

**THE ROLE OF CT UROGRAPHY IN THE EVALUATION OF ADULTS
PATIENTS WITH UROLOGICAL MANIFESTATIONS AT MUHIMBILI
NATIONAL HOSPITAL**

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DEPARTMENT OF RADIOLOGY AND IMAGING**



**MASTER OF MEDICINE DISSERTATION
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WITH UROLOGICAL MANIFESTATIONS AT MUHIMBILI NATIONAL HOSPITAL**

**By
Fatma Ali Omar Ali (MD)**

**A Dissertation Submitted in (Partial) Fulfillment of the Requirement for the
Degree of Master of Medicine (Radiology) of
Muhimbili University of Health and Allied Sciences**

October, 2021

CERTIFICATION

The undersigned certifies that she has read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled **“The role of CT urography in the evaluation of adult patients with urological manifestations at Muhimbili national hospital”**, in (Partial) Fulfillment of the requirements for the degree of Master of Medicine (Radiology) of Muhimbili University of Health and Allied Sciences.

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(Supervisor)

Date:: _____

DECLARATION AND COPYRIGHT

I, **Fatma Ali Omar Ali**, declare that this dissertation is my original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

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Heartfelt gratitude is extended to my dear mother and father Swaudah Rashid Soud and Ali Omar Ali especially for all that they have ever done to support me and mold me. This also goes to my siblings and in-laws for all their support.

DEDICATION

This work is dedicated to

My beloved husband Dr. Tariq Esmail Essajee for unconditional love, care, and support.

Our adorable daughters Haneefah and Saudah for their love and understanding

My dearest mother Mrs.Swaudah Rashid Soud for her endless love, care, and support.

My father Mr.Ali Omar Ali forever believing that I could do it.

My dearest aunty Umi Ali Omar for her endless love and support

My loving brothers Mohamed Ali and Omar Ali Omar

ABSTRACT

Background:

CT urography is emerging to be the standard imaging tool for the evaluation of patients with urological manifestations such as hematuria and renal colic as it allows comprehensive evaluation of the upper and lower urinary tract. Accurate and prompt diagnosis is very crucial for best patient care hence imaging plays a major role.

Broad Objective:

This study aimed to determine the role of CT Urography in adult patients with urological manifestation at MNH from august 2020 to January 2021

Methodology:

This study was a hospital-based descriptive retrospective and prospective study of adults aged 18 years and above. It was done at Muhimbili National Hospital in the Radiology Department using a structured data collection tool. The information obtained includes Socio-demographic information, clinical information, and CT Urography findings. Comparison of CTU results with other clinical results (Endoscopy: cystoscopy and ureteroscopy, open surgery and urinalysis and histopathological results (where available). Data analysis was done using SPSS and summarized using tables and figures.

Results

Study participants included were 106(54.1%) males and 90 (45.9%) females. The 2 most common symptoms were renal colic 156(79.6%) and hematuria 43(21.9%). CTU depicted many urinary tract abnormalities including renal stones 43 (21.9%), Ureteric stones 25(12.8%). Bladder stone 6(3.1%), solid renal mass 23(11.7%), bladder mass 8(4.1%), 95 cases of other urinary system disorders, and 24 extra-urinary findings. Among the 120 patients who underwent surgery, CTU correctly diagnosed all urinary tract stones 53 however one false positive was encountered (sensitivity 100%, specificity 98.5%)

Conclusion

CTU is a useful modality for detecting many urinary tract abnormalities. It has exceptional capabilities with high sensitivity and specificity in detecting urinary tract stones. In addition,

CTU has the advantage of detecting extra-urinary and incidental findings which may not be suspected clinically.

Recommendation

Sensitization for prompt referral of patients with hematuria and renal colic to a specialized urological clinic for proper workup and management. CTU should be considered the primary imaging modality in the evaluation of high-risk patients with hematuria

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LIST OF ABBREVIATIONS

CM:	Contrast Medium
CT:	Computed Tomography
CTU:	Computed Tomography Urography
IV:	Intravenous
IVU:	Intravenous urography (conventional)
KUB:	Kidney ,Ureter and bladder
LUTS:	Lower urinary tract symptoms
MDCT:	Multidetector computer tomography
MNH:	Muhimbili National Hospital
MR:	Magnetic Resonance
MUHAS:	Muhimbili University of Health and Allied Sciences
NPV:	Negative predictive value
PPV:	Positive predictive value
PUJO:	Pelvic-ureteric junction obstruction
RCC:	Renal cell Carcinoma
SPSS:	Statistical Package for Social Sciences
TCC:	Transitional cell carcinoma
UUT-UCC:	Upper urinary tract urothelial cell carcinoma
VUJO:	Vesicoureteric junction obstruction.

DEFINITION OF TERMS

- Hematuria:** The presence of at least 5 red blood cells/HPF in 3 of 3 consecutive centrifuged specimens obtained at least 7 days apart(1)
- Microscopic hematuria:** Detection of blood on urinalysis or urine microscopy(1)
- Macroscopic (Gross) hematuria:** Gross hematuria is visible blood in the urine by naked eyes (1)
- Renal colic:** Severe form of sudden flank pain that typically originates over the costovertebral angle and extends anteriorly and inferiorly towards the groin or testicle(2)
- Role of CT Urography:** Characterization and detection of radiological findings and accuracy of diagnosis
- Urolithiasis:** The presence of stones in the kidney, bladder or ureter
- Urological manifestation:** Genital urinary symptoms such as hematuria, renal colic, dysuria, oliguria, polyuria, and urinary retention(3)

CHAPTER ONE

1.0 INTRODUCTION AND LITERATURE REVIEW

1.1 BACKGROUND

Urological manifestations that are worrisome and usually warrant thorough investigations are hematuria and renal colic. Hematuria and renal colic can be a sign of serious urological conditions including urinary calculi, urinary bladder cancer, upper urinary tract urothelial cell carcinoma (UUT-UCC), renal cell cancer (RCC), metastatic disease or renal trauma (4)(5). Several studies have shown that there are significant associations between hematuria and urinary calculi, bladder tumor, and renal masses(6,7)(8) The presence of urinary calculi is the most common cause of hematuria (9–11). Gross hematuria is more worrisome than microscopic hematuria and has a high predictive value for malignancy therefore it warrants a thorough urological evaluation(5,12). It has been reported in the developed countries that the prevalence of carcinoma among patients with gross hematuria is as high as 18.9% (6) However, the prevalence in developing countries with low social status has not been well established. Gross hematuria, urinary retention, and renal colic are classic urological complaints, more common among men that are universally thought to require medical attention (13)

Therefore patients with urological manifestations suspicious for urinary tract abnormalities need a thorough investigation of the urinary tract to establish the cause. Conventional IVU sensitivity for detecting urinary tract lesions is 50–60.5% with a specificity of 90.9% (14) was traditionally used as the imaging modality to investigate the urothelium however currently CT urography is the emerging one step imaging modality due to its high (sensitivity 100%, specificity 92%) in detecting urinary stones and fast scan time (4,8)(15)CT urography allows comprehensive evaluation of the upper urinary tract(16)(17)(18) It is defined as CT examination of the kidneys, ureters, and bladder with at least one series of images acquired during the excretory phase of intravenous contrast media (CM) enhancement(4)(16). CT urography provides details about the soft tissues surrounding the kidneys, ureters, and bladder in addition to also having the ability to detect extra-urinary findings(18,19). Moreover, CTU can be used in the staging of urinary tract malignancies which is important in patient management and treatment(8).

