Role of Multidetector Computed Tomography in the Evaluation of Obstructive Uropathy

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Abstract

Introduction: Obstructive uropathy is a significant and potentially reversible factor that can lead to the development of acute and chronic kidney disease. Multidetector Computed Tomography Urography (MDCTU) is a non-invasive imaging method capable of identifying both the cause and level of urinary tract obstruction. **Aim:** To evaluate the efficacy of MDCTU in identifying the etiology and severity of urinary tract obstruction in individuals with obstructive uropathy. **Methods:** A retrospective analysis of 82 patients who underwent MDCTU for obstructive urography between February and November 2018 was conducted. The MDCT results for urinary tract dilatation, level, and source of urinary tract blockage were documented. **Results:** Our study showed that urinary tract stones were the main cause of obstructive uropathy for over half of the patients (59.7%). Also, prostate enlargement was responsible for 19.5% of cases, and congenital anomalies such as solitary kidney, horseshoe-shaped kidneys, double moiety (ureter), and ureteral atresia, accounted bout 10.9% of the all cases. Tumoral growth in the urinary tract was responsible for 9.7% of cases. **Conclusion:** The MDCTU examination, with or without contrast, is an accurate and a precise method for detecting the levels and causes of urinary tract obstruction. It should be considered for assessing patients with obstructive uropathy.

Keywords: MDCTU, obstructive uropathy, renal stone, prostate enlargement

Introduction:

Obstructive uropathy is a reversible condition that is responsible for both chronic and acute kidney disease. It requires prompt treatment to prevent permanent damage to the kidneys (1). It can be defined as a structural or functional obstruction to urine flow that causes damage to the kidneys. Of all cases of chronic and acute kidney disease, obstructive uropathy makes up around 10% (2,3).

To assess obstructive uropathy, a number of imaging modalities are available, including computed tomography (CT), magnetic resonance imaging (MRI), radiography, ultrasound, and intravenous urography (4). Ultrasonography (USG) is a safe and sensitive method for detecting ureter dilatation (4,5). Nevertheless, despite their dilation, it is incapable of showing the middle region of the ureters (6). In addition, USG fails to reveal the status of renal function (7). Although MR urography is a somewhat effective imaging method for obstructed urinary systems, it offers lower diagnostic accuracy compared to CT urography (7). And it is also expensive and time-consuming (8).

Modern multidetector CT technology has greatly improved the ability to quickly scan and produce high-quality images with contrast medium opacification. Two-dimensional and three-dimensional reconstruction images, including virtual cystography, are easily achievable with this technology. Renal malignancies, urinary tract infections (UTI), trauma, urolithiasis, and obstructive uropathy are among the numerous urological conditions for which MDCTU is the preferable radiological examination (8). Additionally, CT urography provides a precise view of the detailed anatomy of the urinary tract and any extrinsic urinary tract blockage(9).

Here, we aimed to evaluate the function of MDCT in the diagnosis of obstructive uropathy, and identifying the severity of urinary tract obstruction in individuals with obstructive uropathy.

Materials and Methods:

Observational research was undertaken at Tripoli University Hospital from February to November 2018. The study was approved by the ethical committee and included patients who underwent MDCTU for urinary tract obstruction in the radiology department. The study included patients of all age groups who were referred for CT urography to detect the level of the obstruction. Patients who had already undergone surgery on their urinary system were not included in the research.

A CT scan was conducted using an Ingenuity CT scanner manufactured by Toshiba, Siemens Medical Systems. The type of contrast used (neural or positive) depended on the clinical situation. The scan had three phases. The initial non-contrast period marked the first stage. The second stage involved capturing the nephrographic phase, which occurred 90-100 seconds after infusing 80-120 mL of intravenous non-ionic iodinated contrast for the purpose of studying the renal parenchyma. The third phase, known as the delayed phase, was captured 5-10 min following the administration of the contrast agent. This phase facilitated the assessment of the excretory function of the kidneys and the visualization of the ureters and urine bladder. The study also included reviewing 3D reconstruction images as shown in figure 1 as an example.

The data was collected in specific data sheath, and included information about: sociodemographic character, past medical history, indication of MDCTU, the diagnosis by MDCTU, the stone character, the level of urinary tract dilatation and cause of urinary tract obstruction.

The data analysis was conducted using IBM SPSS Statistics for Windows, Version 21.0. The study included frequencies and percentages for categorical variables and averages along with standard deviations (SDs) for continuous variables. The Chi-square test was employed to analyze both category and numerical data. A P-value of less than 0.05 was deemed to be statistically significant.

