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THE VALUE OF NUCLEAR MEDICINE VERSUS ULTRASONOGRAPHY IN DIAGNOSING RENAL DISEASE

Salman A. Mohammed[1] [1,2,3]*King Abdulaziz University, Jeddah, Saudi Arabia*
Omar M. Alamoudi[2] [3]*Email: smbafaraj@kau.edu.sa*
Saeed M. Bafaraj[3+]

(+ Corresponding author)

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ABSTRACT

Objective: The study aims to assess the value of nuclear medicine and ultrasonography for diagnosing renal diseases among patients of different ages. Method: Quantitative analysis has been opted for evaluating the effectiveness of both imaging modalities for the diagnosis of renal diseases. 80 patients were targeted, who were having renal disease indications and they were diagnosed through modalities. The outcomes of both imaging techniques were compared through data analysis. Results: Positive findings of the nuclear medicine were observed between the age groups 0-12 years (58.1%), 13-24 years (16.1%), 25-36 years (1.6%), 37-48 years (9.7%), 61-72 years (3.1%) and 73-84 (8.1%) years of patients. Concerning the ultrasonography technique, positive effects were observed among the patients of age-group 0-12 years (58.7%), 13-24 years (17.5%), 25-36 years (3.2%), 49-60 years (3.2%) and 73-84 years (3.2%). The sensitivity rate for nuclear medicine was 100% as compared to ultrasonography, which was 93.6%. However, the specificity and accuracy rates for nuclear medicine were 78.4%, and 21.5%; however, similar rates for ultrasonography were 79.7%, and 13.92%, which showed better outcomes of ultrasonography. Conclusion: Ultrasonography was observed showing positive results among all age groups as compared to nuclear medicine imaging modalities. Future studies must focus on other imaging techniques to timely diagnose the disease and initiate the treatment before it get worse.

Contribution/Originality: The study contributes to assess the efficiency difference between the nuclear medicine and ultrasonography to effectively analyze the case of the renal patients, before it gets severe. The study further documents the value of nuclear medicine in comparison with ultrasonography for the early diagnosis of renal mortal and morbid complications.

1. INTRODUCTION

The definition of renovascular disease has remained unchanged along with the stenosis of the renal artery or the proximal branches of renal artery; whereas, the clinical review has transformed dramatically over the last years and its management remains provocative [1]. There has been a shift in clinical issues regarding treatment and diagnosis, and the relative contribution of several pathological mechanisms involved in the kidney disease progression. Acute kidney injury is caused due to abrupt deterioration in kidney function, established by a rise in the level of serum creatinine with or without decreased urine output. There is a range from mild to advance in the injury spectrum, which sometimes need renal replacement therapy. In order to classify the acute kidney injury as intrinsic renal, pre-renal or post-renal, the diagnostic evaluation can be utilised [2]. Concerning the issues

associated with the diagnosis of renal diseases, the study focused to evaluate the value of nuclear medicine versus ultrasonography in diagnosing renal disease.

2. LITERATURE REVIEW

A study conducted by Veenboer, et al. [3] studied the additional advantages of performing Tc-99m dimercaptosuccinic acid scintigraphy among adults, having spinal dysraphism and it was then compared with ultrasonography for diagnosing renal difference and scarring in split renal function. Ultrasonography has been found of great among adults with spinal dysraphism for the detection of stones and dilatation of the upper urinary tract in contrast with DMSA (dimercaptosuccinic acid) renography. Renal scars cannot be diagnosed during impaired findings of ultrasound. A study by Abrahamsson, et al. [4] investigated the ultrasonography among the patients with obesity or spinal angulation, and associate it with the outcomes of mercaptoacetyltriglycine renography. Although, Ultrasonography is usually utilized to envision the upper urinary tract among adolescents and children with meningomyelocele [5]. Severe obesity and spinal angulation among patients with meningomyelocele, which can reduce the chances to investigate the urinary tract by ultrasonography. Although, it appears that renography can be a liable substitute for the evaluation of renal conditions among patients where ultrasonography is insufficient.

Valuable information is provided by the imaging of kidneys in the management and work up of acute kidney injury. The technique of imaging modalities are utilized to collect data and evidences to rule out obstruction on anatomy of the kidney and differentiate between the acute kidney injury and chronic kidney disease for obtaining the information on glomerular filtration rate and renal blood flow. In the initial stage of acute kidney injury, ultrasound is a broadly used imaging modality. The utility of magnetic resonance imaging and contrast enhanced computerized tomography is limited due to the toxicities linked with contrast agents used. Kalantarinia [6] reviewed the essentials of ultrasonography with an emphasize on assessing the concerned acute kidney injury. Novel advancements among different modalities have also been focused.

