ADDIS ABABA UNIVERSITY
COLLEGE OF MEDICINE AND HEALTH SCIENCES
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF RADIOLOGY

ASSESSMENT OF THE SENSITIVITY OF CT SCOUT RADIOGRAPH IN DETECTING URETEROLITHASIS ON NON-CONTRAST COMPUTED TOMOGRAPHY AS GOLD STANDARD,TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA,ETHIOPIA

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A FINAL RESEARCH PAPER SUBMITTED TO RADIOLOGY DEPARTMENT, COLLEGE OF HEALTH SCIENCE, ADDIS ABABA UNIVERSITY IN PREPARATION FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE POST GRADUATE STUDY IN RADIOLOGY.

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ABSTRACT

Introduction: Imaging plays an important role in the management of patients with urinary stone disease including initial diagnosis, treatment planning and follow up after medical therapy or urologic interventions. There is high variability in determining the choice of imaging protocols to observe progression of ureteral calculi for follow up. Noncontract computerized tomography for kidney ureter bladder (NCCT or CT KUB) scan has become widely accepted as gold standard and imaging study of choice for examining patients with acute flank pain. Scout view is always included as an essential part of NCCT. Some have proposed using scout view in management of ureteric calculi owing to its reduced radiation dose. Therefore, our study aim was to assess the sensitivity of CT scout radiography for detecting ureteral stones in patients with ureterolithiasis diagnosed on NCCT as a standard reference.

Methodology: Institutional based cross-sectional prospective study was conducted over an 11month (between September 30, 2017, and August 7, 2018) study period in Radiology department of TASH. A total of 86 patients who has undergone NCCT KUB were assessed for initial eligibility. Out of these, 58 were enrolled in this study which had ureteric calculi.

Location of the stone, size, density characteristic of the stone was determined from the NCCT KUB. Moreover, the visibility of that stone on scout radiograph was documented by a radiologist who was blinded for NCCT findings. The sensitivity, positive and negative predictive value of the scout films were calculated in reference to NCCT. Before statistical analysis, data was first checked manually for completeness and then coded and entered in to SPSS and analyzed using SPSS version 21.0. Level of significance ($p < 0.05$) and CI (95%) was employed. Results were presented in graphs, charts and texts.

Results: A total of seventy-six calculi were analyzed from fifty-eight patients who had ureteric calculi. Of the 76 total ureteric calculi stones, 37(48.7%) were definitely visible on the scout radiograph, 34(44.7%) were definitely not visible, and 5 (6.6%) were indeterminate, which giving a sensitivity of 48.7 %. On the basis of stone location, the sensitivity of the scout view for stone detection was as follows: proximal ureter, 56%; mid ureter, 37%; distal ureter, 50%; and ureterovesical junction, 37%. On the basis of stone size category, the sensitivity of the scout view for stone detection was as follows: < 4mm, 33%; 4-8 mm, 48%; and >8 mm, 52% as well the mean size of stones visible on the scout view was 8.36 mm. Mean HU visible on scout was 779 HU in the range 344-1601HU.

Conclusion: *In our study, 48.7% of ureteral stones were visible on the often overlooked routine CT scout radiograph. Therefore, the CT scout view should be encouraged and reported routinely in conjunction with CT KUB as a baseline for treatment follow up. It may avoid the need for obtaining a conventional radiograph at the time of diagnosis. So, we will postulate, it is good practice to report if the calculus is visible on the scanogram of the study to establish if a plain KUB radiograph is sufficient for follow up purposes rather than a higher radiation CT study.*

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ABBREVIATIONS AND ACRONYMS

NCCT - Non-contrast CT.
KUB - kidney-ureter-bladder abdominal radiography.
IVP - intravenous pyelography.
PACS - picture archiving and communication system.
CHS - College of Health Science.
US - Ultrasound.
TASH - Tikur Anbessa Specialized Hospital.
ALARA - As low as reasonably acceptable.
SPSS - Statistical Package for the Social Sciences
ESWL - Extracorporeal Shock Wave Lithotripsy
VUJ - Vesico Ureteric Junction
UPJ - Uretero-Pelvic -Junction
EAU-AUA - European Association of Urology (EAU) - American Urological Association
HU - Hounsfield unit
KVp - kilo voltage
MAs - mile ampere second
MM - mile meter
CT - Computerized tomography

CHAPTER ONE: INTRODUCTION

1.1 Background

By definition, urolithiasis refers to the presence of calculi anywhere along the course of the urinary tracts. Ureteric calculi or stones are those lying within the ureter, at any point from the uretero-pelvic -junction (UPJ) to the ureterovesical junction (UVJ). The classical clinical symptoms of ureteric stones are colicky abdominal pain with associated nausea, vomiting, and hematuria. The location of referred pain associated with ureteric calculus depends on the location of the stone in the course of ureter.

Urolithiasis is a universal problem affecting patients across geographical, cultural, and racial boundaries. The prevalence of urinary calculi is estimated to be 1-5% worldwide, 2-13% in developed countries and 0.5-1% in developing countries, however has progressively increased in the industrialized nations, and a similar trend is being observed in developing countries due to changing social and economic conditions [1-2]. The lifetime prevalence of ureteric calculi is relatively high, occurring in approximately 12% of men and 7% of women. Approximately 1.2 million Americans are affected annually, and it is estimated that up to 14% of men and 6% of women will develop stone disease during their lifetime [3, 4]. The prevalence of urolithiasis in black African is considered to be lower than other parts of the world. A study in Nigeria found a prevalence of 6.3 per 100000 populations, with a male to female ratio of 4:1[5]. A hospital-based study in TASH shows that urolithiasis is one of the major reasons for urologic admissions in TASH accounting for 22.2 % [6]. The rising prevalence of urinary stone disease has had a significant impact on the healthcare system due to the direct cost involved and the morbidity associated with complications such as infection and chronic renal failure.

1.1.1 Normal anatomy

The ureter is a muscular tubular structure that measures 25 cm in length and drains via peristalsis. It is typically subdivided into: proximal (including the renal pelvis between the uretero-pelvic junction and the iliac vessels), mid (between the iliac vessels and pelvic brim distal (between pelvic brim at anterior iliac spine process level and vesico-ureteric junction) and at vesico-ureteric junction [7]. The ureter passes infero medially from the renal hilum (Figure 1), where the renal pelvis lies behind the main renal vein and artery. The proximal two thirds (proximal and middle) of the ureter crosses within the abdomen, and lies anterior to the psoas muscle, which separates the ureter from the underlying tips of the transverse processes of the lumbar vertebral bodies from L2 to L5.