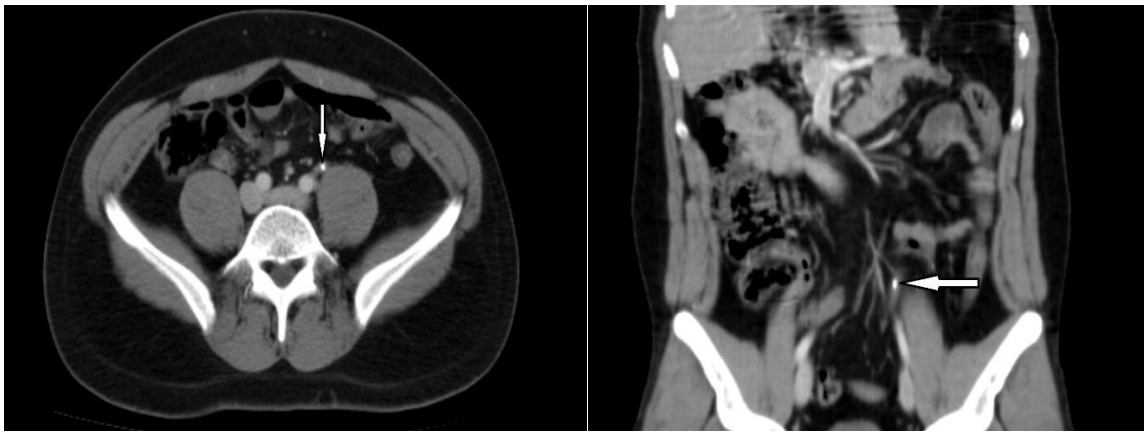

Figure 1: The venous phase of MDCTU of the patient shows a small left ureteric stone (as indicated by the white arrows).

Result:

In our study, we included a total of 82 patients who underwent MDCU to detect the cause and level of obstruction. The age of the patients ranged from two months to 91 years, with a majority of male patients (78%) and the remaining 22% being female. (See Figure 2)

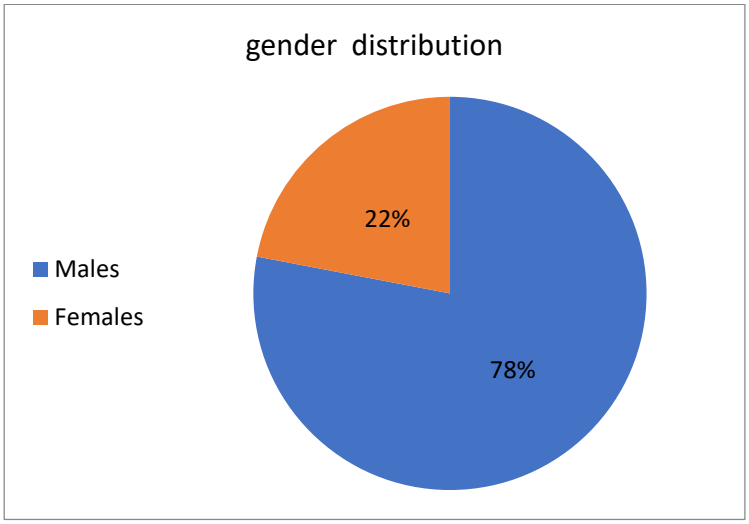

Figure (2): Gender distribution for patients underwent MDCU.

Out of the total cases, 34% (28 cases) of the patients had requested the examination due to the presence of hydronephrosis detected by US examination. Complaints of loin pain were the second most common reason for undergoing the examination, with 24.3% (20 cases) of the

patients reporting it. Weak stream was the third most common complaint, with 16 cases (19.5%). Hematuria was reported by 12 patients (14.6%), while only 6 cases (7%) complained of suprapubic pain as summarized in table 1.

Causes of obstructive uropathy:

According to our findings, of the 82 cases, 49 (59.7%) of obstructive uropathy were due to urinary tract stones, and 16 (19.5%) by prostatic enlargement, 9 (10.9%) by congenital anomalies (such as horseshoe kidneys, double moiety and ureter, and posterior urethral valve), and 8 (9.7%) by urinary tract tumoral growth as given in Table 2.

Table (1): The indications of C.T.U according the enrolled data.

Character	No	Percentage
Hydronephrosis detected by US examination	28	34%
Loin pain	20	24.3%
Weak stream	16	19.5%
Hematuria	12	14.6%
Suprapubic pain.	6	7%

Table (2): The main causes of obstructive uropathy as diagnosed by multidoctor computed tomography

Cause	No	Percentage
Urinary tract stones stones.	49	59.7%
prostatic enlargement.	16	19.5%
Congenital anomaly	9	10.9%
Urinary tract tumoral growth.	8	9.7%

Level of obstruction:

Table (3) summarizes the degree of blockage in uropathies observed by multidetector CT urography. Out of 82 cases, 30 (36.5%) had obstruction in the ureter, 12 (14.6%) had obstruction at the pelvic-ureteric junction, 22 (26.8%) had obstruction at the vesicoureteral junction, 16 (19.5%) had obstruction at the prostate level, and only 2 (2.4%) had obstruction at the urethra.

