

Evaluation of Hydronephrosis using ^{99m}Tc -DTPA Renal Scintigraphy and CT Urography

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Abstract: The evaluation of Hydronephrosis using ^{99m}Tc -DTPA renal Scintigraphy & CT- Urography has been carried out among 60 hydronephrotic patients with age groups between 20-80 year, 27 patient assessed by CT urography ,27 assessed by dynamic renal Scintigraphy and 6 patient assessed by both . The parameters discussed are the age, weight and degree of the Hydronephrosis (mild-moderate - severe). The results from dynamic renal Scintigraphy using ^{99m}Tc -DTPA radiopharmaceutical reveal that: - the predominant occurrences of hydronephrosis were among the age group of 20-30 years old, While the least occurrence for the age group of 30-40 years old. The result also found that the relationship between the age and occurrence of hydronephrosis is an inverse relationship demonstrated by the following equation ($y = -0.571x + 18.66$). The results also reveal that the predominant occurrence of hydronephrosis were among the weight group of 50-60 kg, While the least occurrence for the weight group of 90-100 kg with inverse relation demonstrated by equation ($y = -3.192x + 27$) . Also the result reveals the degree of hydronephrosis (mild 50% -moderate 16.67%- Severe 33.33%). The results from CT urography reveal that the predominant occurrence of hydronephrosis were among the age group of 40-50 years old, While the least occurrence for the age group of 70-80 years old which has reversible relation and could be demonstrated by the following equation ($y = 3.964x + 30.12$) . The results also reveal that the predominant occurrence were among the weight group of 50-60 kg, While the least occurrence for the weight group of 80-90 kg which has also reverse relationship demonstrated by the equation $y = 1.585x + 22.20$. Also the result reveals the degree of hydronephrosis (mild 50% -moderate 16.67%- Severe 33.33%). The accuracy, resolution and cost of these methods has been compared.

Keywords: Hydronephrosis, ^{99m}Tc -DTPA, CT-Urography

1. Introduction

Hydronephrosis is an abnormal dilation of the renal pelvis and the calyces of one or both kidneys, caused by an obstruction of urine flow in the genitourinary tract. Although partial obstruction and hydronephrosis may not produce symptoms initially, the pressure built up behind the area of obstruction eventually results in symptomatic renal dysfunction (1). Almost any type of obstruction of uropathy can result in hydronephrosis (6). The most common causes are benign prostatic hyperplasia, urethral strictures, and calculi; less common causes include strictures or stenosis of the ureters or bladder outlet, congenital abnormalities, abdominal tumors, blood clots, and neurogenic bladder. If obstruction is in ureters, it's usually unilateral. Obstructions distal to the bladder cause the bladder to dilate and act as a buffer zone, delaying hydronephrosis. Total obstruction of urine flow with dilation of the collecting system ultimately causes complete cortical atrophy and cessation of glomerular filtration (8). Hydronephrosis occurs in 1 out of every 100 people (2), Clinical feature of hydronephrosis vary with the cause of the obstruction. In some patients, hydronephrosis produces no symptoms or only mild pain and slightly decreased urinary flow ; in others , it may produce severe , colicky renal pain or dull flank pain that may radiate to the groin, and gross urinary abnormalities, such as hematuria , pyuria, dysuria, alternating oliguria and polyuria , or complete anuria (8).

Other symptoms of hydronephrosis include nausea, vomiting,

abdominal fullness, pain on urination, dribbling, or hesitancy .Unilateral obstruction may cause pain on only one side, usually in the flank area. (6)

The most common complication of an obstructed kidney is infection (pyelonephritis) due to stasis that exacerbates renal damage and may create a life –threatening crisis. Paralytic ileus frequently accompanies acute obstructive uropathy (7).

The kidneys can be image using various radiographic technique including CT urography and radionuclides studies. Both techniques can be used in the investigation of Hydronephrosis with each other. CT urography is the most Valuable examination of urinary tract it gives excellent anatomical images, high resolution and gives an indication of the kidneys function. The importance of radionuclide in the investigation of renal diseases is the functional and Quantitative information. They provide whereas radiological techniques for the most part (subjective information) provide structural detail. The methods are therefore, complementary and in general they provide more useful clinical information together than alone.