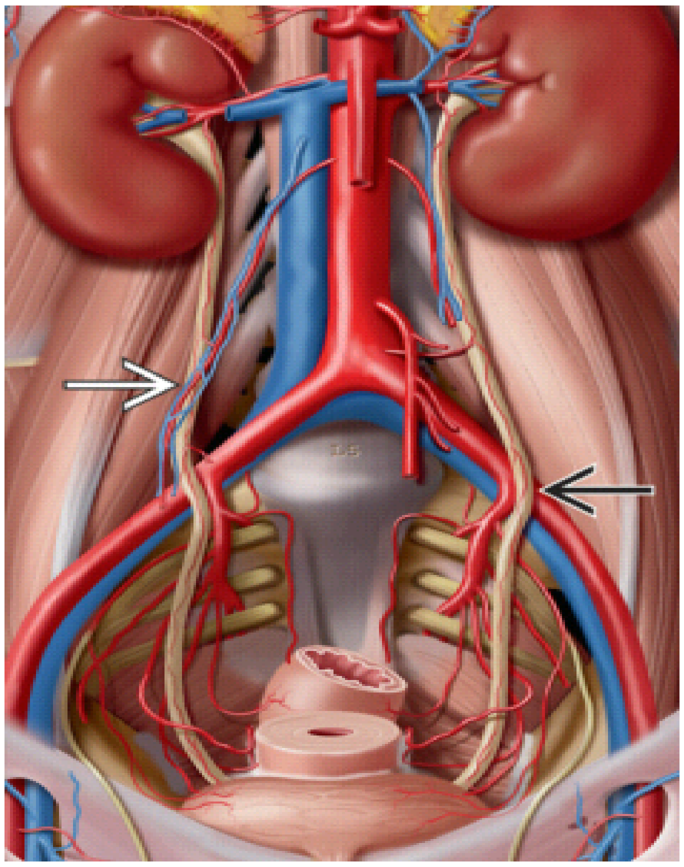


Figure 1 **illustrates the normal course of the ureters, which extend from the renal pelvis to the urinary bladder. The ureters travel along the psoas muscle, passing posterior to the gonadal vessels St. Near the pelvic brim, the ureter passes over the iliac vessels** (***Adopted from Diagnostic Imaging: Genitourinary, Third Edition***)

It is important to note that the gonadal vessel crosses anteriorly to the ureter in the middle third. The abdominal ureter becomes the distal or pelvic ureter as it passes over the pelvic brim. The distal pelvic ureter runs over the lateral wall of the pelvis, crosses anterior to the common iliac artery and then posterior to the superior vesical branch of the internal iliac artery.

At the VUJ, the intra vesical portion of the ureter passes obliquely through the muscular wall to help produce a valve like arrangement to prevent urinary reflux [7]. There are three recognized locations where stones may be impacted due to normal anatomical narrowing of the ureter: the pelvi-ureteric junction; at the level ureter crosses the pelvic brim; and the VUJ.

1.1.2 Imaging of urolithiasis

Imaging in urolithiasis has evolved over the years due to technologic advances and a better understanding of the disease process. Nowadays, plenty of different imaging modalities are available for the evaluation of patients with urolithiasis, with specific pros and cons related to costs, radiation exposure, and diagnostic accuracy of each technique. It plays an important role in the management of patients with urinary stone disease including initial diagnosis, treatment planning and follow-up after medical therapy or urologic interventions.

1.1.2.1 CTKUB

Non contrast CT of kidneys, ureters and the bladder (NCCT KUB) has become widely accepted as the imaging study of choice for examining patients with acute flank pain and is now the 'gold standard' for the diagnosis of ureteric stones in the context of acute loin pain [8]. The reported sensitivity and specificity of unenhanced helical CT in diagnosing ureterolithiasis is 95-98% and

96-100%, respectively [9]. It can also identify extra urological causes of flank pain in about 10-30% of patient.

The most direct CT sign for ureterolithiasis is a stone within the ureteral lumen, with proximal ureteral dilatation and a normal distal caliber [9, 11]. Ureteral dilatation may be absent in a small number of cases of ureterolithiasis. Dalrymple et al [10] reported that in patients presenting with acute flank pain, ureteral stones are most likely to be lodged in the proximal (37%) and distal (33%) portions, as opposed to the mid ureter (7%) and the ureterovesical junction (18%). The diagnosis of ureterolithiasis can be confirmed on the basis of several secondary signs at CT as well. The most reliable signs include hydroureter, hydronephrosis, perinephric stranding, periureteral edema, and unilateral renal enlargement [11, 12]. Perinephric fat stranding and dilatation of the intrarenal collecting system have a positive predictive value of 98% and a negative predictive value of 91% for the detection of ureteral calculi.

CT is fairly accurate in helping predict stone composition, the attenuation values of urinary calculi at 120 kV usually fall within certain ranges: uric acid, 200-450 HU; struvite, 600-900 HU; cystine, 600-1100 HU; calcium phosphate, 1200-1600 HU; and calcium oxalate monohydrate and brushite, 1700-2800 HU[13]. High CT attenuation makes stones easy to differentiate from other urinary tract filling defects such as tumors, hematoma, fungus balls, or sloughed papilla.

Current European Association of Urology (EAU) - American Urological Association(AUA) Guidelines on the Management of Ureteral Calculi recommend that medical expulsive therapy (MET) should be considered as first-line treatment for most patients with ureteral stones whose symptoms are controlled.[14] Patients with suspected ureteric calculi often undergo repeated imaging studies, and patients with urinary calculus disease are at high risk for recurrence .There is high variability in determining the choice of imaging protocols to observe progression of ureteral calculi in follow up. The treatment of some patients with ureteral calculi may require serial imaging studies. This has been traditionally performed with abdominal radiography. Conventional abdominal radiographs have been used for many years to detect ureteral stones in patients with acute flank pain. However, when interpreting abdominal radiographs bowel, costal cartilage, and bone which often obscure the regions of ureters. In addition, many structures such as phleboliths, arterial calcifications, calcified lymph nodes, and calcified pelvic or abdominal masses may mimic ureteral calculi in appearance and location. Previous studies have shown that the sensitivity for revealing calculi on radiography was as high as 90% [15, 16]. However, in a recent study Levine et al. [17] showed that the sensitivity of abdominal radiography for revealing ureteral calculi is considerably lower. In this study, only 40% of CT diagnosed ureteral calculi were revealed on abdominal radiography when the radiographs were interpreted independently of CT scans. However, the detection rate improved to 59% if abdominal radiographs were interpreted in conjunction with axial CT scans. Some studies recommend scout view CT to identify calculus and as per their study calculus is visualized in 50% of the case [18].

1.2 Statement of the problem

CT KUB has emerged as the most sensitive and specific modality for detecting ureteral calculi. Consequently, CT is frequently used in the initial diagnosis of ureteral calculus disease and in the follow up of known ureteral calculi before and after treatment[19].

Once ureterolithiasis is diagnosed, decisions concerning the treatment of patients with ureteral calculi are based on several factors, the most important of which are stone size, location, and stone migration. In some patients, radiologic follow up is essential for determining whether a calculus has passed or migrated more distally; however, it is imperative that the follow up imaging study be able to consistently and reliably identify the calculus. Although repeated CT examinations would be most effective, they are relatively expensive and repetitively expose the patient to high doses of radiation. However, the definitive diagnosis of stone passage is difficult. Therefore, it is common practice to use serial plain abdominal radiographs (KUB) for baseline and follow up investigations to track the passage of stones for patients with known ureteral stones.

Even though, digital CT scout radiographs are produced routinely to assist in positioning patients before axial images are acquired, the scout view is often overlooked and deemed not to be of diagnostic quality and value. However it has been proposed that careful study of the scout radiograph may identify the calculus and negate the need for a baseline plain abdominal KUB radiograph [20].
In our institution, only a small number of patients who had ureteric calculi diagnosed on NCCT had baseline plain radiographs at the same clinical presentation. The timing of the baseline plain KUB radiographs taken differs depending on varying urologists' clinical practices. This has posed a real clinical dilemma as the absence of calculi on follow-up plain KUB taken several days after the initial presentation could be due either to the successful passage of calculi or to a radiographically occult stone. As a consequence, repeat CT KUB is occasionally performed in order to clarify the position of the calculi. If scout radiographs have sufficient sensitivity to detect calculi, we will propose that it should be reported in conjunction with all the CT KUB examinations and that helps to decide whether a stone can be followed by plain KUB radiography alone or need a repeat axial NCCT. In our observation , use of extracorporeal shock-wave lithotripsy (ESWL) for removal of stones is increased in TASH, and urologist use plain KUB in treatment planning when ESWL is considered, since it allows to determine the radio-opacity of the stone and therefore to confirm the possibility of localize the stone during the treatment. In this context, study shows that additional plain KUB can change the surgical management of up to 17% of stone patients initially diagnosed with NCCT [22].We will postulate that if scout radiograph has a good sensitivity in detecting ureteral calculi, it will be use for localizing during ESWL.