Table (3): The levels of obstructions detected by MDCTU.

Level of obstruction detected ETU	No	%
Ureter	30	36.5%
Pelvic-ureteric junction	12	14.6%
Vesicoureteral junction	22	26.8%
Prostate	16	19.5%
Urethra	2	2.4%

Characters of urinary tract stones:

Most stones diagnosed by MDCTU were > 1cm in size for 38 cases (77.5%), and only 11 stones (22.5%) their size < 1cm. The density of the stones was <500 HU for 35 cases (71.4%), and about 14 stones (28.6%) their density > 500 HU (table 4). Furthermore, nearly 82% of urinary tract stones were present in unilateral side of kidney and only 18% of renal stone were found bilateral as summarized in figure (3).

Table (4) Character of urinary tract stones (N=49)

Character	No	%
Size of stone		
< 1 cm	11	22.5%
> 1cm	38	77.5%
Density of stone		
< 500 HU	35	71.4%
> 500 HU	14	28.6%
Level of stone		
Pelvic ureteric junction	12	24.4%
Ureter	30	65.2%
Vesicoureteric junction	7	14.2%

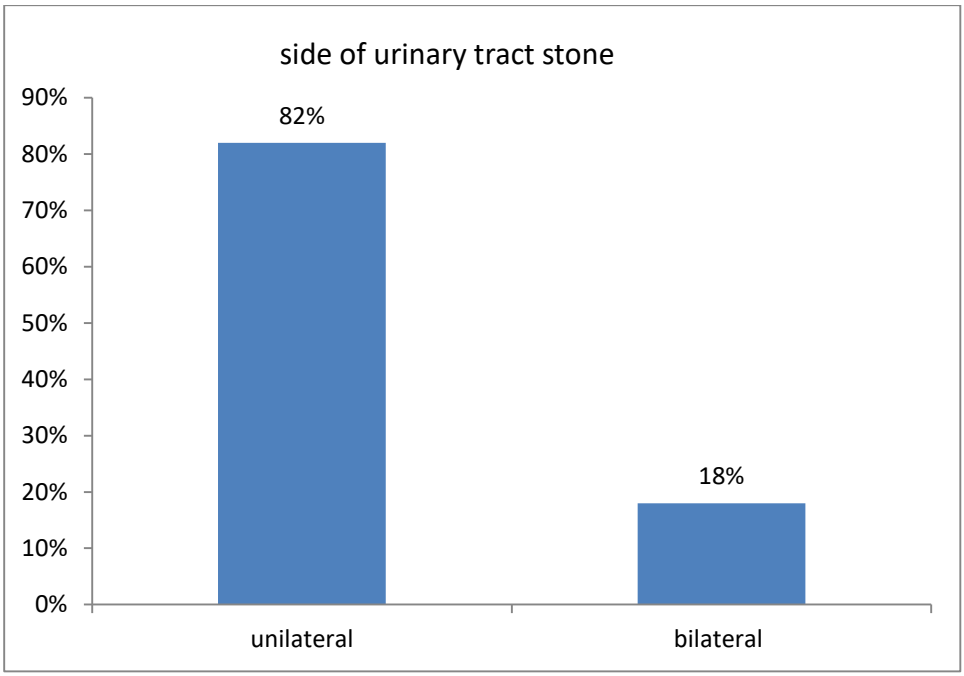

Figure (3). Site of the detected urinary tract stone in 49 cases.

Discussion:

Obstructive uropathy refers to a condition where there is an obstruction in the regular flow of urine. It can be caused by either structural or functional abnormalities in the urinary tract (10). Because of its short scan time and excellent image quality, helical CT scans have developed into an accurate diagnostic tool for disorders in the urinary system. Also, a significant reduction in radiation dose is achieved through the implementation of a multidetector helical CT scan design. Recent research has indicated that the radiation exposure associated with CT urography is comparable to, or marginally higher than, that of IVU (11). Advances in MDCT allow for the easy determination of the reason and extent of obstruction, even without the need for contrast injection (12).