2. Materials and Method

A. This is a prospective study and is carried out in Radiation and Isotopes Center of Khartoum (Khartoum oncology center) at both nuclear medicine and diagnostic departments. The study includes 60 patients whom attend to these departments for dynamic renal scan and CT urography. Both

males and females included with different ages (20-80) year. The samples include hydronephrotic patients and all patients had previously undergone clinical staging by physical examination, renal Scintigraphy and CT urography examination. Primary data collected from patient files, and their dynamic radionuclide renal scan with Tc99m-DTPA and CT urography on certain period of time.

B. For dynamic renal scan with ^{99m}Tc-DTPA: Planer Gamma Camera model (Nucline spirit (DHV) variable angle dual head SPECT and whole body DH -503066-VO) acquisition parameter acquired for renal dynamic study which includes: Low energy general purpose collimator. All subjects well hydrated, 0.5-1 liter of water 30 mint before the study. Their weight and height was measured for the kidney depth measurement, and void bladder prior to the imaging was mandatory step.

C. Subject preparation for CT urography: the patient was fasted the day prior to the date of examination, also a laxative was taken to achieve a good preparation. On the day of the procedure scout/pilot film was taken to check patient preparation and also for radio opaque calculi. The serum creatinine level was checked to be within normal range (as per hospital guidelines). The history of patients was taken for drug allergies followed by a written informed consent for the procedure.

D. The renal scintigraphic with Tc99m (Renogram): after the preparation of the dose (3-5 mCi) generally (5mCi for most patients), patients directed to void prior the study acquisition. Then they lined down over the camera in supine position on the examination table, the kidney area center in the camera field of view center, patients were instructed to keep non-move during acquisition time. Dynamic study requires that radiopharmaceutical to inject into many parts. This is refer to as bolus and the dose deliver in as small volume as possible. The acquisition starts immediately at time of injection. Lasix was injected 20 min after the administration of radiopharmaceutical to aid in clearance of radioactivity from the kidneys

E. For Intravenous CT urography procedure: Exposure are generally in the 65-75kv range, mA of 600-1000, with exposure of < 0.1 sec. Higher kV ranges reduce contrast of renal parenchyma. IV access is required for administration of a water soluble contrast (Nonionic contrast was used). The dose varied as per the weight of the patient; generally up to 1.5 ml/kg body weight is well tolerated by patient. The contrast dose is usually instilled at a fast (bolus) rate. The calyces are usually visualized in < 2 minute following contrast administration- this is the nephrogram. Then Serial image are taken at 5-20 minutes for visualization of the pelvicalyceal systems and ureters when required and with operator preference other Additional views taken: - prone and oblique for visualization of ureters. The full length 10-15 minute film is performed with a compression band applied to the patient. Compression should not be applied if ureteral calculi, ureteral obstruction, recent surgery, nephrostomy, or abdominal aortic aneurysm is suspected lastly take a full bladder and post void film.

3. Results and Discussion

A total of 60 patients were considered as the sample of the study (hydronephrotic patients) 27 patients assessed by renal scintigraphy, 27 patient assessed by CT urography and 6 patients assessed by both. The parameters discussed are the age, weight and degree of the disease (mild- moderate – severe hydronephrosis) for each group.

For The renal scintigraphy patients assessed by ^{99m}Tc DTPA: As mentioned above a total of 27 patients were considered as the sample of the study. The percentage of male to female was 48 and 52 % respectively. Their age rang was 20-80 years old. The results in Figure (1) reveal that the predominant occurrence were among the age group of 20-30 years old, While the least occurrence for the age group of 30-40 years old, However the results in Figure (2) showed the relationship between age and occurrence of hydronephrosis which has reversible relation and could be demonstrated by the following equation $y=0.751x + 18.66$, where (y) refer to occurrence of hydronephrosis and (x) refer to age in years.