1.3. Significance of the study

This study aims to determine the sensitivity of scout view of CT in detecting ureteric stone and decide if KUB radiograph will be adequate for follow up imaging of ureteric calculus. Knowing the sensitivity of CT scout radiograph also important because can be used as a baseline study in those patients requiring subsequent imaging and in management of ureteric calculus owing to its reduced radiation dose.

This study also will provide information about previous work on the topic, which remains uncertain about sensitivity and the clinical implications of scout radiograph. It avoids the need for obtaining a conventional radiograph at the time of diagnosis. So, we will postulate, it is good practice to report if the calculus is visible on the scanogram of the study to establish if a plain KUB radiograph is sufficient for follow up purposes rather than a higher radiation CT study.

CHAPTER TWO: LITERATURE REVIEW

The increased use of CT KUB in the investigation of acute loin pain has prompted the possible inclusion of CT scout radiographs as part of the management algorithm. There are several previous studies looking at the sensitivity of the scout view in detecting ureteric calculi. Previous studies have reported CT scout films to have sensitivity as low as 17% [12]. However, these studies were done using printed films and lower resolution CT tomograms. With the widespread use of electronic viewing software, which allows films to be easily magnified, the black white scale to be adjusted or inverted, as well as many other tools, it seems that the sensitivity of tomograms have improved considerably.

In 1999, Chu et al. [20] studied 215 patients with ureterolithiasis diagnosed on NCCT retrospectively in order to determine the sensitivity and value of digital CT scout radiography with detection of ureteral stones. They revealed that 49% of ureteral stones were visible on the routine CT scout radiographs and concluded that CT scout radiography could be used as a baseline study in patients requiring follow-up radiographs. It has been also suggested that the less dense stones can be detected by using low peak kilovoltage techniques. A lower peak kilovoltage will cause a higher percentage of photoelectric reactions between X-rays and the calcium within the stones. They recommended the use of 80 kVp and 200-300 mAs to improve the detection rate.

Assi et al [25] found that CT scout radiography had an overall sensitivity of 47% for revealing ureteral calculi in 60 consecutive patient's .In this study; they recommend that a statement be dictated in every CT report as to whether calculi can be seen on CT scout radiography. This would ensure that follow up images are obtained with the appropriate technique. Additionally, a statement could be made in the CT report about stone location on the CT scout radiograph relative to anatomic landmarks, such as osseous structures.
Ege et al [11] looked at a group of 111 patients, and showed that 40% of all stones were visible on CT scout radiographs and 52% on plain radiographs. These results support the use of CT scout radiography as a baseline study, especially for big stones. Johnston et al [18] showed that the sensitivity of scout radiographs was 47% when 108 ureteric calculi were assessed.

The more recent series by Yap et al have shown that the sensitivity of CT scout view is between 42% and 52% [26]. It also found that the sensitivity for the detection of stones, 4mm in diameter by CT scout radiographs to be 31%, and based on location is 43% when the stones are located in the upper tract (intrarenal and upper ureter combined) and 35% when located in the distal ureter and vesico-ureteric junction.

Bell reported the mean attenuation of a series of calculi detected on CT as 305 HU with a range of 221 to 530 HU. Ureteral calculi are usually geometric or oval in shape and are seldom completely round. This feature is useful in differentiating stones from phleboliths [27]. The positive predictive value of geometric shape in identifying a calculus has been reported as 100%

The patient with known urolithiasis and recurrent symptoms also presents a challenge. In this setting, the likelihood of urolithiasis as the cause of flank pain is higher [28], but repeated NCCT raise a concern about excessive radiation exposure. Katz et al [21] examined the issue of radiation exposure associated with repetitive NCCTs in this setting. Further, if the patient has persistence of symptoms from documented stone and repeat imaging is contemplated, a limited NCCT of the area of the stone through the bladder could be considered if stone passage is the main question. Alternatively, if the stone can be seen by KUB, a repeat KUB might provide useful information at a much lower dose. KUBs can be used to follow stones that are visible on the scout radiograph of a CT [28]. Stones that are not visible on the CT scout radiograph may not be visible on a follow up KUB.

CHAPTER THREE: OBJECTIVES

3.1 General objective

- To assess the sensitivity of CT KUB scout radiography for detecting ureteral stones in patients with ureterolithiasis diagnosed on CT KUB as a standard reference.

3.2 Specific objectives

- To assess the effect of Mean Housefield unit (MHU), location and size in the sensitivity of detection of calculi on scout radiographs.

CHAPTER FOUR: METHODS AND MATERIALS

4.1 Study area

The study was conducted at TASH, department of Radiology College of health science, Addis Ababa Ethiopia. TASH is Ethiopia's largest general public and referral hospital TASH offers diagnosis and treatment more than 800,000 patients per a year. There are different units and clinics that provide specialized service for clients. Among these, radiology department is the one which serves 1500-2000 patients monthly.

4.2 Study design and period

Institutional based cross-sectional prospective diagnostic study was conducted over 11 month period (between September 30, 2017, and August 7, 2018).

4.3 Population

4.3.1 Source population

All adult patients who underwent CT KUB for known or clinically suspected urolithiasis, based on the presence of at least one of the following symptoms: flank pain and hematuria.

4.3.2 Study population

-All adult patients with the diagnosis of ureteric stones on CT KUB.

4.3.3 Inclusion and exclusion criteria

4.3.3.1 Inclusion criteria

- All patients (≥15 years) who had ureteric stones on CT KUB.
- Patients with ureteral stones and concomitant renal stones.

4.3.3.2 **Exclusion criteria**

- Those patients who diagnosed based on secondary sign of ureteric stone with no visible stone on NCCT.

4.5. Measurement and Data collection

4.5.1. Sample size determination

Fifty eight adult patients with the diagnosis of ureteric stones on CT KUB were included as per inclusion criteria in the study.

4.5.2. Sampling Method

Among 86 patients who underwent CT KUB for known or clinically suspected urolithiasis, convenience sampling method was used to select study participants, accordingly 58 were selected from the total patients satisfying the inclusion criteria.

4.6. Data collection Procedure

We screened our radiology department CT registries books and ID number of all patients who underwent CT KUB for the clinical reasons of suspected or with diagnosis for urolithiasis in the study period was recorded. Using the patient ID number, the patients' CT reports and images were then reviewed retrospectively using the PACS (picture archiving communication system). All clinical data including patient's age, gender and clinical indication on the CT reports were recorded.

4.6.1. Materials

All CT examinations were performed using a Hi Speed Advantage scanner (General Electric Medical Systems, Milwaukee, WI) a dedicated protocol with 5.0-mm collimation and 1.0 pitch (120-140 kVp, 120-140mA). CT was performed with no oral or intravenous contrast medium administered. Scanning was performed from the lower chest to the symphysis pubis, with images reconstructed at 5.0 mm intervals. The scout radiographs were obtained using the manufacturer's programmed default settings of 140kVp and 80 mAs. The anteroposterior CT scout image was obtained from the level of the xyphoid process to the level of the lesser trochanter before the axial CT sections on each patient and exported to soft copy as DICOM image. The window and level settings were individually adjusted for each patient.