Acute kidney injury is comparatively common among the patients and is characterized by an increasing decline in kidney functions within few hours to days. It is common, especially among the ICU (intensive care unit) patients and is linked with greater mortality and morbidity cases. Causes of acute kidney injury may range and vary from prerenal azotemia and reduced kidney perfusion to direct urinary tract obstruction and toxicity [7]. With respect to the likelihood of kidney anatomy, edema and inflammation, obstruction, and form and quantity of renal perfusion are the effective techniques for imaging that could offer effective information. Although, considering the severe renal complications, all imaging modalities are not suitable for an individual. In many conditions, ultrasonography is preferred because of its easy use, safety profile, non-invasive nature. Moreover, professionals can easily access this technique. It has been reported that renal sonography remains the most useful, safest and broadly utilised imaging practice in the preliminary assessment of the patients with acute kidney injury. Information regarding the echogenicity and kidney size is valuable for the guidance of physicians in an appropriate and suitable manner of decision making in the acute kidney injury management. Eliminating the probability of significant decision making is one of the chief efficacies of ultrasound in this setting [6].

In the urinary tract, bladder cancer is considered as the most common cancer. 70% of the patients suffer from heterogeneous cancer, presenting with superficial tumours, which incline to recur, but are usually not life threatening [8]. Renal cell carcinoma is considered as the most recurrent type of kidney cancer and the most toxic cancer in the urinary tract among adults [9]. There has been a significant evaluation in the biological understanding in both bladder cancer and renal cell carcinoma, which is essential in treatment strategies of cancer. Accurate imagining in the bladder cancer and renal cell carcinoma is still one of the bases of staging, diagnosis and clinical management among patients. The capability of preoperatively identifying metastatic disease is of much importance in defining optimal cure of the patient [8].

Information regarding changes in pathobiochemical and pathophysiological changes are provided by the nuclear medicine imaging; whereas, morphological based imaging provides high resolution information on the structural alterations, which occur in a particular process. In clinical practice, nuclear medicine imaging is available in a daily clinical observance as a whole-body imaging; whereas, magnetic resonance imaging, computed tomography and other techniques offer information on one part of the body. The target of nuclear medicine imaging is to find non-particular radiopharmaceuticals [10].

A primary role is played by nuclear medicine in the management and diagnosis of several congenital and disorders among children and infants of genitourinary. Nuclear procedure processes are usually non-invasive and need no or little preparation. There is no systemic pharmacologic effects and no cause of allergic reaction in radiopharmaceutical. Low absorbed radiation doses have been observed in radionuclide studies [11]. Quantitative functional information is offered most importantly in radionuclide studies, which are presently unavailable with other imaging modalities. Moreover, they lend themselves to a variety of pharmacologic and physiologic interventions that may improve the diagnostic accuracy [11]. 99m Technetium (Tc) refers to renal isotope within imaging of nuclear medicine. It has been found effective because of its good imaging proficiency with little radiation doses and its short half-life of about six hours [6]. The use of 99mTc-MAG3 scan to study RBF may be effective in the setting of acute kidney injury, but it is not broadly used. While, there is normal effect of renal uptake within one-two minutes in prerenal azotemia. It is probable to be decreased in parenchymal and vascular diseases [12].

The literature provided has presented value of nuclear medicine and the ultrasonography in different diagnostic procedures. There is no effective outcomes observed, which clearly explain the efficacy of imaging modalities. Following section provides the methodology for the evaluation of the value of nuclear medicine versus ultrasonography in diagnosing renal disease. The results provide comparison between efficacies of both imaging modalities for the diagnosis of renal diseases.

3. METHODOLOGY

The study targeted the patients, suffering from renal diseases and investigate the positive and negative effect of its diagnosis through nuclear medicine and ultrasonography. The diagnosis of renal diseases from nuclear medicine and ultrasonography has assist to evaluate the effectiveness of the diagnostic procedure. The value of nuclear medicine versus ultrasonography in diagnosing renal disease has been evaluated by comparing the effect obtained from the experimental study. The study has experimented the effectiveness of both diagnostic procedures for the diagnosis of renal diseases among patients. The study has targeted 80 patients of different ages having renal diseases. The positive and negative effects of both diagnostic procedures has been then compared quantitatively. Statistical Package of Social Sciences (SPSS) version 20.0 has been used to compare the effectiveness of the procedures and evaluate the comparison.