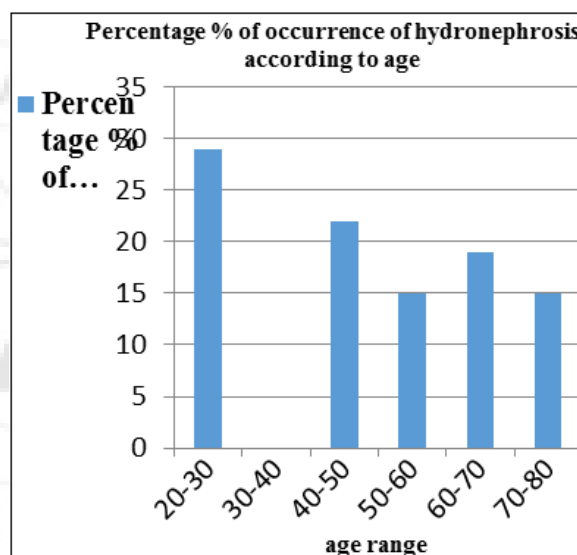


Figure 1: illustrate the relationship between the ages of the hydronephrotic patients and percentage of occurrence investigated by gamma camera during year 2017.

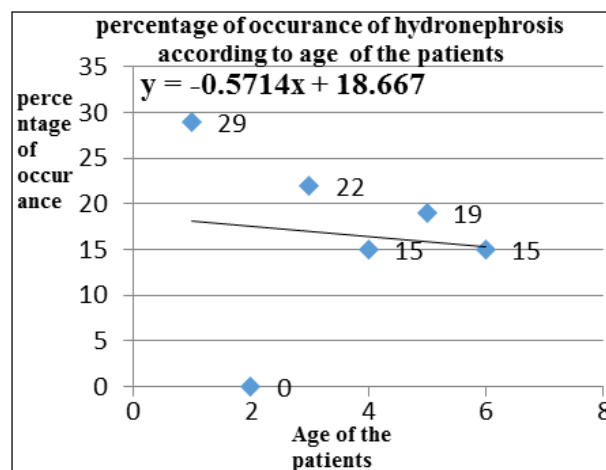


Figure 2: illustrate the relationship between the ages of the hydronephrotic patients and percentage of occurrence investigated by gamma camera during year 2017

The study also showed the weight range versus the occurrence of hydronephrosis. It reveal in Figure (3) that the predominant occurrence were among the weight group of 50-60 kg, While the least occurrence for the weight group of 90-100 kg, and the relationship between weight and occurrence of hydronephrosis demonstrated in figure (4) which has reversible relation and could be demonstrated by the following equation $y = 3.192x + 27$, where (y) refer to occurrence of hydronephrosis and (x) refer to weight in kg.

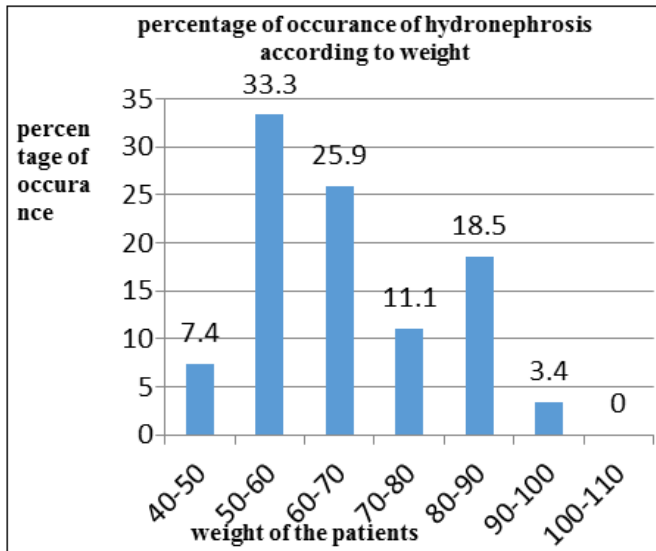


Figure 3 illustrate the relationship between the weight of the hydronephrotic patients and percentage of occurrence investigated by gamma camera during year 2017