4.6.2 Image interpretation

Based on the previous published criteria which are described by Smith et al, urolithiasis on CT KUB defined as the presence of a high-density structure within the ureter lumen [11]. Once the ureteric calculi were identified on CT using a PACS (picture archiving communication system) workstation, the scout radiographs were viewed on RadiAnt DICOM viewer for each patients by one body imaging radiologist, who was blinded to all patient information, including the final radiological diagnosis. The scout radiograph images was reviewed in terms of stone visibility along the ureteric course (classified as visible, not visible and indeterminate) and location (proximal, middle distal and at VUJ).

All ureteric calculi were recorded in terms of location, size and mean Hounsfield unit. Calculi were measured in an axial plane on CT KUB; record the maximum transverse diameter was performed using the electronic caliper. The ureter is divided into proximal (between the uretero-pelvic junction and the iliac vessels), mid (between the iliac vessels and pelvic rim), distal (between pelvic rim at anterior iliac spine process level and vesico-ureteric junction) and at vesico-ureteric junction. Size and location are important factors in determining the treatment of stones that do not pass spontaneously. Stones larger than 5 mm and located in the proximal two-thirds of the ureter are more likely to intervention . The sizes divided into diameters of 4 mm, between 4 and 8 mm and above 8 mm. Stones smaller than 4 mm nearly always pass spontaneously; stones of 6 mm pass about half the time and those larger than 8 mm have less than a 50% chance of spontaneous passage and are more likely to need intervention

[18]. Locations of the calculi were record based on the above division recorded on coronal reconstructed images.

The MHU for each calculus were measured by placing the cursor over the calculus. Virtually all stones are identified as high-attenuation foci on CT images viewed on soft-tissue windows. Categorized as <400 HU, 400-600HU and >600HU.

4.7. Data Processing and Analysis

All data were checked for the completeness. Then the data cleared, entered, and analyzed using SPSS version 20 software. All ureteric calculi were recorded in terms of location, size and mean Hounsfield units for mean, SD and frequency. Sensitivity was calculated at the 95% confidence interval. Indeterminate results were considered as negative result and incorporated into the final analysis.

The socio demographic variables were presented using descriptive statistics .The mean size and Hounsfield units of the calculi not visible were compared with those definitely visible using t - test. A p-value, 0.05 is considered significant.

4.8 Ethical considerations

Ethical clearances were obtained from Addis Ababa University, college of health science department of radiology ethical clearance committee and TASH. All information obtained from the patients was kept confidential.

4.9 Operational Definition of the Terms

Computed Tomography (CT)

A CT scan combines a series of x-ray images taken from different angles to produce cross-sectional images of bones and soft tissue inside the body.

Scout radiograph

It is digital image automatically produced routinely during CT positioning of patients before axial images are acquired. It covers the KUB region from the xiphoid sternum to the pubic symphasis.

4.10 Dissemination plan

The finding of the study will be presented to Addis Ababa University, college of health science, department of radiology and disseminated to TASH. It will be presented and disseminated to all stakeholder, concerned bodies, and different professional association annual meeting. The final paper will be published on peer reviewed journal to be said scientific work.

5. RESULTS

From all 86 patients who had NCCT KUB for the indication of suspected ureteric stones in the study period, 58 were included in the study based on inclusion criteria with a completion rate of 67.4%.

Out of 76 total stones, 43 calculi were in the right ureter, 33 were in the left ureter and 18 were occurring bilaterally .Ten patients had two calculi each on the same side but at different locations.

5.1. Socio-Demographic Characteristics of Study Participants

A total of 58 patients who had ureteric stones on NCCT KUB were included, out of this 39 (67%) were males and 19(33%) were female as shown in Table 1. Male to female ratio was about 3:1.The mean age of our study population was 41.65 years (range 18-83 years). A higher prevalence of stones found in 25-34 years age group.

Table 1 **Socio demographic characteristics of the study participants, TASH, Addis Ababa Ethiopia,** 2018

Demographic data		Number (%)
Sex	Male	39(67.2%)
	Female	19 (32.8 %)
Age group in years	15-24	5 (8.62 %)
	25-34	15 (25.9%)
	35-44	14 (24.1 %)
	45-54	11 (19.0 %)
	55-64	9 (16.3 %)
	>65	4 (6.9 %)

5.2 Location, Mean Hounsfield units, sizes of calculi and sensitivity of scout radiographs

The location of the ureteral calculi on CT KUB was as follows: 32 in the proximal ureter, eight at the mid ureter, 20 at the distal ureter, and 16 at the ureterovesical junction as shown in the figure 2.

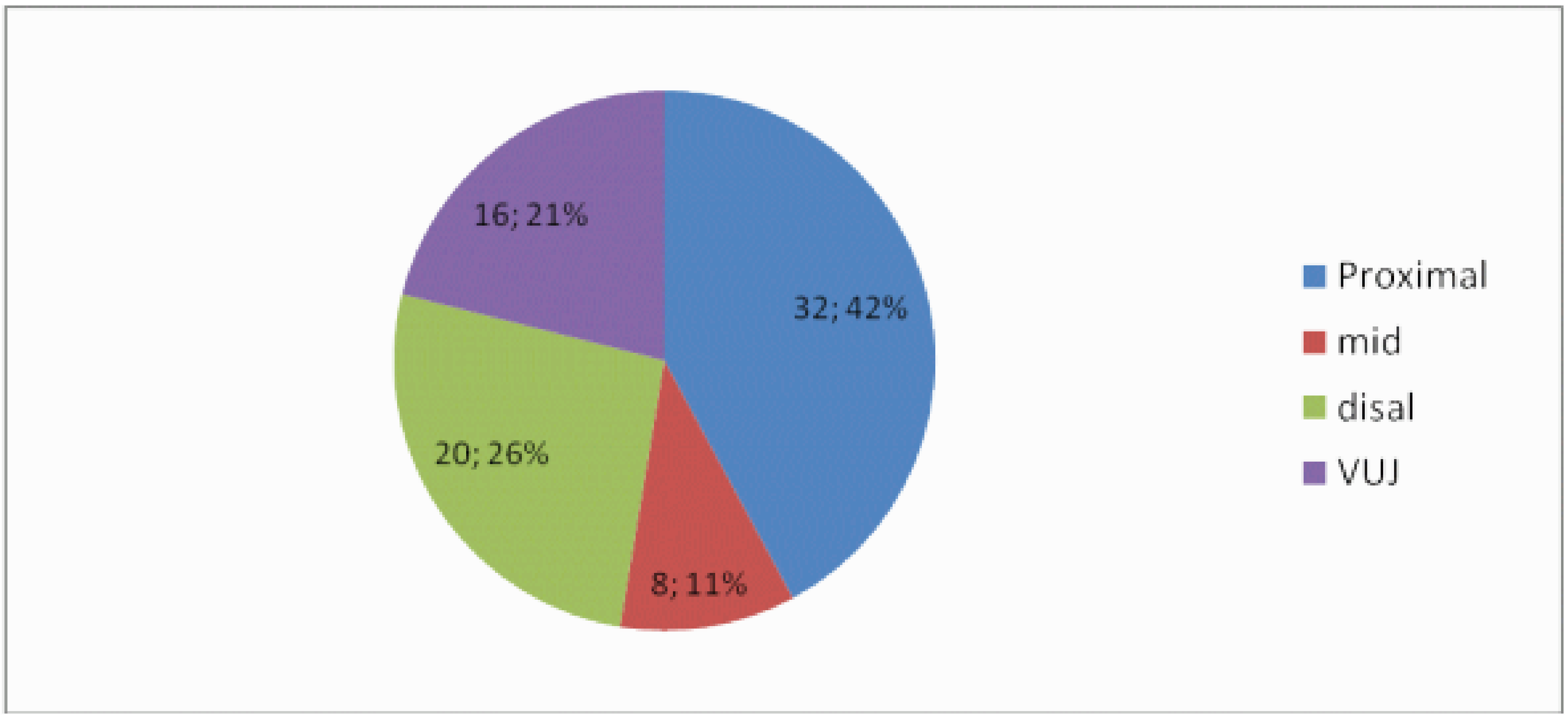


Figure 2 the frequency of calculi based on location on CT KUB

The mean size of calculi on the CT KUB was 7.6 mm with the range of (3.4-10.7mm). The minimum size of calculus is 3.4 mm.