1.2 PROBLEM STATEMENT

Hematuria and renal colic are common urological manifestations in adults and are of public health concern as they can signify serious urological conditions like cancer(4,5). In Tanzania haematuria is the most common presentation in patients with urinary tract malignancies (20,21). For many years, in developing countries, still, the majority of patients with urinary symptoms like haematuria or renal colic are either treated empirically or investigated with USS or conventional IVU which are less sensitive compared to CT Urography (4)(8)(22)(5) and which sometimes cannot explain or detect the etiology. There is limited and scanty literature in Tanzania among other Sub-Saharan African countries on the role of CT urography in imaging the urinary tract hence this proposed study will determine CT urography findings in patients presenting with urological manifestations. This will increase awareness of the importance of using CT Urography for better patient management.

1.3 RATIONALE

This study aims to establish the CT urography imaging findings in adult patients who present with urinary tract manifestations. This will help to formulate the best management plan for patients' care in resource-limited areas. In the developed countries CTU has largely replaced conventional IVU because of its high sensitivity and specificity for detecting urological conditions and ability to thoroughly evaluate renal parenchyma, periureteric tissues, and retroperitoneum(5)(23)(16)(9). Currently in Tanzania CT scans are available in many zonal hospitals and therefore it's high time that the use of CTU should be increased to ensure early diagnosis of urological conditions, proper management, and treatment which will lead to a reduction in morbidity and mortality.

1.4 CONCEPTUAL FRAMEWORK

The figure below illustrates the conceptual framework that was used to conduct the study. The study intends to determine CT Urography imaging findings for patients with urological manifestations. CT findings are urinary calculi, simple /complex cysts, PUJ obstruction, trauma, infection, benign or malignant renal/urothelial masses, and some extra-urinary conditions. Moreover Risk factors such as advanced age, male gender, smoking, radiation exposure associated with increased risk of renal/bladder malignancy

INDEPENDENT VARIABLE

- Age
- Sex
- Hematuria
- Renal colic
- Dysuria
- Anuria
- Smoking
- Radiation exposure



DEPENDENT

CT FINDINGS

- Renal calculi
- Ureteric calculi
- Bladder calculi
- Simple renal cysts
- Complex renal cysts
- Hydronephrosis
- PUJ obstruction
- Solid renal mass /tumor
- Ureteric tumor
- Bladder tumor.
- Pyelonephritis
- Cystitis
- Renal injuries /urothelial injuries
- Prostate enlargement
- Congenital variants/ anomalies
- Extra-urinary disease

1.5 Research Questions

- i. What are the sociodemographic characteristics of patients presenting with urological manifestations referred for CTU at Muhimbili National Hospital?
- ii. What are the clinical symptoms of patients presenting with urological manifestations referred for CTU at Muhimbili National Hospital?
- iii. What are the radiological findings of patients presenting with urological manifestations referred for CTU at Muhimbili national hospital?
- iv. Is there any association between clinical symptoms and radiological findings?
- v. Is there any concordance between CTU urinary stone diagnosis with intraoperative findings of patients presenting with urological manifestations referred for CTU at Muhimbili National Hospital?

1.6 Research Objectives

1.6.1. General objective

To determine the role of CT Urography in patients presenting with urological manifestations at Muhimbili National hospital from August 2020 to January 2021.

1.6.2. Specific objectives

The study aims at meeting the following specific objectives;

- i. To determine sociodemographic characteristics of patients presenting with urological manifestations referred for CTU at Muhimbili National Hospital from August 2020 to January 2021.
- ii. To determine urinary tract symptoms of patients presenting with urological manifestations referred for CTU at Muhimbili National Hospital from August 2020 to January 2021.
- iii. To determine radiological findings of patients presenting with urological manifestations referred for CTU at Muhimbili National Hospital from August 2020 to January 2021.
- iv. To determine the association between clinical symptoms and radiological findings.
- vi. To correlate CTU urinary stone diagnosis with intraoperative diagnosis in adult patients referred for CTU at Muhimbili National Hospital?

1.7 Literature Review

1.7.1 Sociodemographic characteristics, associated risk factors, and clinical findings.

Hematuria and renal angle pain are common urological complaints encountered in clinical practice and can be a red flag for occult cancer(24). Studies done in the developed countries show that the prevalence of urological cancers in patients presenting with hematuria varies from 10- 20% and a significant percentage of patients initially diagnosed with benign conditions, upon follow up ended up having urological malignancy(6,25). (12) However, the prevalence in developing countries with low social status has not been established. Furthermore, evidence shows that the causes of gross hematuria in Africa are reported to have shifted in the previous 50 years from schistosomiasis being the utmost common cause of malignancy(26).

Different studies and reports have shown that hematuria is more common in the elderly above 50 years with an increased risk of upper urinary tract cancer(10,14,27,28).renal colic suggestive of urinary tract stones is more common in the younger age group (41-50) years(29) however a recent study revealed that hematuria is also an emerging problem with young adults less than 40 years(12). Hematuria and renal malignancies are more commonly seen in men than women(14). Mariani A J et al reported that life-threatening lesions were more common in men 13.6% compared to females 4.9%(27). Several studies report that hematuria was associated with other risk factors such as the history of smoking, history of chronic cystitis, and pelvic irradiation (10)(14)

Suprapubic pain, flank pain, renal angle pain, frequent urination, painful urination are the common symptoms associated with hematuria and urological disorders (7,30). The significant urological lesion was associated with gross hematuria than with microscopic hematuria(31).

1.7.2 CT urography findings in adults with urological manifestations

Conventional IVU was traditionally used as the imaging modality to investigate the urothelium however currently CT urography has emerged to be the initial one-step imaging modality for the investigation of hematuria due to its high sensitivity, specificity, and fast scan(4,8). CT urography provides details about the soft tissues surrounding the kidneys, ureters, and bladder in addition to also having the ability to detect extra-urinary findings(18,19). Moreover, CTU can be used in the staging of urinary tract malignancies which is important in patient management and treatment(8).