4. RESULTS

Table 1 has shown some of the findings observed through the nuclear medicine and ultrasonography among the patients having different indications including hydronephrosis, renal stone, severe right obstructive uropathy, post right nephrostomy tube insertion, hypertension, left pyeloplasty, and renal pelvis dilatation.

Table-1. Some of the findings observed through the assessment of Nuclear Medicine and Ultrasonography for diagnosing renal disease among patients

Nuclear Medicine Findings	Ultrasonography Findings
Right Kidney Obstruction	Bilateral Echogenic Kidneys, Correlation With Renal Function Test Is Recommended
No Evidence Of Obstruction + Decreased Blood Flow And Function	Interval Increase In Left Renal Hydronephrosis
Likely Dilated Non Obstructed Bilateral Hydronephrosis	Stable Degree Of Right Severe Hydronephrosis
Multiple Renal Scars	Unremarkable KUB Ultrasound Study Apart From Internal Debris Is Seen Within The Urinary Bladder
Decreased Flow And Function Bilaterally With No Response To Lasix Likely Related To Massive Hydronephrosis	Both Kidneys Are Normal In Size, Shape And Echo-Pattern With No Stones, Space Occupying Lesions Or Hydronephrosis Noted
The Left Kidney Obstructed	Multiple Left Renal Stones With Moderate Hydronephrosis
Dilated Nonobstructed Left Kidney	Left Renal Severe Hydronephrosis And Proximal Hydroureter
Left Lower Moiety Show Partial Obstruction	Mild Fullness Of The Right Renal Pelvis, And Marked Dilatation Of The Left Renal Pelvis
Right Kidney Contributing By 42% Of The Total GFR	The Right Kidney Is Hydronephrotic With Cortical Thinning. No Stones Could Be Identified
No Evidence Of Obstruction Bilaterally	Left-Sided Hydroureter Is Noted
No Evidence Of Obstruction Bilaterally	Bilateral Medical Renal Disease With Left Hydroureteronephrosis
Left Kidney Showed Decrease Perfusion	Left Kidney Is Apparently Disconfigured With Irregular Outlines, Of Normal Cortical Echogenicity
No Evidence Of Obstruction Bilaterally	Bilateral Moderate Hydronephrosis Is Noted. The Left Renal Pelvis Is Also Dilated
The Left Kidney Is Small	Mild Right Hydronephrosis
Dialated Nonobstructed Pelvocaliceal System	Interval Progression Of Bilateral Moderate Hydronephrosis
Small Functioning Left Kidney	Bilateral Fullness Of The Renal Pelvis With Grade 1 Medical Kidney Disease. Small Left Kidney
Small Left Kidney With Moderate Decreased Flow And Function	Findings Of Neurogenic Bladder With Secondary Infection
Bilateral Renal Scars	Interval Improvement In Right Hydronephrosis And Increase In The Left Side Hydronephrosis
The Right Kidney Is Small In Size, Still Functioning And Contributes By 18% Of The Total Counts.	Right-Sided Mild Hydronephrosis
There Is No Evidence Of Obstruction At Both Hydronephrotic Kidneys.	Redemonstration Of Bilateral Slightly Echogenic Kidneys With Severe Hydronephrosis In The Right Side
The Right Kidney Is Not Obstructed. -The Left Kidney Is Not Functioning	No obstruction
Both Kidneys Showed Faint Uptake Due To Impaired Renal Function.	Evidence Of Bilateral Hydronephrosis And Increased Renal Parenchymal Echogenicity
Both Kidneys Are Not Obstructed.	Bilateral Mild Worsening Of The Renal Pelvic Dilatation , More Pronounced On The Right Side

Source: This table is developed via collected data from the participants during research

The results were analyzed statistically to observe the effectiveness of nuclear medicine and ultrasonography imaging techniques against different age groups (Table 2 and Table 3).