Of the total, calculi 42 (55.3%) were in > 8mm category, 25 (32.9%) in the 4-8mm category and 9 (11.8%) in < the 4mm category as shown in figure 3.

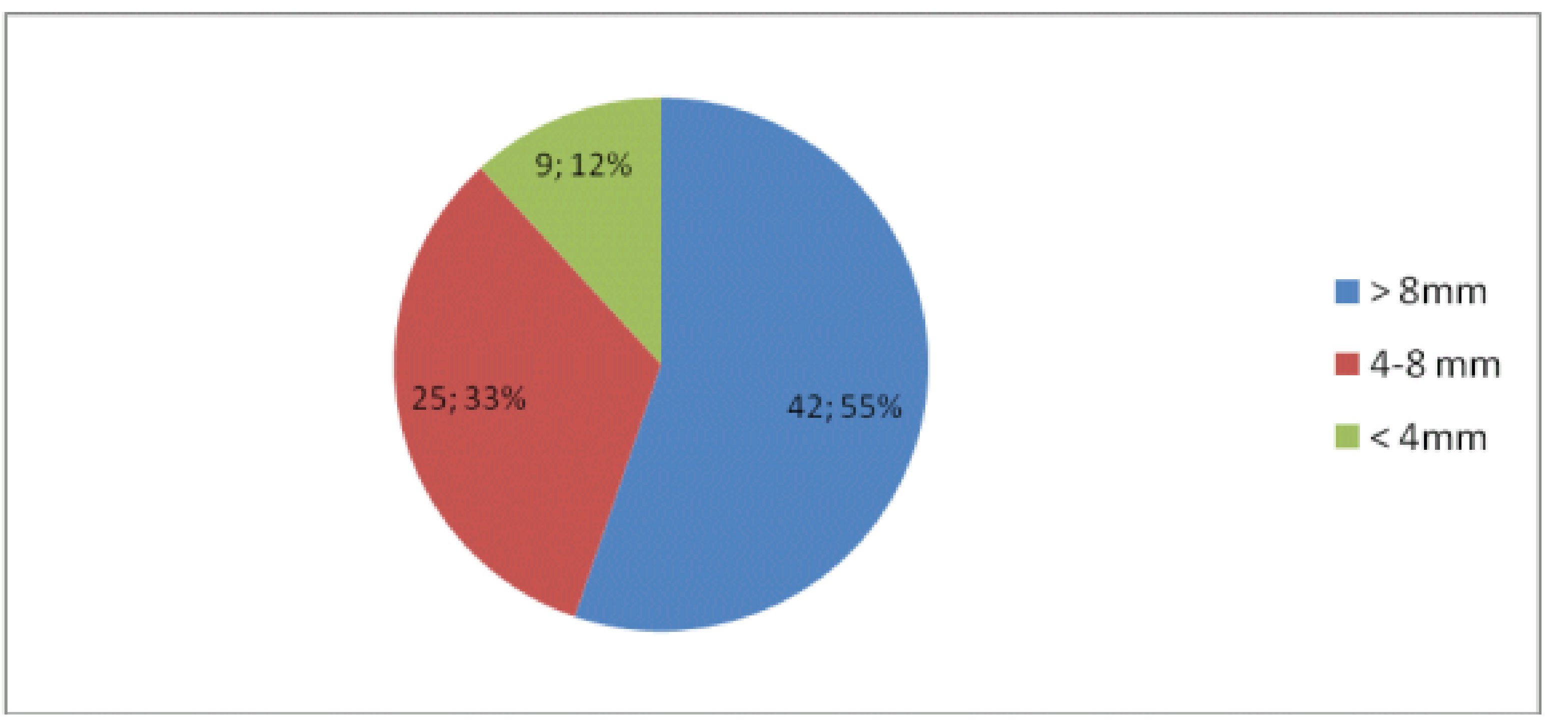


Figure 3 the frequency of calculi based on size on CT KUB

The mean of mean Hounsfield units of calculi was 746 HU with the range of (276-1601HU). Of the total, 33 (43.4%) calculi were in > 600 HU category, 33 (43.4%) in the 400-600 HU category and 10 (13.2 %) in the < 400 HU mm category as shown in figure 4.