Regarding CTU findings in the kidney, many kinds of literature have shown that renal calculi (18.9%) to be the most common abnormalities(9–11)Furthermore renal calculi were found to be associated with hydronephrosis, hydroureter, and renal cysts(30). Renal masses (2.3%) are another common finding reported in several studies where the CTU finding was either a solid mass or complex cystic masses(9,12,17,31). Solid masses are worrisome and are presumed to be malignant and usually require surgery(17). A combination of unenhanced with Nephrographic phase is the ideal phase for adequate assessment of renal masses(17,32,33) Other findings detected by CTU reported by Bretlau T *et al* and Albani M *et al* was found to be renal infection/ inflammatory conditions and renal trauma(9). The appearance of Renal infection/ inflammatory conditions has been described by M.Goldman *et al* as increased in kidney size, wedge-shaped areas of hypo attenuations post-contrast injection, and perinephric fat stranding(34)(17).

Ureteral abnormalities have been reported to be best assessed in the excretory phase and the commonest CTU finding was calculus, neoplasm, and stenosis(17)(35) In a review by Joffe *et al* ureteric stones was best appreciated in the nonenhanced phase as radio-opaque density and neoplasm as filling defect in the excretory phase with ureteric wall thickening and enhancement(17)

A retrospective study done in the USA in patients who had undergone cystoscopy and CTU showed that CTU had high sensitivity and specificity in detecting bladder tumors in patients presenting with hematuria and had an advantage of being non-invasive (36). Bladder tumors have been associated with focal wall thickening, irregular mass, and best evaluated in the excretory phase(37)(17)(9) In a study done in Nigeria bladder infections especially schistosomiasis was also a common finding with associated bladder stones(38).

Several studies have shown that there are significant associations between hematuria and renal/ ureteral calculi, bladder tumor, and renal masses(6,7) (8)

1.7.3. Modalities for investigating the urinary tract

There are several different imaging techniques used for investigating the urinary tract depending on the patient's urinary symptoms and general medical history. Plain X-ray kidney ureter and bladder (KUB), Conventional Intravenous urography (IVU), and ultrasound have been used in evaluating the urinary tract however they have limitations such as a low sensitivity for small lesion detection(39)(15)

X-ray (KUB) has been used in identifying and monitoring radio-opaque urinary stones but is not useful in assessing the urinary tract. In addition, X-rays only have a low sensitivity of approximately 60% in detecting renal and ureteric calculi. (14) However it has the advantages of having a low radiation dose and relatively cheaper compared to CT Urography(15)

Ultrasound has no risk of radiation, is widely available, and is cheaper. It can help look for hydronephrosis, characterization of renal tumors, cystic lesions, and moderately large bladder lesions such as stones or tumors(14). However it usually requires follow up with a corresponding CT scan, it is operator dependent and has a 40% sensitivity for identifying renal tumors, but this can range from 0–57% depending on the size of the lesion(14)

Magnetic Resonance Imaging is expensive, time-consuming, and has poor sensitivity for urolithiasis(40)However it can be used to evaluate patients with suspected urinary tract obstruction, hematuria, and congenital anomalies who are hypersensitive to iodinated contrast and in pediatric or pregnant patients or when ionizing radiation is to be avoided(41)

CTU is the preferred imaging modality of the renal tract for the detection of genitourinary malignancy and disease. (14) It can visualize the collecting system, ureteric and pelvicalyceal surfaces. Sensitivity for detecting pathology in patients with hematuria varies from 94.1–100%(14)However it has a risk of ionizing radiation.

CHAPTER TWO

2.0 METHODOLOGY

2.1 Study design

This study was a hospital-based descriptive retrospective and prospective study where medical records and CTU images of patients with urological manifestations undertaken from August 2020 to January 2021 were reviewed

2.2 Study Duration

The study was conducted from November 2020 to May 2021

2.3 Study area

The study was done at Muhimbili National Hospital MNH located in Dar es Salaam city, in Tanzania. There are five municipal councils in the city (Kinondoni in the North, Ilala in the center, Ubungo, Temeke in the South, and Kigamboni in the East) and is the largest city in Tanzania.

Muhimbili National Hospital is the largest tertiary hospital in Tanzania and it is a national referral hospital. It is a teaching hospital for Muhimbili University of Health and Allied Sciences (MUHAS). Currently, it has two campuses one at Upanga (MNH) and one at Kibamba 3 km off Dar-es-Salaam Morogoro highway MAMC). This study was conducted in the Radiology and Imaging Department of MNH (Upanga) which is well equipped with almost all imaging modalities. It has radiography, fluoroscopy, ultrasound, and CT and MRI units. It attends to about 2 million patients annually who come for various imaging investigations.

2.4 Study Population

All adults' patients with urological manifestations referred to Muhimbili National Hospital Radiology Department for CT Urography from August 2020 to January 2021

2.5 Inclusion and Exclusion Criteria

2.5.1 Inclusion Criteria

1. All adult patients with urological manifestations referred to MNH Radiology department for CT Urography
2. Patients above 18 years

2.5.2 Exclusion Criteria

Images of poor diagnostic quality

2.6 Variables

2.6.1 Independent Variables

Age, sex, occupation, smoking, and alcohol abuse

2.6.2 Dependent Variables

CT Urography findings renal/ureteric/bladder calculi, Simple renal cysts, Pyelonephritis, cystitis, solid mass or complex cyst in the kidney/ renal pelvis/ureter, bladder, renal trauma, congenital anomalies, and extra-urinary disease

Intraoperative / histopathological findings

2.7 Sampling method

Convenient nonprobability sampling was used. All adults patients with urological manifestations referred to the CT department meeting inclusion criteria during the study period were included in the study

2.8 Sample size calculation

The sample size calculation from Fisher's formula; $n = z^2 p (1-p) \div E^2$ Where by:

- n- Is the minimal sample size
- Z – Is the point of the normal distribution corresponding to the significance level of 1.96
- P – prevalence of kidney stones in USA 15%(29)
- E- Error margin 5% (0.05).
- From this formula the sample size was calculated as follows:
- $n = (1.96)^2 \times 15 (100 - 15) \div (5)^2 = 196$
- Sample Size (n)= 196

2.9 Data collection and Instruments

Data collection was done using structured data collection and monitoring of a tool filled by the principal investigator. Retrieved images from the available database (clear canvas) at MNH were reviewed by an investigator and confirmed by the radiologist(s) on duty after consensus was reached. Intra-operative findings (Endoscopic or open), urinalysis, histological findings (where available) were obtained from the available database (Jeeva) and patients files. The sensitivity was determined as the proportion of stones detected using CTU divided by stone detected (Endoscopically or open surgery+_ histology results) multiplied by 100. The specificity was determined from patients with urinary stones/urinary tract mass at CTU and divided by patients without stone (Endoscopically or open surgery+_ histology results) multiplied by 100.