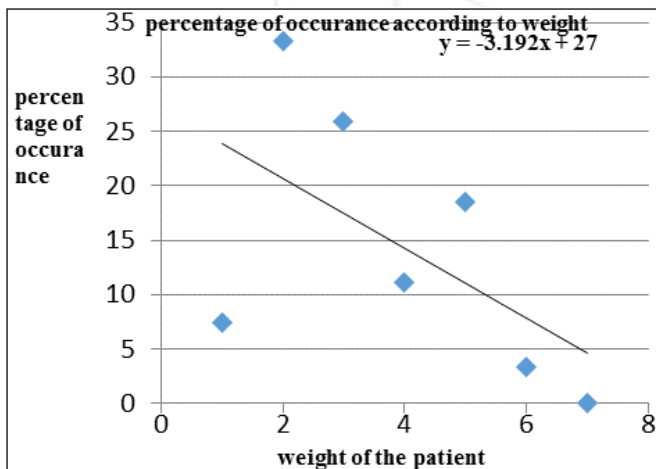


Figure 4 illustrate the relationship between the weight of the hydronephrotic patients and percentage of occurrence investigated by gamma camera during year 2017.

The researchers also studied the degree of severity and the percentage of occurrence. the figure 5 reveal that the kidneys cleared the radioactivity 5min after the injection of the Lasix at 50% of the cases indicated mild hydronephrosis, 33.3 % of the cases shows no excretion indicating severe hydronephrosis while 16.6% of the cases are moderate hydronephrosis

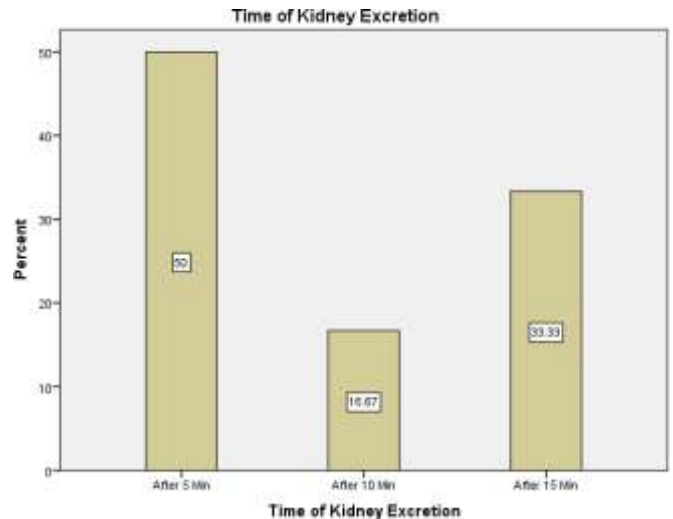


Figure 5 illustrate the degree of severity and the percentage of occurrence of the hydronephrotic patients and percentage of occurrence investigated by gamma camera during year 2017

For The CT urography patients: The parameters discussed are the age, weight, and degree of the disease (hydronephrosis: - mild- moderate - severe). A total of 27 patients were considered as the sample of the study. The percentage of male to female was 40.7 and 59.3% respectively. Their age rang was 20-80 years old. The result shows the age range versus the occurrence of hydronephrosis. The results in Figure (6) reveal that the predominant occurrence were among the age group of 40-50 years old, While the least occurrence for the age group of 70-80 years old. However the results in Figure (7) showed the relationship between age and occurrence of hydronephrosis which has reversible relation and could be demonstrated by the equation , where y refer to occurrence of hydronephrosis in and x refer to age in years.