Table-2. Effectiveness of Nuclear Medicine (NM) against different age groups

Cross tabulation					
			NM Anatomical Finding		Total
			Positive	Negative	
Age Category	**0-12 years**	**Count**	36	9	45
		% within NM Anatomical Finding	58.1%	52.9%	57.0%
	13-24 years	Count	10	4	14
		% within NM Anatomical Finding	16.1%	23.5%	17.7%
	25-36 years	Count	1	1	2
		% within NM Anatomical Finding	1.6%	5.9%	2.5%
	37-48 years	Count	6	1	7
		% within NM Anatomical Finding	9.7%	5.9%	8.9%
	49-60 years	Count	2	1	3
		% within NM Anatomical Finding	3.2%	5.9%	3.8%
	61-72 years	Count	5	1	6
		% within NM Anatomical Finding	8.1%	5.9%	7.6%
	73-84 years	Count	2	0	2
		% within NM Anatomical Finding	3.2%	0.0%	2.5%
Total		Count	62	17	79
		% within NM Anatomical Finding	100.0%	100.0%	100.0%

Source: This table is retrieved through SPSS via collected during research

Nuclear medicine anatomical findings were 58% positive among the patients of age-group 0-12 years. It was 16% positive among the patients of age groups 13-24 years and 23.5% negative. Similarly, table 2 has presented the positivity and negativity the nuclear medicine imaging techniques as observed from the medical assessment of the patients. The patients were observed with nuclear medicine and ultrasonography imaging technique to examine the effectiveness of both techniques for the diagnosis of renal diseases. Percentages have been shown with respect to different age groups in table 2. The positive findings were observed between the age groups 0-12 years, 37-48 years, 61-72 years and 73-84 years of patients. However, negative findings were observed among the patients of age groups 13-24 years, 25-36 years and 49-60 years (Table 2). Patients were diagnosed through nuclear medicine and ultrasonography by observing the indications of flank pain, right renal stone with shrunken left kidney, ureteric obstruction and others.

Table-3. Effectiveness of Ultrasonography (US) against different age groups

Cross tabulation						
			US Finding			Total
			Positive	Negative	Missed	
Age Category	0-12 years	Count	37	6	2	45
		% within US Finding	58.7%	54.5%	40.0%	57.0%
	13-24 years	Count	11	3	0	14
		% within US Finding	17.5%	27.3%	0.0%	17.7%
	25-36 years	Count	2	0	0	2
		% within US Finding	3.2%	0.0%	0.0%	2.5%
	37-48 years	Count	4	1	2	7
		% within US Finding	6.3%	9.1%	40.0%	8.9%
	49-60 years	Count	2	0	1	3
		% within US Finding	3.2%	0.0%	20.0%	3.8%
	61-72 years	Count	5	1	0	6
		% within US Finding	7.9%	9.1%	0.0%	7.6%
	73-84 years	Count	2	0	0	2
		% within US Finding	3.2%	0.0%	0.0%	2.5%
Total		Count	63	11	5	79
		% within US Finding	100.0%	100.0%	100.0%	100.0%

Source: This table is retrieved through SPSS via collected during research

Table 3 has presented the positive and negative effects of the ultrasonography as an imaging technique for the diagnosis of renal disease. Similar age groups were observed as taken in table 2. Positive effects were observed among the patients of age-group 0-12 years (58.7%), 13-24 years (17.5%), 25-36 years (3.2%), 49-60 years (3.2%) and 73-84 years (3.2%). The remaining percentages were observed with negative effects; although majority of the patients having different age groups, have shown positive results using this technique for the diagnosis of renal diseases. Table 4 is providing complete details about the two approaches related to sensitivity, specificity, and accuracy. It has been evaluated that nuclear medicine approach has higher sensitivity rate as compared to ultrasonography, as NM has successfully detected all of the cases with 100%; however, 5 cases were missed by ultrasonography. In regards of specificity, ultrasonography is better than nuclear medicine as 79.7% of the cases had positive findings in US; however, NM had 78.4% positive findings. Moreover, ultrasonography is also better in terms of accuracy as compared to nuclear medicine as 13.92% cases had negative results (US); however, the rate of negative results for nuclear medicine was 21.5%. Therefore, it can be said ultrasonography is beneficial as compared to nuclear medicine.