Data collected included:

Sociodemographic information: Age and sex

Clinical findings: Smoking, Diabetics, Schistosomiasis infection, Alcohol abuse, renal angle pain, suprapubic pain, palpable mass, type of hematuria, other urological manifestations

CT findings: From the whole urinary system from the kidneys, ureters, and bladder. Extra-urinary findings

Other investigations/intervention: Urinalysis, intraoperative and or pathological findings (where available)

Imaging and evaluation:

The CT scan machine for acquiring the images was CT-SCAN 128, slices Multidetector helical SIEMENS SOMATOM DUO-SOURCE, Munich, Germany

Patients were asked to void immediately before the examination and to drink 900mls of water. Patients were then scanned using a three-phase protocol, including unenhanced imaging of the abdomen and pelvis (0.6-2.5mm collimation,120kVp, and variable tube current)100 seconds after administration of iopamidol (100mls of isovue 300 at 3 mL/s and excretory phase imaging the abdomen and pelvis (0.6-1.0 mm collimation,120 kVp, and variable tube current) 10-15 minutes after contrast material injection .excretory phase scans was reconstructed at 3- 5 mm sections in the axial plane and 3mm section in the coronal plane.

2.10 Data Analysis

The collected data were coded, entered, and analyzed using the statistical package SPSS version 24. Descriptive statistics were computed to analyze all items from the questionnaire. Socio-demographic and risk factors served as independent variables, while the CT findings were considered as dependent variables. Frequency distribution and two-way tables were used to summarize the data. Quantitative variables (age) were measured using mean and/or median. Categorical variables association was assessed using Chi-square (χ^2) test. P-values < 0.05 will be considered statistically significant.

2.11 Ethical considerations and clearance

Formal ethical approval was obtained from Muhimbili University of Health and Allied Sciences Senate Research and Publications Committee. All ethical issues were adhered to as per Senate Research and Publications Committee criterion. Permission to conduct the study at MNH in Radiology was obtained from necessary authorities. Patients' information was kept confidential and names were not used. Research identification numbers were used for all participants in the data collection tool.

CHAPTER THREE

3.1 RESULTS

A total of 240 patients underwent CTU at MNH from August 2020 to January 2021 however only 196 patients with urological manifestations suggestive of urinary tract disease were recruited into this study. Only 120 patients had further clinical workup (Endoscopic surgery=cystoscopy or and ureteroscopy, open surgery, urinalysis or histopathology) for comparison with CT Urography results.

3.1.1: Social demographic characteristics among adult patients presenting with urological manifestations who underwent CTU from August 2020 to January 2021

Among the 196 adult patients with urological manifestations who underwent CTU, Majority were males 106(54.08%), and most of the common age group affected was 31-40 years category 47 (23.9 %). The age range was 18 to 87 years. The mean age was 46 years. Only 21 (10.7%) had a history of tobacco smoking while 18(9.2%) drunk alcohol.

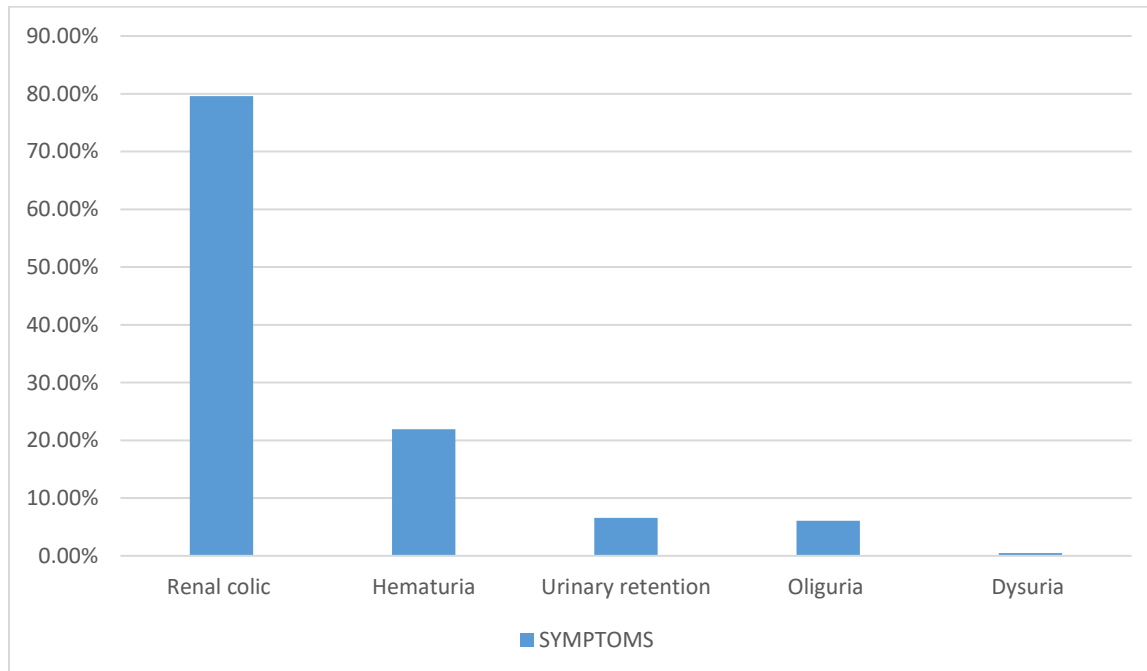
Table 1: Frequency distribution table showing socio-demographic characteristics of adults patients with urological manifestations who underwent CTU at MNH from August 2020 to January 2021

		Frequency(n)	Percentage (%)
Gender	Males	106	54.08
	Females	90	45.92
	Total	196	100
Age group	< 0r = 20	14	7.14
	21-30	24	12.24
	31-40	47	23.98
	41-50	31	15.82
	51-60	33	16.84
	61-70	35	17.85
	71-80	7	3.57
	80 and above	5	2.55
	Total	196	100
Tobacco Smoking	Yes	21	10.70
Alcohol use	Yes	18	9.20

3.1.2 Clinical presentation of adult's patients who underwent CTU from August 2020 to January 2021

Among patients who underwent CTU from August 2020 to January 2021, the most common presenting symptoms were renal colic 156 (79.6%) followed by hematuria 43(21.9%)

Figure 1: Bar chart showing the distribution of urinary tract symptoms among patients who underwent CTU at MNH from August 2020 to January 2021



3.1.3. Ct findings among adult patients presenting with urological manifestations who underwent CTU from August 2020 to January 2021

3.1.3.1 All Imaging findings

The commonest finding was renal stone 43 (21.9%) while solid renal mass 23 (11.7%) was the most common urinary tract tumor seen.