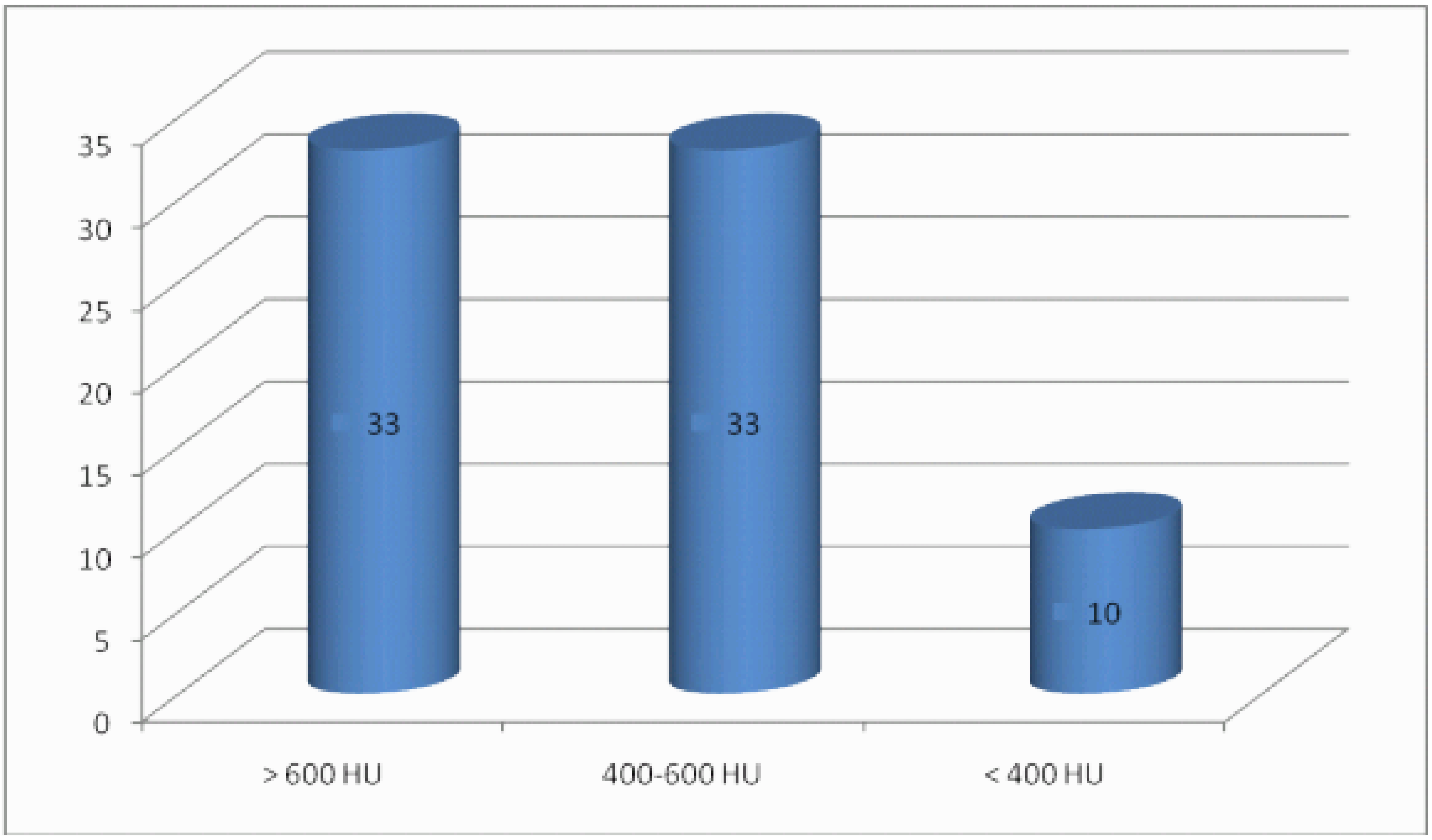


Figure 4 the frequency of calculi based on mean Hounsfield units on CT KUB

Of the 76 total ureteric calculi stones, 37(48.7%) were definitely visible on the scout radiograph, 34(44.7%) were definitely not visible, and 5 (6.6%) were indeterminate as shown in the figure 5, which giving a sensitivity of 48.7 %.

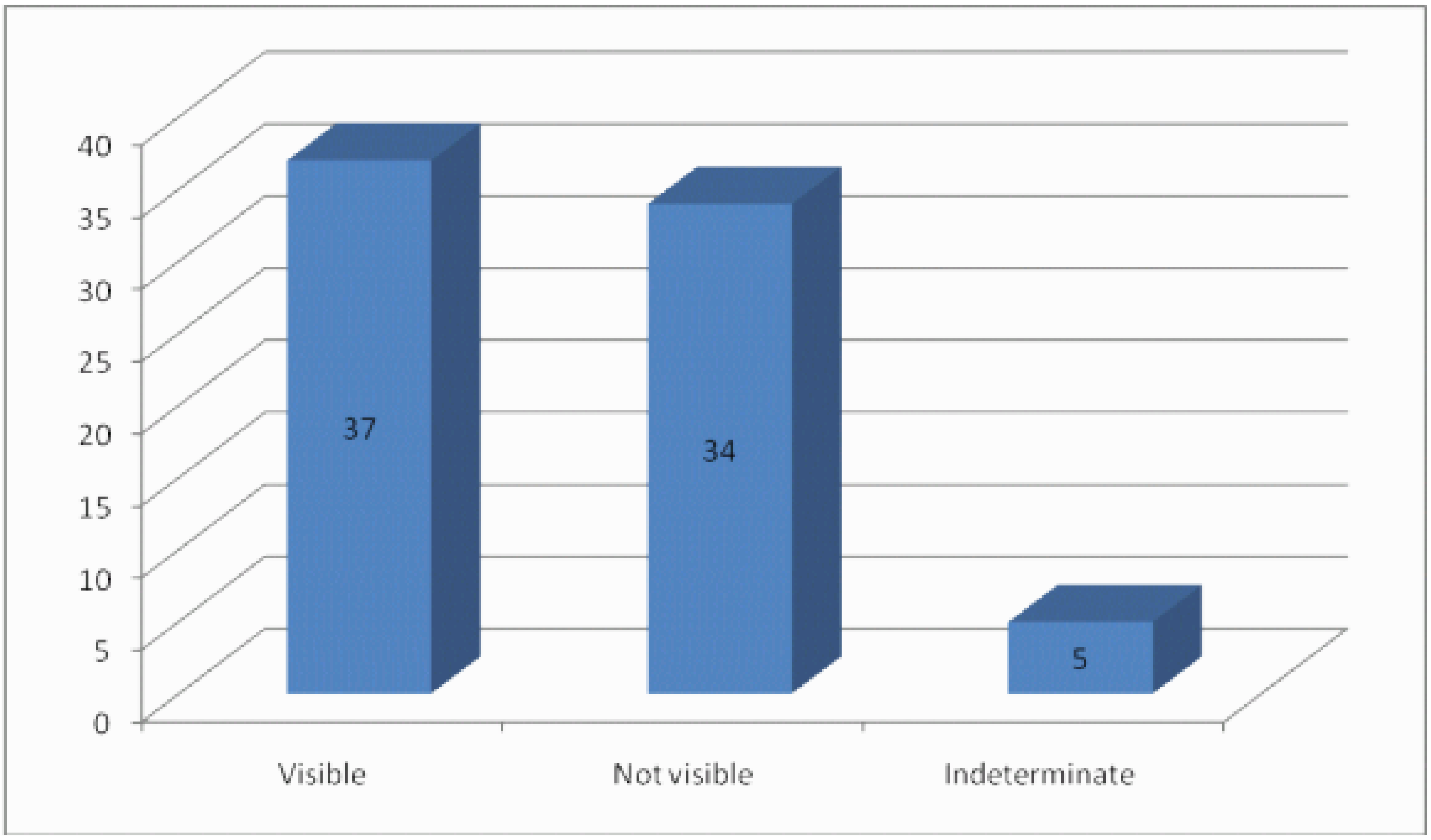


Figure 5 the frequency of calculi based on the visibility on the scout radiograph

Table 2 **Sensitivity of scout radiograph in detecting ureteric calculi on NCCT KUB as standard reference, TASH, Addis Ababa Ethiopia,** 2018

Visibility of calculi on scout radiograph	No of positive calculi on CT KUB (n=76)
Visibility (positive)	37
Non visible (negative)	34

Note: CT KUB was taken as gold standard reference demonstrated calculus in all patients' patients (100%) and indeterminate scout radiograph was considered as negative result.

Stone visibility versus stone size as shown in Table 3, the mean size of stones visible on the scout view was 8.36 mm and the mean size of stones not visible on the scout view was 3.7 mm.

Table 3 **Visibility of calculi on scout radiograph based on size of study subjects, TASH, Addis Ababa Ethiopia,** 2018

Visibility of calculi on scout radiograph	Diameter of the ureteric calculi		
	<4mm (n9)	>4-8 mm (n25)	>8 mm (n42)
Visible	3	12	22
Not visible	6	13	20

On the basis of stone location, the sensitivity of the scout view for stone detection was as follows: proximal ureter, 56%; mid ureter, 37%; distal ureter, 50%; and ureterovesical junction, 37%, as shown in Table 4.

Table 4 **Visibility of calculi on scout radiograph based on location of study subjects, TASH, Addis Ababa Ethiopia,** 2018

Visibility of calculi on scout radiograph	Location of ureteric calculi			
	Proximal ureter (n32)	Mid-ureter (n8)	Distal ureter (n20)	VUJ (n16)
Visible	18	3	10	6
Not visible	14	5	10	10

The visibility of calculi based on the mean Hounsfield units (HU) on the scout radiograph was summarized in table 5.