Table-4. Sensitivity, Specificity, and Accuracy

	Nuclear Medicine	Ultrasonography
Sensitivity	100% (All of the cases have been detected)	93.6% (There were 5 cases, which were missed)
Specificity	78.4% (62 cases were positive)	79.7% (63 cases were positive)
Accuracy	21.5% (17 cases were showed negative results)	13.92% (only 11 cases showed negative results)

Source: This table is retrieved through SPSS via collected during research

5. DISCUSSION

The present study has observed different positive findings of nuclear medicine imaging technique; including right kidney obstruction, no evidence of obstruction with decreased blood flow and function, dilated non-obstructed bilateral hydronephrosis, multiple renal scars, left kidney obstruction, and dilated non-obstructed left kidney. However, there were some negative effects observed including both kidneys that showed faint uptake due to impaired renal function and are not obstructed. The ultrasonography and its effects were also observed among the recruited patients, which showed different findings; some of which include multiple left renal stones with moderate hydronephrosis, left renal severe hydronephrosis and proximal hydroureter, mild fullness of the right renal pelvis, and marked dilatation of the left renal pelvis.

The ultrasonography imaging technique has been observed more effective as compared to the nuclear medicine for the immediate and effective diagnosis of renal diseases as observed through the analysis. The ultrasonography is found effective for assessing unchanged bilateral severe hydrouretero-nephrosis and multiple internal echoes in the left renal pelvis, which could be attributed to infection for clinical correlation. It effectively diagnosed that kidneys are normal in size, shape, and echo-texture.

The diagnosis of renal-artery disease has been increased substantially due to the use of Doppler ultrasonography among patients having hypertension. Angioplasty is usually used as a treatment for the patients of a renal artery having stenosis of more than fifty percent of luminal diameter to reserve the renal function and lower blood pressure. Although, the treatment is unable to improve the renal function and blood pressure in around twenty-forty percent patients. There is no authentic or reliable technique to prospectively diagnose the patients [13]. The color Doppler technique was observed beneficial to identify the renal-artery stenosis, which enabled to recognize the diameter reduction of at least fifty percent with 97% sensitivity and 98% specificity of renal arteries [14]. The method may offer the severity estimation of the stenosis that is precise and reproducible [13].

A study by Harper, et al. [15] updated regarding the technique of ultrasonically relocate the kidney stones, and it was found that the technique was effective and safe in the porcine model. Stones were efficiently expelled and

repositioned from the kidney. There were no adverse outcomes observed with the acute explorations that directly targeted the pancreatic tissue and kidney. There was also no indication of delayed tissue injury.

A study by Ather, et al. [16] has determined the accuracy of ultrasonography, as compared un-enhanced helical among patients having renal failure in the obstruction and stone diagnosis. Ultrasound has many different intrinsic advantages, which comprise of universal availability, scarcity of radiations, non-invasive, and inexpensive. It is effective and useful in the diagnosis of ureteric and renal calculi. Stones are categorically demonstrated through ultrasonography having high echogenic foci with discrete acoustic shadowing. The utmost challenge regarding ultrasonography is the recognition of ureteral calculi, specifically in upper pelvic, and the abdominal course. This restriction of ultrasonography is because of the incapability to scan retroperitoneum. Ultrasonography was observed as 81% sensitive, 100% specific; and hydronephrosis was observed as 93% sensitive and 100% specific. Ureteric stone was 46% sensitive to be picked. The X-ray kidney, ureter and bladder enhanced the sensitivity for ureteric stone for up to 77% [17].

Anatomical information is effectively provided by the nuclear medicine, and it cannot be contrasted with high resolution obtained with MR or CT imaging techniques. The advantage of nuclear medicine scintigraphy is that it offers metabolic (functional) information before any anatomic change. Physicians observe the images through nuclear medicine according to the position, size and morphology of the renal tissues functioning. The use of cortical radiopharmaceuticals allows retained radiography and vesicoureteral reflux in the collecting system to impede with percent differential renal function determination. It is stated that the treatment of renal disease should not be delayed; while, waiting for the nuclear medicine outcomes [18].

6. CONCLUSION

Ultrasonography is observed relatively effective for the diagnosis of renal disease among the patients indicating flank pain, right renal stone with shrunken left kidney, ureteric obstruction, left chronic renal stone , hydronephrosis follow up, post pyeloplasty to asses renal Function, left renal artery aneurysm, post bilateral pyeloplasty, posterior urethral valve, and other relevant indications. The results have shown the effectiveness of ultrasonography as an imaging modality for the diagnosis of renal diseases among patients of all age groups. Effective and positive findings have been observed among patients of younger ages as well as older ages. Future studies should emphasize on conducting the researches based on other imaging modalities for the diagnosis of renal diseases as it is essential to timely diagnosis the disease before the organ failure.

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