Table 2: Frequency distribution table showing disease prevalence according to CT Urography in adults patients with urological manifestations who underwent CTU at MNH from August 2020 to January 2021

Radiological Findings	Frequency	Percentage (%)
Renal stone	43	21.9
Renal cyst	27	13.8
Complex renal cyst	7	3.6
Solid renal mass	23	11.7
Renal laceration	1	0.5
Renal infection	5	2.6
Pelvic-ureteric junction obstruction (PUJO)	17	8.7
Ureteric stone	25	12.8
Ureteric mass	2	1.0
Ureteric injury	7	3.6
Ureteric vesical junction obstruction(VUJO)	14	7.1
Urinary bladder stone	6	3.1
Urinary bladder mass	8	4.1
Urinary bladder infection	4	2.0
Ureteric stricture	3	1.5
Renal -Anatomic variants	4	2.0
Ureter-Anatomic variants	4	2.0
Extra urinary findings	24	12.2

Figure 2: CTU image of a 56-year-old male with a bladder stone.



Axial CT image (non-contrasted) at the level of the bladder showing a well-defined rounded hyperdense focus at the posterior bladder lumen. The bladder wall thickness appears normal.

3.1.3.2. Distribution of urinary stones diagnosed by CT Urography

A total of 74 urinary stones were diagnosed, males were more affected than females with a ratio of 2.7:1. The majority of the stones were renal (58.1%) least common were bladder stones (8.1%).

Table 3 : Distribution of urinary stones diagnosed by CT Urography according to anatomical site in adults patients with urological manifestations who underwent CTU at MNH from August 2020 to January 2021

CATEGORY	MALES n=52 (72.6%)	FEMALES n=22 (27.4%)	TOTAL n=74
ANATOMICAL SITE			
Renal	30	13	43 58.1%
Ureteric	18	7	25 33.7%
Bladder	4	2	6 8.1%

Figure 3: CTU image of a 35-year-old female with left renal stones



Coronal reformatted image in the non-enhanced phase showing multiple rounded radiopaque foci in the lower pole of the left kidney. There is associated dilatation of the left renal calyces.

3.1.4. Association of urinary symptoms and CT Urography findings using chi-square test

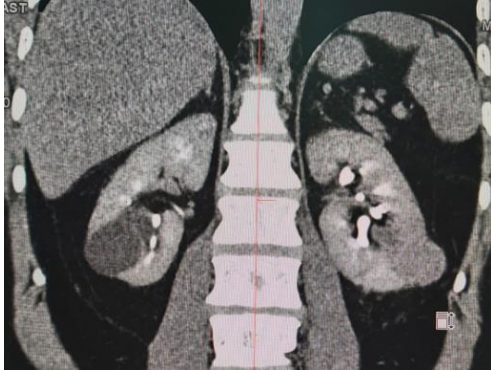
3.1.4.1 Association of hematuria and CT Urography findings using chi-square test

There was a statistically significant association between hematuria with solid renal mass, renal cyst, urinary bladder mass, and renal infection (P- values 0.001, 0.001, <0.0001, and 0.037 respectively)

Table 4: Association of hematuria and CT Urography findings

CTU Findings	Hematuria		Total	X2	P-Value
	Yes	No			
Renal stone	N=43	N = 153	N = 196		
Yes	8(18.6%)	35(22.9%)	43(21.9%)	0.358	0.550
No	35(81.4%)	118(77.1%)	153(78.1%)		
Renal cyst	N = 43	N=153	N=196		
Yes	6(13.9%)	21(13.7%)	27(13.8%)	0.969	0.001
No	37(86.1%)	132(86.3%)	169(86.2%)		
Solid renal mass	N=43	N=153	N=196		
Yes	12(27.9%)	11(7.2%)	23(11.7%)	13.9	0.001
No	31(72.1%)	142(92.8%)	173(88.3%)		
Renal laceration	N=43	N=153	N=196		
Yes	0(0.0%)	1(0.7%)	1(0.5%)	0.282	1.0
No	43(100.0%)	152(99.3%)	195(99.5%)		
Renal infection	N=43	N=153	N=196		
Yes	3(7.5%)	2(1.3%)	5(2.6%)	4.340	0.037
No	40(92.5%)	151(98.7%)	191(97.4%)		
PUJO	N= 43	N=153	N=196		
Yes	2(4.7%)	15(9.8%)	17(8.7%)	1.125	0.289
No	41(95.3%)	138(90.2%)	179(91.3%)		
Ureteric stone	N=43	N=153	N=196		
Yes	5(11.6%)	20(13.1%)	25(12.8%)	0.063	0.802
No	38(88.4%)	133(86.9%)	171(87.2%)		
Ureteric trauma	N=43	N=153	N=196		
Yes	3(7.5%)	4(2.6%)	7(3.6%)	1.855	0.173
No	40(92.5%)	149(97.4%)	189(96.4%)		
Bladder stone	N=43	N=153	N=196		
Yes	3(7.5%)	3(2.0%)	6(3.1%)	2.846	0.092
No	40(92.5%)	150(98.0%)	190(96.9%)		
Bladder mass	N=43	N=153	N=196		
Yes	7(16.3%)	1(0.7%)	8(4.1%)	20.933	<0.0001
No	36(83.7%)	152(99.3%)	188(95.9%)		

Figure 3: Figure 4: CTU image of a 54-year-old male with histologically proven RCC



Coronal reformed image in excretory phase showing an ill-defined heterogeneously enhancing mass at the lower pole of the left kidney causing contour deformity. No hydronephrosis was seen. There is a well-defined rounded thin-walled non-enhancing hypodense (cystic) lesion at the lower pole of the right kidney. (Bosniac1)

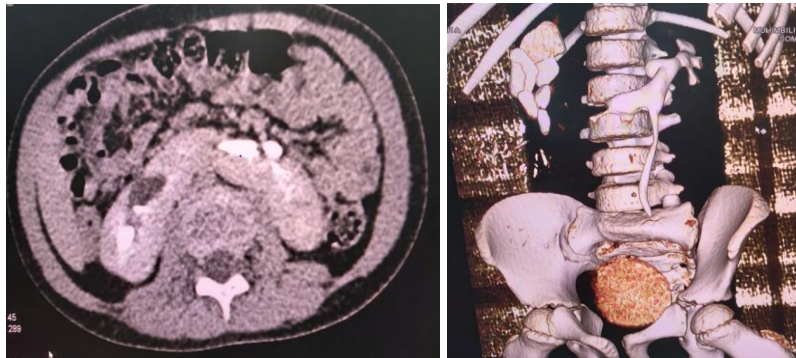
3.1.4.2 Association of Renal colic and CT Urography findings using chi-square test

There was a statistically significant association between renal colic with PUJO, renal infection, bladder, and ureteric trauma. (P-values 0.026, 0.001, 0.006 and 0.014 respectively)

Table 4.2: Association of Renal colic status and CT Urography findings using chi-square test