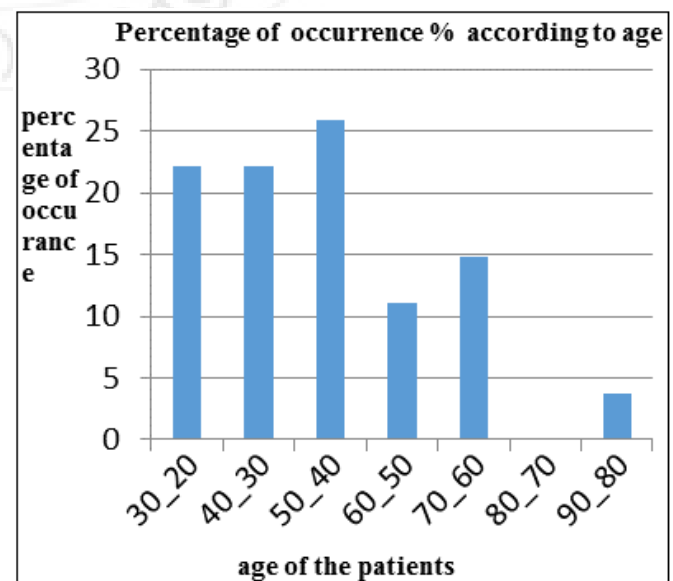


Figure 6 Illustrate the relationship between the Age of the hydronephrotic patients and percentage of occurrence investigated by computed tomography during year 2017

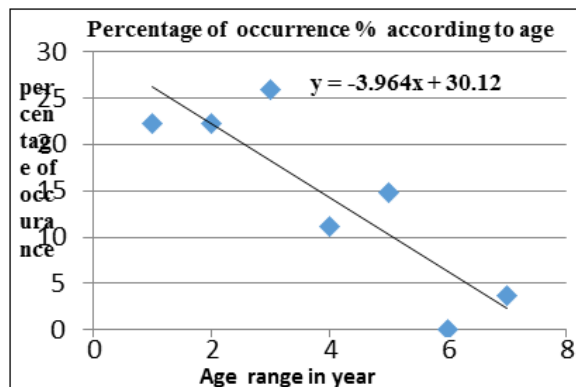


Figure 7 Illustrate the relationship between the Age of the hydronephrotic patients and percentage of occurrence investigated by computed tomography during year 2017.

The research also demonstrated the weight range versus the occurrence of hydronephrosis. The results in Figure (8) reveal that the predominant occurrence were among the weight group of 50-60 kg, While the least occurrence for the weight group of 80-90 kg, also showed the relationship between weight and occurrence of hydronephrosis which has reversible relation and could be demonstrated by the equation $y=1.585x+22.20$, where (y) refer to occurrence of hydronephrosis in and (x) refer to weight in kg.

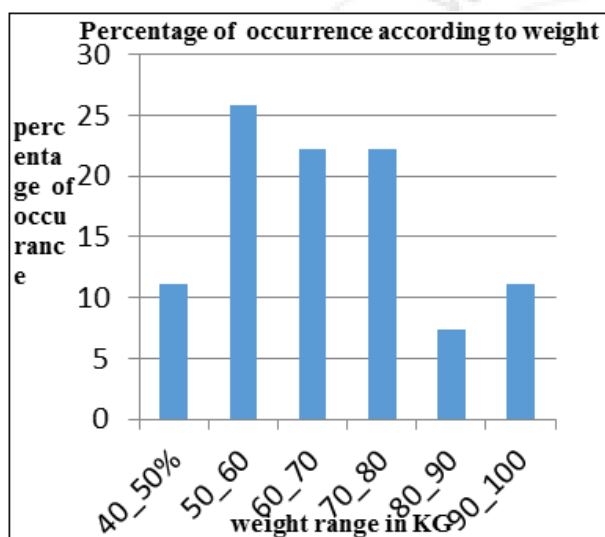


Figure 8 Illustrate the relationship between the weight of the hydronephrotic patients and percentage of occurrence investigated by computed tomography during year 2017

The researchers also studied the degree of severity and the percentage of occurrence. the figure 9 reveal that the kidneys cleared the radioactivity 5min after the injection of the Lasix at 50% of the cases indicated mild hydronephrosis , 33.3 % of the cases shows no excretion indicating severe hydronephrosis while 16.6% of the cases are moderate hydronephrosis