Table 5 **Mean Hounsfield units** (**HU) of visible and not visible calculi on scout radiographs, TASH, Addis Ababa Ethiopia,** 2018

	Mean HU visible on scout in HU	Mean HU not visible on scout in HU
Mean	779	456
Range	344-1601	232-678

6. DISCUSSION

Our results have shown that the sensitivity of CT scout radiographs in detecting ureteric calculi when interpreted in conjunction with the CT KUB is 48% which is comparable to previous published series. Among several previous studies about the sensitivity of the scout view in detecting ureteric calculi: Studies have shown sensitivity of the scout view in detecting ureteric calculi to be between 40 to 49% ,in Chu et al [20] study , 47% in Assi et al [25] study and 40% of Ege et al .[11] study . Johnston et al [18] showed that the sensitivity of scout radiographs was 47% and recent studies Yap et al have shown that the sensitivity of CT scout view is between 42% and 52% [26].

In our study, ureteric stones were found to be more common in men than in women and the higher prevalence of stone found in 35-44 years group which are in agreement with the study done in Tikur Anbessa Specialized Hospital (TASH) Addis Ababa, Ethiopia [6].

CTKUB is now the first line investigation for acute loin pain with clinical suspicion of urinary stone disease. The reported sensitivity and specificity of unenhanced helical CT in diagnosing ureterolithiasis is 95-98% and 96-100%, respectively [9]. In our study CT KUB was included in the initial investigation and taken as gold standard.

Most of the calculi located in the proximal ureter and the mid ureter is the least site. Our study showed the sensitivity of detecting ureteric stone based on location is greater when the stones are located in the proximal ureter as compared with the distal ureter/VUJ which was relatively comparable to study done by Yap et al[26]. In clinical practice, proximal ureter stones are more likely to need follow up, as they are likely to be treated if they are large and have the potential to cause obstruction if they migrate distally.

On the basis of stone size category, the sensitivity of the scout view for stone detection was as follows: <4mm, 33%; 4-8 mm, 48%; and >8 mm, 52%.The majority of calculi (98%) 5mm in diameter have been shown to pass spontaneously especially when they are in the distal ureter [28]. Based on this assumption, we calculated the sensitivity for the detection of stones, 4mm in diameter by CT scout radiographs to be 33%. CT scout radiographs are less sensitive when used as a baseline investigation for stones, 4 mm. However, this group of patients is unlikely to need intervention and hence follow-up imaging. As a result, the low sensitivity will not have a significant clinical impact and symptomatic management of these patients may be more appropriate.

The study found that calculi MHU in range of 344-1601 HU are more likely to be seen on the scout radiograph.

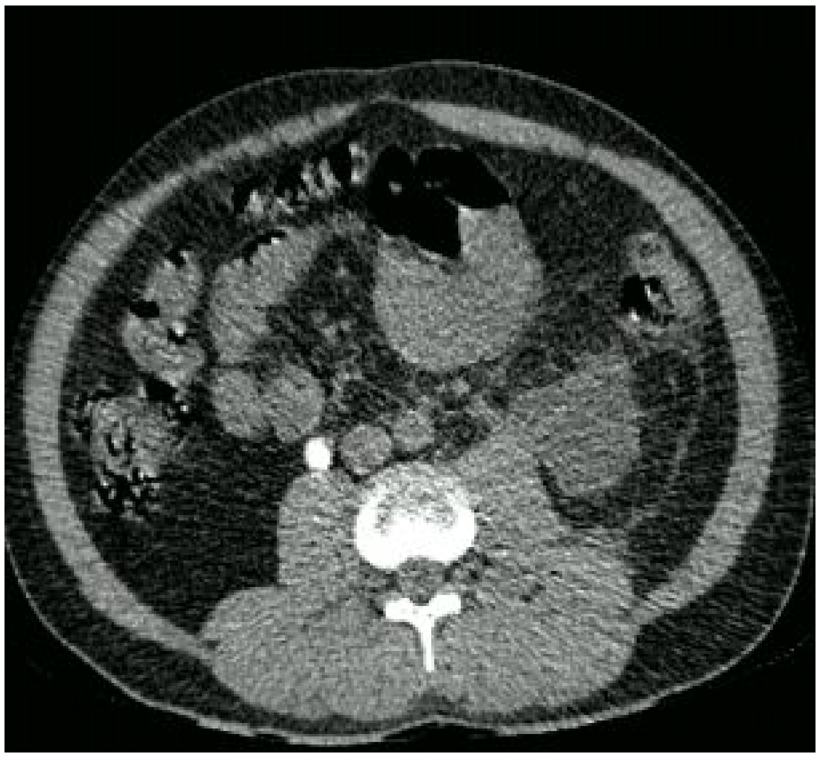
6.1 STRENGTH AND LIMITATION

6.1.1 Strength

This was the first study in the country focused on scout radiograph value; it will be used as base line for further studies.