CTU Findings	Renal Colic		Total	X2	P-Value
	Yes	No			
Renal stone	N=156	N = 40	N = 196		
Yes	36(23.1)	7(17.5%)	43(21.9%)	0.578	0.447
No	120(76.9%)	33(82.5%)	153(78.1%)		
Renal cyst	N = 156	N=40	N=196		
Yes	23(14.7%)	4(10.0%)	27(13.8%)	0.603	0.437
No	133(85.3%)	36(90.0%)	169(86.2%)		
Solid renal mass	N=156	N=40	N=196		
Yes	19(12.2%)	4(10.0%)	23(11.7%)	0.146	0.702
No	137(87.8%)	36(90.0%)	173(88.3%)		
Renal laceration	N=156	N=40	N=196		
Yes	1(0.6%)	0(0.0%)	1(0.5%)	0.612	0.258
No	155(99.4%)	40(100%)	195(99.5%)		
Renal infection	N=156	N=40	N=196		
Yes	4(2.6%)	1(2.5%)	5(2.6%)	0.982	0.001
No	152(97.4%)	39(97.5%)	191(97.4%)		
PUJO	N= 156	N=40	N=196		
Yes	17(0.1%)	0(0%)	17(8.6%)	4.773	0.026
No	139(99.9%)	40(100%)	179(91.4%)		
Ureteric stone	N=156	N=40	N=196		
Yes	21(13.5%)	4(10.0%)	25(12.8%)	0.343	0.558
No	135(86.5%)	36((90.0%)	171(87.2%)		
Ureteric trauma	N=156	N=40	N=196		
Yes	3(1.9%)	4(10.0%)	7(3.6%)	6.031	0.014
No	153(98.1%)	36(90.0%)	189(96.4%)		
Bladder stone	N=156	N=40	N=196		
Yes	3(1.9%)	3(7.5%)	6(3.1%)	3.337	0.068
No	153(98.1%)	37(92.5%)	190(96.9%)		
Bladder mass	N=156	N=40	N=196		
Yes	6(3.8%)	2(5.0%)	8(4.1%)	0.108	0.742
No	150(96.2%)	48(95.0%)	188(95.9%)		
Bladder trauma	N=156	N=40	N=196		
Yes	1(0.6%)	3(7.5%)	4(2.0%)	7.492	0.006
No	155((99.4%)	37(92.5%)	192(98.0%)		

Figure 5: CTU image of an 18-year-old male with horseshoe kidney



Axial CT scan and VRT reconstructed images showing bilateral renal lower poles pointing medially and fused across the midline by an isthmus of functioning renal tissue.

3.1.5: Correlation of CT diagnosis of urinary stones with intraoperative findings among adult patients (n=120) with urological manifestations who underwent CTU and surgery at MNH from August 2020 to January 2021

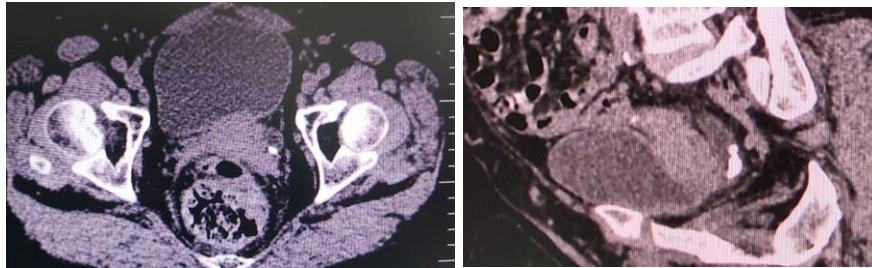
There was very high (100%) concordance in urinary stones diagnosis between CTU and intra-operatively however the specificity was 98.5%.

Only one false positive was encountered.

Table 5: Table 5: Correlation of CT diagnosis of urinary stones with intraoperative findings among adult patients (n=120) with urological manifestations who underwent CTU and surgery at MNH from August 2020 to January 2021

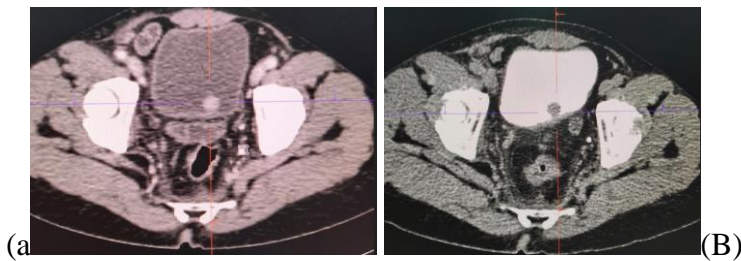
Urinary stone CTU	Urinary stone (Intraoperative)		Total
	Yes	No	
Yes	53(100.0%)	1 (1.5%)	54 (45.0%)
No	0 (0.0%)	66 (98.5%)	66 (55.0%)
Total	53 (100.0)	67 (100.0)	120 (100.0)

Figure 5: Figure 6: CTU image in a 42-year-old female with distal left ureteric stone



Axial and reformatted sagittal-oblique (non-contrasted) CT scan shows a well-defined ovoid hyperdense focus at the distal left ureter associated with proximal dilatation of the ipsilateral ureter and ureteric wall thickening,

Figure 6: Figure 7: CTU image of a 45-year-old male with histopathologically proven TCC



Axial CT images at the bladder (a) nephrographic phase showing a well-defined homogeneously enhancing polypoid mass arising from the posterior bladder wall. (b) Excretory phase showing the polypoid filling defect. There is an adjacent bladder wall thickening.

CHAPTER FOUR

4.0 DISCUSSION

CT Urography offers good imaging resolution and short examination time for diagnosis of a wide variety of urinary tract abnormalities. This hospital-based retrospective cross-sectional study involving 196 adults participants aimed at determining the role of CT Urography in patients with urological manifestation at MNH from August 2020 to January 2021

In our study majority of the participants were males 106(54.0%) with male to female ratio of 1.2:1 this in keeping with a study done in Taiwan (42) which had a sample size of 102 where 61(59.8%)were males and 41(40.2%) females and also in other studies done in Michigan(37) India, Ohio, and the UK which also showed male predilection(6,9,43). The reason for this could be due to lifestyles as males are more prone to be exposed to risk factors such as drinking alcohol, smoking, and dehydration. Study participants in this study were mostly within the age range of 31-40 years. This is contrary to the study done in India (43) where the elderly (51-60 years) were commonly affected. This could be attributed due to their small sample size of 50 participants and all their patients had hematuria.

In our study, the common presenting symptoms were renal colic 156(79.6%) and hematuria 43(21.9%). Similar to a study done in China (42). In a study done in Michigan with 65 participants referred for CTU were studied, 26 (40%) presented with hematuria. These two urinary symptoms are highly suggestive of urinary tract abnormality that warrant CT Urography(16,17).