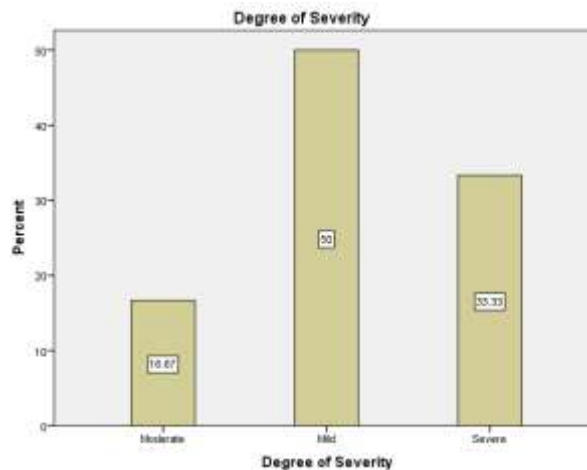


Figure 9 Demonstrate the Degree of Severity Of The Hydronephrotic Patients And Percentage Of Occurrence Investigated By Computed Tomography During Year 2017

The result of the patient assessed by both CT urography and nuclear medicine scintigraphy:-The parameter discussed is the degree of the disease (hydronephrosis: - mild- moderate - severe) for both right and left kidneys. The RT. kidney result showed in Table 1 and figure 10 which demonstrated Time of Kidney Excretion (count) * Degree according to CT.U Cross tabulation

Table 1 shows the degree of severity as detected by CT-Urography

		Degree according to CT.U			Total
		Normal	Mild	Severe	
Time of Injection	After 5 Min	0	1	2	3
	After 10 Min	0	1	0	1
	After 15 Min	2	0	0	2
Total		2	2	2	6

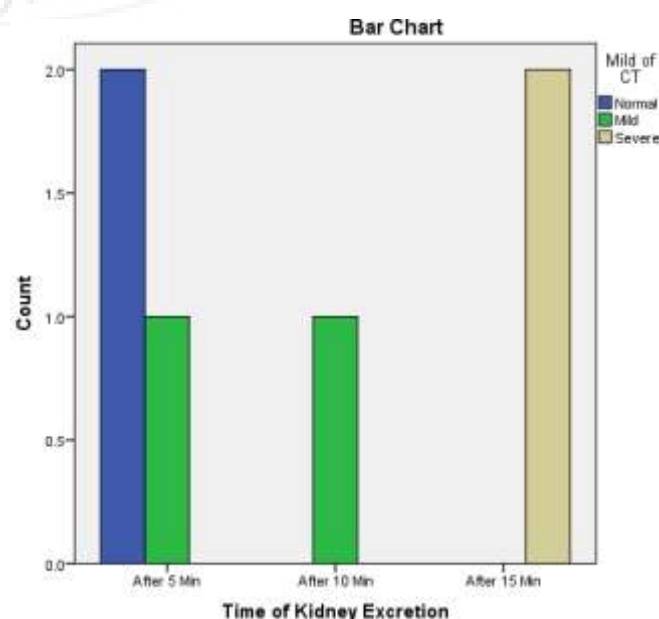


Figure 10 Time of Kidney Excretion, Degree of severity according to CT.U Cross tabulation

The L T. kidney result showed in Table 2 and figure 11 which demonstrated the Time of Kidney Excretion (count) * Degree according to CT.U Cross tabulation.

Table 2 shows the degree of severity (Lt. Kidney) as detected by CT-Urography

	Time of Injection	Degree according to CT.U			Total
		Normal	Mild	Severe	
	After 5 Min	0	1	2	3
	After 10 Min	0	1	0	1
	After 15 Min	2	0	0	2
	Total	2	2	2	6