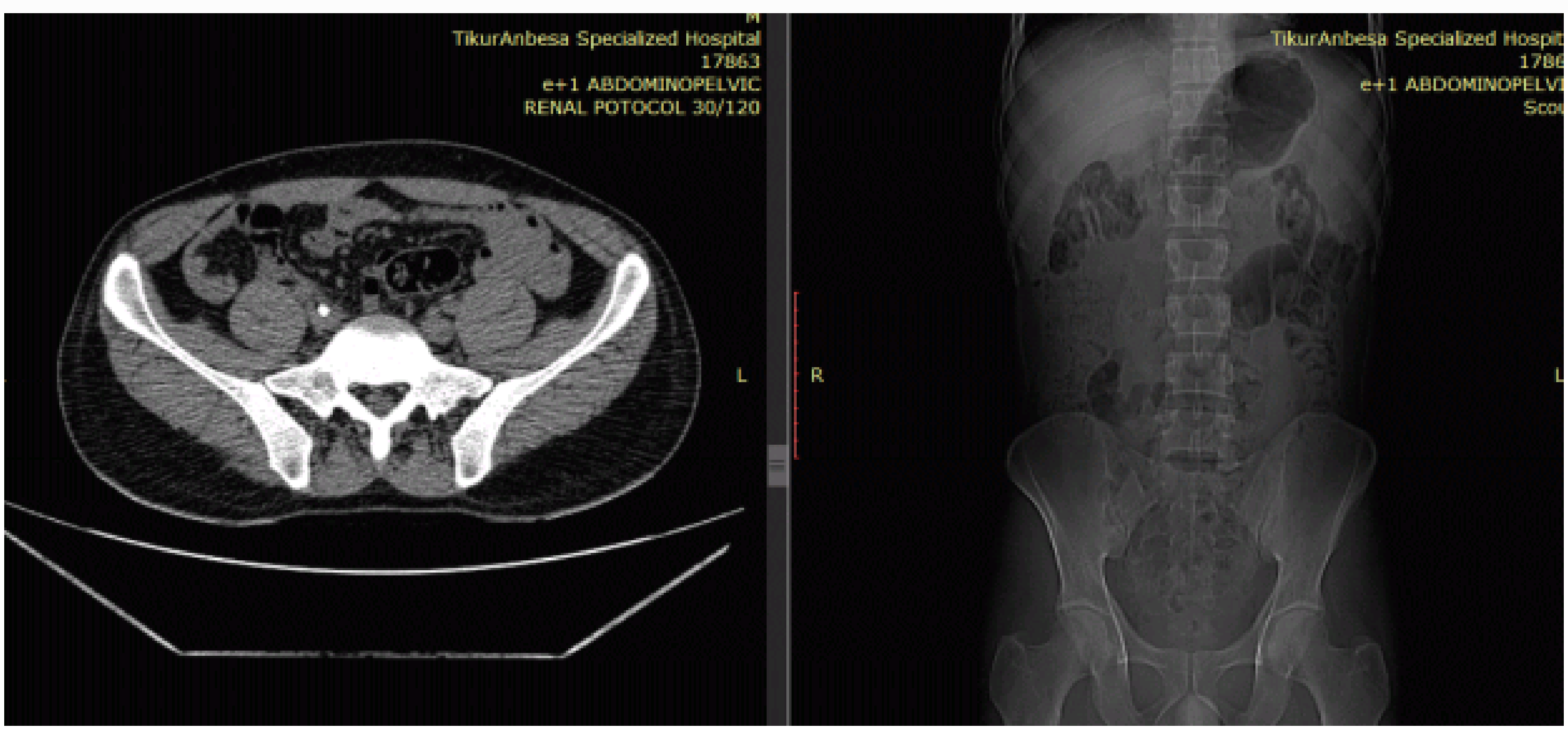
6.1.2 Limitation

- Small sample size and statically misinterpretation.
- We acknowledge that scout radiographs vary tremendously in quality depending on the manufacturer's settings on the different scanners and individual institution scanning protocols.
- Scout radiograph by nature has less sensitively due to its lower spatial resolution.



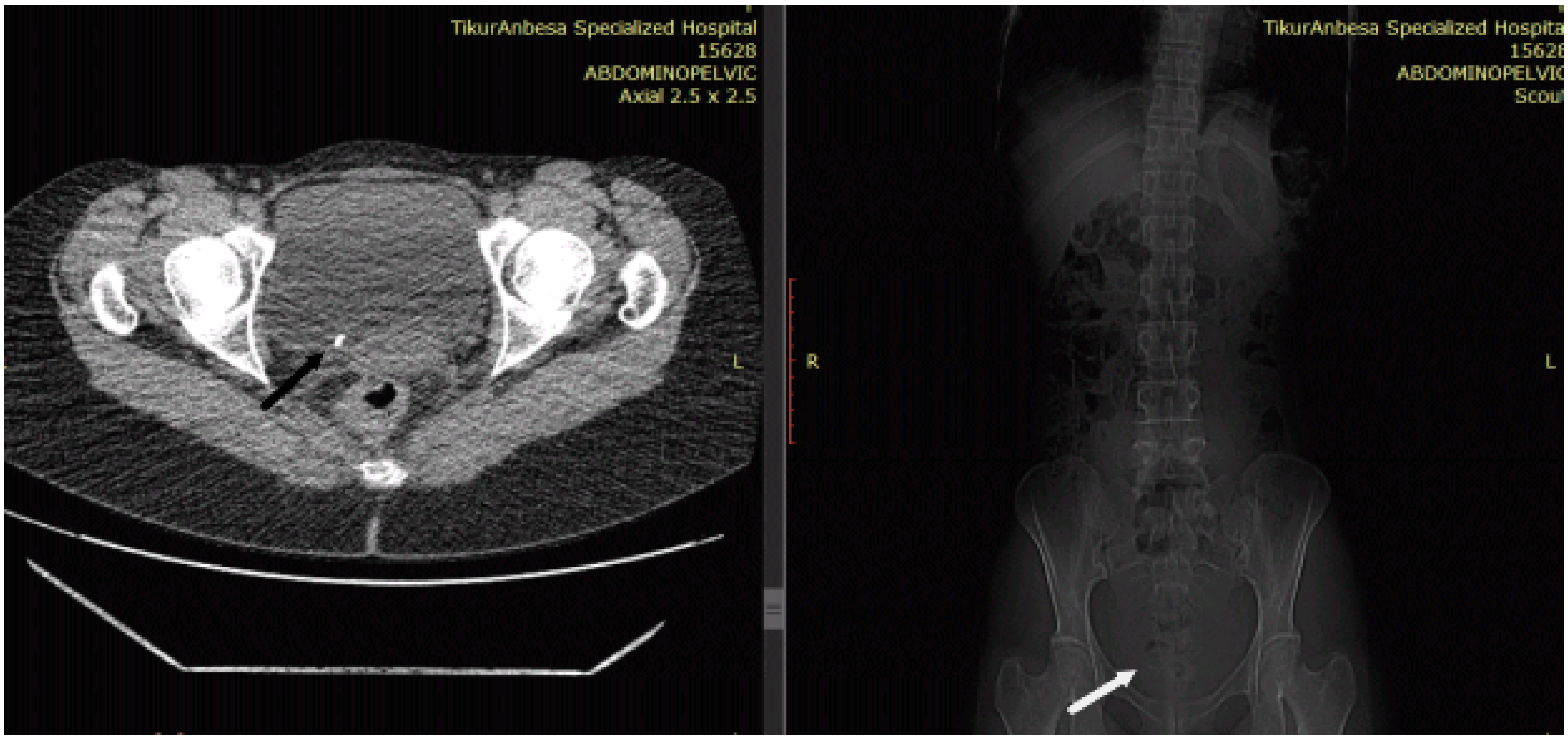
a. b.

Figure 6 calculus in mid ureter (white arrow) on (a) an unenhanced helical CT for kidney, ureter and bladder, is clearly visible (b) the scout radiograph.



a. b.

Figure 7 30 years old male patient with the diagnosis of left distal ureter non obstructive calculus which is seen in both axial NCCT a (black arrow) and on scout radiograph b (white arrow)



a. b.

Figure 8 23 years old female with the diagnosis of non obstructive ureteric calculus at left VUJ which is seen in both axial NCCT a (black arrow) and on scout radiograph b (white arrow)

7. CONCLUSION AND RECOMMENDATION

Our study has shown that the sensitivity of CT scout radiographs in detecting ureteric calculi is similar to other published data. Approximately 50% of ureteral stones were visible on the often overlooked routine CT scout radiograph. The sensitivity depends on mean Hounsfield units, location and size, and these factors affect clinical management. The usage of CT scout radiographs therefore should be encouraged and reported routinely in conjunction with CT KUB as a baseline study for KUB radiograph treatment follow up.

According to our result we recommend:

- All CT scout films should be viewed and reported at the same time of the initial CT KUB whether calculi can be seen on CT scout radiography. This would ensure that follow-up images are obtained with the appropriate technique.
- In the CT report about stone location on the CT scout radiograph relative to anatomic landmarks, such as osseous structures should be mentioned.

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ANNEX III: DATA COLLECTION FORMAT

Table 6 **Socio-demographic characteristics of the study participant's**

Patient ID	SEX		AGE					
	M	F	15-24	25-34	35-44	45-54	55-64	>65
1.								
2.								
3.								
4.								

Table 7 **Characteristic of calculi on Scout CT radiograph**

Patient ID			
	Definitely visible	Not visible	Indeterminate
1			
2			
3			
4			

Table 8 **Characteristic of visible calculi on Scout CT radiograph**

Patient ID	Stones projected over the shadow of ureters course								Stones projected other than ureters course (over renal, urinary bladder shadows …
	Right				Left				
	Proximal	mid	distal	VUJ	Proximal	mid	distal	VUJ	
1									
2									
3									

Table 9 Characteristic of visible calculi on CT KUB radiograph

Patient ID number	NO of stones	Axial diameter of stone in mm			MHU , in HU			Location of stones in the ureter								Stones pr other tha course a patholog than stor
								RIGHT				LEFT				
		<4	4-8	>8	<400	400-600	>600	Proximal	Mid ureter	distal	VUJ	Proximal	Mid ureter	distal	VUJ	
1	Stone 1															
2	Stone 1															
	Stone 2															