In this study a wide variety of urinary abnormalities and extra-urinary abnormalities were detected by CT urography, this is consistent with many studies done elsewhere. (8,9,17,31,37,42–44). Renal stones was the commonest finding 43 (21.9 %) similar to other studies(9,12,30,43). In regards to the distribution of the urinary tract stones, we found that majority were renal stones 43(58.9%) followed by ureteric stones 24 (32.8%) lastly bladder 6 (8.2%). This was moderately comparable to a study done in Baghdad where the majority of the stones were renal(67.4%), then ureteric (12.5%), lastly bladder(14.6%) (29). Another study in Ohio also revealed that the majority were renal stones (9) Generally urinary tract stones were

much more common in males than females with a ratio of 2.7:1 in our sample. This is similar to the findings of a study done in Iraq and Pakistan (29,45)

In this study the prevalence of solid renal mass by CTU was 25 (12.7%) in addition it was also the most common type of urinary tract tumor. Contrary to this, a review article looking at disease prevalence according to CT Urography revealed that bladder tumor was most common (18.6%), then renal tumor at (2.4%)(4) This variation could be attributed to our setting where due to low socioeconomic status, most patients diagnosed of bladder mass on ultrasound are sent for cystoscopy without doing CT urography.

We also detected 8 congenital anomalies (3 cases of ureteral duplication, 2 cases of pelvic kidney, 1 case of the retrocaval ureter, and 2 cases of horseshoe kidney). We found that CT urography was sufficient in diagnosing these congenital disorders; the same conclusion was also made in other studies(39,42)

In our study hematuria was significantly associated with solid renal mass, bladder tumor, and renal infection (P- values 0.001, <0.0001, and 0.037 respectively). This implies hematuria is a risk factor for a serious urological disease in keeping with several other studies(8,43,46) There was a significant association between renal colic with PUJO, ureteric, and bladder trauma. However Contrary to what is well established, in this study no significant association was seen between renal angle pain and renal stone ($p < 0.447$). This could be due to the small sample size.

According to our results, CT urography showed extremely high sensitivity (100%), specificity (98.5%) for diagnosing urinary tract stones which were relatively similar to the prior study done in China (sensitivity 97.5%, specificity 100%) (42), and a recent study comparing the accuracy of conventional IVU to CT Urography(15). These results can be attributed to the fact that most urinary stones are radiopaque and therefore can be well visualized on a CT scan.

CHAPTER FIVE

5.0 CONCLUSION, RECOMMENDATION, STUDY LIMITATIONS, AND DISSEMINATION PLAN

5.1 CONCLUSION

Urinary stones were the commonest finding and CT urography has high diagnostic accuracy in detecting urinary stones with exceptional capabilities at revealing urinary tract anatomy and detecting a variety of other urinary tract abnormalities. Results in this study support the use of CT Urography as an initial diagnostic tool for high-risk patients with suspected urinary tract pathology presenting with hematuria and or renal colic. This will allow timely and comprehensive evaluation of patients and proper management for urinary tract abnormalities.

5.2 RECOMMENDATION:

1. CTU should be considered the primary imaging modality in the initial evaluation of high-risk patients with hematuria.
2. Sensitization for prompt referral of patients with hematuria and renal colic to a specialized urological clinic for proper workup and management
3. Patients suspected of urinary stones and the precontrast study shows a stone, should not be given contrast media.

5.3 LIMITATIONS:

In our study, not all patients underwent confirmatory studies. Therefore determination of the true positive and false positive and true negative and false-negative diagnoses in CT urography should be viewed with caution. In addition, some of our patients with normal CT urography studies did not undergo further evaluation

5.4 DISSEMINATION PLAN

The dissertation report will be submitted to Muhimbili University for partial fulfillment of the Masters of medicine in Radiology. The results will also be disseminated to the Teaching, Research, and Consultancy Coordination Unit of MNH and thereafter disseminated to the Dean School of Medicine and the Director of Postgraduate Studies.

The University and the principal author will hold the copyright of the research findings and they will be published in the local and/or international journals.

CHAPTER SIX

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APPENDICES

APPENDIX I: DATA COLLECTION AND MONITORING TOOL

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES SCHOOL OF MEDICINE

DEPARTMENT OF RADIOLOGY

P.O.BOX 65001 MUHIMBILI DAR ES SALAAM TANZANIA 24

CIRCLE THE APPROPRIATE NUMBER/FILL IN BLANKS

Identity number:

PART 1: SOCIODEMOGRAPHIC INFORMATION

DOB: (Dd/mm/yyyy)

Age (years): Address...

Sex: 1. Female 2. Male

PART 2: CLINICAL HISTORY

- a. Hematuria 1. Yes, 2. No
- b. Microscopic hematuria 1. Yes, 2. No
- c. Smoking 1. Yes, 2. No
- d. Alcohol use 1. Yes, 2. No
- e. Renal angle pain 1. Yes, 2. No
- f. Suprapubic pain 1. Yes, 2. No
- g. Hematuria 1. Yes, 2. No
- h. Urinary retention 1. Yes, 2. No
- i. Dysuria 1. Yes, 2. No
- j. Fever 1. Yes, 2. No
- k. History of trauma 1. Yes, 2. No
- l. Reduced urine 1. Yes, 2. No

PART 3: IMAGE (CT IVU) FINDINGS

- a. Normal CTU 1. Yes, 2. No
- b. Kidney
 - i. Surface pattern 1. Smooth 2. Irregular
 - ii. Size 1. Normal 2. Small 3. Enlarged
 - iii. Surface discontinuity 1. Yes, 2. No

- iv. Linear hypo attenuations 1. Yes, 2. No
- v. Area of hypoattenuation with post-contrast enhancement 1. Yes 2.No
- vi. Extra nephric contrast extravasation 1. Yes, 2. No
- vii. Per nephric fat stranding 1. Yes, 2. No
- viii. Renal stone 1. Yes, 2. No
- ix. Simple renal cyst 1. Yes, 2. No
- x. Complex renal cyst 1. Yes, 2. No
- xi. Solid renal Mass 1. Yes, 2. No
- xii. Renal laceration 1. Yes, 2. No
- xiii. Renal infection 1. Yes, 2. No
- xiv. Hydronephrosis 1. yes 2. No
- xv. Pelvic-ureteric obstruction 1. Yes, 2. No
- xvi. Congenital anomaly 1. Yes, 2. No
- xvii. Delayed nephrogram 1. Yes, 2. No
- xviii. Persistent nephrogram 1. Yes, 2. No

c. Ureters

- i. Ureteric stone 1. Yes, 2. No
- ii. Hydro-ureter 1. Yes, 2. No
- iii. Ureteric mass 1. Yes, 2. No
- iv. Ureteric infection 1. Yes, 2. No
- v. Ureteric trauma 1. Yes, 2. No
- vi. Uretero-vesical junction obstruction 1. Yes, 2. No
- vii. Mucosal pattern 1. Smooth 2. Irregular
- viii. Contrast extravasation 1. Yes, 2. No
- ix. Peri-ureteral fat stranding 1. Yes, 2. No
- x. Luminal narrowing 1. Yes, 2. No
- xi. Congenital anomaly 1. Yes, 2. No