The MDCTU examination performed in this study was divided into three phases. The first phase involved precontract imaging of the abdomen and pelvis to detect the kidneys, determine calcifications, and evaluate urolithiasis. The second phase is known as the nephrographic phase, and it began 100 seconds following the intravenous contrast media was administered. This phase is ideal for identifying localized masses that originate in renal parenchyma. The third phase, called as the delayed or excretory phase, begins 5 to 10 minutes after the injection of contrast material. It is used to evaluate the renal collecting system and the ureters. When the nephrogram becomes less dense, the contrast medium is expelled, permitting view of the

calyces, renal pelvises, and ureters. This technique is based on the standard CT urography protocol postulated by Kocakoc et al.(13)

This study used MDCTU to identify many stages of obstruction, starting with the PUJ and advancing to the upper, mid, and lower ureters, the Ureterovesical junction (UVJ), and bladder neck occlusion. We discovered that obstructive uropathy may be diagnosed using these approaches in numerous parts of the urinary system, including the urethra, bladder neck, vesicoureteric junction, ureter, and renal pelvis. These findings were consistent with previous investigations. According to Yarger et al. (14) and Mahmoud et al. (15). Additionally, we showed that the MDCTU has a high diagnostic potential for urinary tract stones, having identified 49 out of 82 instances or almost 59.7% of all cases. This was in line with the findings of Mahmoud et al. (14), and Chevalier and Klahr (16), who found that renal stones, which obstruct the ureters, are typically the source of urinary tract blockages. This was also consistent with the findings of Cronin et al. (17), who reported that the unenhanced portion of the CT scan is the best way to evaluate urinary tract calculi, locate the obstruction, and find trustworthy secondary indicators of obstructing calculi.

Our findings with MDCT examination in consistence with the literature also demonstrated a high level of sensitivity and specificity in diagnosing calculi, with results reaching up to 100%. For instance, the studies conducted by Boulay et al. (18) and Mohamoud et al. (15), reported that unenhanced CT scans showed a high sensitivity (95-98%) and specificity (96-100%) in detecting urolithiasis. Unlike excretory urography, ultrasonography, and nephrography, MDCT allows for an accurate evaluation of this important illness and distinguishes between urinary calculi and other abnormal conditions, such as blood clots or tumors (19). In fact, it is very important for the clinical management of patients with urolithiasis to accurate determine the position, dimensions, and density of the stones in urinary tract, as well as any associated anatomical or functional abnormalities (20). Therefore, MDCT is represent a gold technique for accurate assessment of obstructive uropathy.

In this study, we showed that the most prevalent cause of obstructive uropathy was urinary tract stones, which were typically positioned on one side of the urinary tract and in the ureter. MDCTU correctly detected the chemical composition of urinary tract stones by measuring their densities in the Hounsfield unit. The stones primarily had a density of <500 HU. In line with Sandhu et al. (21), and Mohammod et al. (19), this study found that the majority of stones discovered by MDCTU were larger than 1 cm, with just 22.5% being smaller. This technique was also able to detect the other causes of obstructive uropathy as prostatic enlargement, or congenital abnormalities such as horseshoe kidneys, collecting system duplication (double moiety and double ureter with obstructed one ureter), and posterior ureteral valve. In this investigation, we observed that prostatic enlargement counted the second prevalent cause of obstructive uropathy by 19.5% of cases, which is considered greater prevalence compared to the study that was done by Mahomed et al. (15), which indicated that just two cases were identified as prostatic issues.

Neoplastic lesions of the urinary bladder are also considered a probable cause of obstructive uropathy. Studies done by Mahmoud et al. (19) and Wang et al. (23) found a significant incidence of bladder cancer as a cause of obstructive uropathy. In their trials, the location and degrees of blockage caused by a urinary mass were accurately discovered with MDCTU and approved with surgical surgery and biopsies. Furthermore, Kim et al. (24) demonstrated that CT urography was effective in detecting 97% of bladder tumors. In our investigation, we discovered that only eight patients (9.7% of our population) had bladder neoplastic tumors encroaching on the vesicoureteral junction, resulting in obstructive uropathy. However, the prior investigation by Kim and others were found in a cohort of 67 individuals with known bladder cancer previously discovered by cystoscopy. As a result, the high frequency of urinary neoplastic lesions in their study was most likely influenced by including criteria from their sample.

Our investigation, consistent with the literature, demonstrated that MDCTU is an accurate and non-invasive approach for detecting the underlying pathology of obstructive uropathy, such as urolithiasis, prostatic lesions, congenital malformations, or urinary neoplastic lesion. It could also properly determine the level of blockages in the urinary tract system. Thus, it is a highly recommended diagnostic tool for occasions with obstructive uropathy.

Conclusion:

The MDCTU examination, whether with or without contrast, is a precise method for detecting the level and cause of urinary tract obstruction. It should be considered for assessing patients with obstructive uropathy.

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