endocrine hormones may also add to this climbing shift.[13] While>80 year age group showed least prevalence in our study. This may be due to lower life expectancy in Nepal and people with renal stones dying at a younger age. Additionally, urolithiasis has been associated to a number of medical conditions like obesity, diabetes mellitus, hypertension, chronic kidney, and cardiovascular diseases.[10]

In the present study urolithiasis was found more common in male which is in agreement with the previous studies.[10–12,14–17] The reason for this preponderance might be due to the impact of sex hormones. There is increase in oxalate excretion and deposition of calcium oxalate in the kidney due to effect of androgens in males.[16] Likewise, more prominent muscle bulk in males leads to generation of more metabolic waste products which can predispose to stone formation. The complicated urinary tract in males, low urine pH and reduced renal function mediators may also predispose to stone formation.[11,14,16] On contrary to the finding of our study, Koirala et al.[18] in his study found that females have more stones in comparison to males.

In our study highest frequency of urolithiasis was seen in kidney in both USG and CT KUB which is in accordance with various studies in literature.[11,12,14,17] The crystallization of the solute out of urine to form calculi might be the reason for this occurrence. This may occur due to urinary stasis, low urine volume, diet containing high oxalate or high sodium, urinary tract infections, systemic acidosis, medications or cystinuria.[19] In contrast to our finding, few studies reported the urinary bladder with the highest frequency of stone in the urinary tract.[20,21] Further, we noticed that a lot of urolithiasis could not be detected by the USG, but they were easily detected by CT KUB. This result is in consistent with Alahmadi et al.[6] and Noble et al.[22] who reported that USG cannot detect many stones. This can be explained as USG is affected by factors like patient compliance, obesity, small calculi. Moreover, USG is highly operator dependent which limits its investigation.

Our study found majority of calculi in right side in both USG and CT KUB which is consistent with findings from previous studies.[5,11] The likely reason behind right sided predominance could be due to sleeping on the right decubitus position. This is supported by study done by Chuang et al.[23] who observed that sleep posture is linked to unilateral formation of calculi. However many studies have shown no significant difference in urolithiaisis distribution between right and left side.[14,24,25] On contrary, Danjem et

al.[12] have shown that it is more common in left than right side.

In our study USG was 83.7% sensitive with specificity of 100% for detecting urolithiasis compared to CT KUB. This is in agreement with previous studies.[5,26,27] However, a wide range of sensitivities and specificities for USG have been reported, in literature.[4,25,28,29] This could be because USG diagnosis is affected by number of factors like small stone size, presence of hydronephrosis, stones abutting renal sinus fat, and vascular calcifications, as well as experience and knowledge of the upper urinary tract anatomy and the presence of bowel gas, which may obscure the urolithiasis.[4,30]

This study bears some limitations. The accuracy of ultrasound could be affected as calculi might have moved or changed in size during the interval between the diagnosis by USG and CT KUB. This study can be further extended to multiple centers with larger sample size and including multiple investigators to get a result which could be generalized.

**CONCLUSIONS**

It was observed that CT KUB is better imaging modality as compared to USG for diagnosis of urolithiasis because USG have poor sensitivity and high specificity. Therefore, use of CT KUB over USG can lead to timely diagnosis and treatment of urolithiasis and prevent associated complications.

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