- d. Urinary bladder
 - i. Bladder stone 1. Yes, 2. No
 - ii. Bladder mass 1. Yes, 2. No
 - iii. Bladder wall thickening 1. Yes, 2. No
 - iv. Bladder infection 1. Yes, 2. No
 - v. Bladder diverticulum 1. Yes, 2. No
 - vi. Bladder trauma 1. Yes, 2. No
 - vii. Contrast extravasation 1. Yes, 2. No
 - viii. Neurogenic bladder 1. Yes, 2. No
 - ix. Peri-cystic fat stranding 1. Yes, 2. No
- e. Congenital anomalies/ anatomical variants
 - i. Renal 1. Yes, 2. No
 - ii. Ureters 1. Yes, 2. No
 - iii. Bladder 1. Yes, 2. No
- f. Extra-Urinary Findings 1. Yes, 2. No
- g. Urinalysis/ Urine cytology
- h. Intra-operative findings
- i. Histopathological findings

Appendix II: Consent Form (English Version)

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

DIRECTORATE OF RESEARCH AND PUBLICATIONS, MUHAS

ID-N0 HD/MUH/K.232/2018

Introduction

My name is Dr. Fatma Ali Omar; I am researching with the title: determining the role of CT urography in the evaluation of adult's patients with urological manifestations at Muhimbili National Hospital

Purpose of the study

The purpose of this cross-sectional descriptive study is to determine the role of CT Urography in adult patients with urological manifestations at MNH from august 2020 to January 2021. Moreover, the study aims at establishing a base to help to formulate the best management plan for patients' care, to ensure early diagnosis of urological conditions and treatment which will lead to a reduction in morbidity and mortality. Furthermore, it is for the partial fulfillment for attaining the degree of Masters of medicine in Radiology from the Muhimbili University.

Participant involvement

Clinical details from the request form as well as the imaging findings will be obtained discreetly.

Confidentiality

Information obtained from each study participant will be kept confidential. No name will appear on any document of the study, and identification numbers shall be used instead.

Participant rights

Refusal or withdrawal from the study will not have interference with your management at the hospital, and no penalty will be given.

Benefits

Your participation will guide the formulation of a better treatment plan for urological patients and will assist in better care and imaging plan for urological patients in our community.

Risks

Your participation in this study will not compromise your disease outcome or influence your health service provision. Also, all your personal medical information will not be disclosed to the public and will be always be kept confidential except to those involved in undertaking the study.

Contacts

In case you have doubts or need more clarification regarding the study, you can contact me,

Dr. Fatma Ali Omar the Principal Investigator through my mobile number +255 789 715 175, or P. O. Box 65001 Dar es Salaam.

Dr. Zuhura Nkhurumbih(Telephone: 255 789 384 790 P. O. Box 65000 Dar es Salaam), the Supervisor of this study, a Lecturer, and HOD from the Department of Radiology.

Furthermore, in case you need more information on your participation rights, you may contact Dr. Joyce Masalu, Chairperson of the Senate Research and Publications Committee, P. O. Box 65001Dar es Salaam. Telephone: +255 022 2152489)

I have read and understood the contents of this form. I have agreed/not agreed to participate in this study.

Signature of ParticipantDate.....

Signature of ResearcherDate.....

Appendix III: Fomu Ya Ridhaa (Informed Consent Swahili version)

MUHIMBILI UNIVERSITY COLLEGE OF HEALTH SCIENCES DIRECTORATE OF RESEARCH AND PUBLICATIONS

Namba ya utambulisho ____ HD/MUH/k.232/2018_____

Utangulizi

Jina langu ni Dr. Fatma Ali Omar. Mimi ninafanya utafiti kwa lengo la kuamua jukumu la uchambuzi wa CT katika tathmini ya wagonjwa wenye ugonjwa wa damu ndani ya mkojo katika Hospitali ya Kitaifa ya Muhimbili

Malengo ya utafiti

Madhumuni ya utafiti huu wa sehemu ya msingi ni kujua jukumu la CT Urografi kwa wagonjwa wazima walio na matatizo mkojo huko MNH kutoka Agosti 2020 hadi Februari 2021. Kwa kuongeza, utafiti unakusudia kuanzisha msingi ili kusaidia kuunda mpango bora wa usimamizi wa huduma ya wagonjwa, kuhakikisha utambuzi wa mapema wa hali ya mkojo na matibabu ambayo itasababisha kupungua kwa vifo. Utafiti unaofanywa ni kwa ukamilisho wa shahada ya uzamili (the degree of Master Medicine in Radiology) kutoka Chuo kikuu cha Muhimbili.

Ushiriki

Maelezo ya kliniki kutoka kwa fomu ya ombi pamoja na matokeo ya CT yatapatikana kwa busara

Usiri

Taarifa zitakazopatikana kutoka kwa kila mshiriki wa utafiti huu zitahifadhiwa kwa siri. Hakuna jina litakaloonekana kwenye hati yoyote ya utafiti na badala yake namba zitatumika.

Haki ya mshiriki

Uamuzi wa kushiriki katika utafiti ni wa hiari. Kukataa/kujiondoa kwenye utafiti hakutoathiri upatikanaji wa huduma na hakuna adhabu yoyote itakayotolewa.

Manufaaa

Ushiriki wako utaongoza katika kuunda mpango bora wa matibabu kwa wagonjwa wa mkojo na utasaidia katika utunzaji bora na utumizi wa CT urografia katika jamii yetu.

Madhara

Ushiriki wako kwenye utafiti huu hautothiri matokeo ya ugonjwa wa mtoto, pia hautothiri kupata huduma hospitalini. Pia taarifa binafsi zihusuzo ugonjwa/matibabu hazitofichuliwa kwa umma na zitahifadhiwa kwa siri isipokuwa kwa wale wanaohusika katika kufanya utafiti.

Mawasiliano

Endapo una shaka, ama utahitaji maelezo zaidi juu ya utafiti huu, wasiliana na:-

Dr. Fatma Ali Omar, mtafiti mkuu (namba ya simu 255 789 715 175SLP 65001,Dar es Salaam)

Dr. Zuhura Nkrumbih (Namba ya simu : 255 789 384 790 , SLP 65000 Dar es Salaam), ambaye ni mshauri na msimamizi wa mtafiti mkuu. Dr Zuhura ni mkufunzi/mwalimu wa kitengo cha Radiolojia.

Endapo utahitaji taarifa zaidi kuhusu haki ya ushiriki wako katika utafiti huu wasiliana na Dr. Joyce Masalu, ambaye ni mwenyekiti wa bodi ya utafiti na uchapaji, SLP 65001 Dar es Salaam kwa namba ya simu +255 022 2152489.

Mimi _____ nimesoma / nimeelewa yaliyomo katika fomu hii.
Nimekubali/sijakubali kushiriki katika utafiti huu.

Sahihi ya mshirikiTarehe.....

Sahihi ya mtafitiTarehe.....