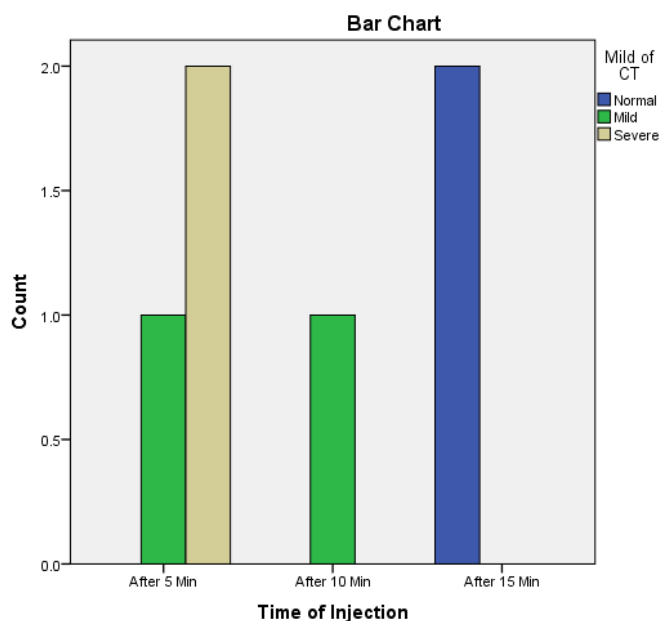


Figure 11 Time of Kidney Excretion (count) * Degree according to CT.U Cross tabulation.

Conclusion

The attempt to evaluate the hydronephrosis using renal scintigraphy and CT.U has been carried out and the accuracy of these methods has been compared. And the analysis of the data

Reverse relationship between the age, weight and occurrence of hydronephrosis. Also the degree of hydronephrosis assessed by both imaging modalities and showed the same result (mild 50%, moderate 16.67% Severe 33.33%) . also CT urography gave better resolution (assess Morphology) but includes several exposure time which depend on personal characteristics (age, weight) which can't control there for the optimization of the result will be very difficult. While the ct scanner more available than gamma scanner but the CT urography less required. The Renal scintigraphy gave more quantitative results (percentage of function) specially split function than the Ct urography. The radiation dose in renal scintigraphy less than the CT urography. The renal scintigraphy with Tc99m- DTPA in private cost 500SDG, and in governmental it cost 150 SDG where The CTU in

private cost 600-1000 SDG, and in governmental :it does not regularly requested so most requested privately which give The renal scintigraphy with Tc99m- DTPA an advantage over CTU in manner of the cost and availability.

References

- [1] John JC. Urinary obstruction. In: Grainger RG, Allison D, Adam A, et al. Diagnostic Radiology a text book of medical imaging , 4th ed. London: Harcourt; 2001.p.1593-1594.
- [2] (Professional Guide to Diseases By Lippincott Williams & Wilkins)
- [3] Nuclear Medicine Technology: procedures and quick reference by Alexander C.Mamourian
- [4] CT Imaging: practical physics ,artifact
- [5] Article :Evaluation of renal function using excretion urography and renal scintigraphy by Mariam Elawad Almuk
- [6] Wilson DR. Pathophysiology of obstructive nephropathy. Kidney Int 1980; 18: 281-292.
- [7] Hodson CJ. Experimental obstructive nephropathy in the pig.Br J Urol 1969; 41(suppl): 5-20.
- [8] Platt JF .Urinary obstruction. Radiol Clin North Am 1997; 34 (6): 1113-1129.
- [9] Kahler S, Pukerson ML. The role of vasoactive compounds in the haemodynamic and structural abnormalities of the obstructive kidney. Am J kidney Dis 1994; 23: 219-223.
- [10] Brander SJ, Buerkert JE, Martin D, et al. Long term effects of 24 hour unilateral ureteral obstruction on renal function in the rat . Kidney Int 1985; 28: 614- 620.
- [11] Zoran LB. Principles of Genitourinary Radiology, 2nd, New York: Thieme; 1994.p.109-115.
- [12] Spector DA, Katz RS, Fuller LM, et al. Acute non dilating obstructive renal failure in a patient with AIDS. AmJ Nephrol 1989; 9: 129-132.
- [13] Dunbar JS, Nogrady MB. The calyceal crescent: roengenographic sign of obstructive hydronephrosis. AmJ Roentgenol 1970; 110: 520-528.

Author Profile



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