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Relationship of GFR using Gamma Camera with Resistive and Pulsatility Index (RI & PI) of Renal Artery using Doppler Ultrasound

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Abstract **Original Research Article**

Background: The aim of this study was to correlate the GFR using Gamma Camera with Resistive and Pulsatility Index (RI & PI) of renal artery using Doppler Ultrasound. ***Methods:*** The data of this study was collected from 150 patients both gender referred to nuclear medicine department in Radiation and Isotopes centre -Khartoum (RICK) – Sudan who underwent renal scintigraphy was performed in conjunction with Doppler ultrasound. ***Results:*** The PI showed inverse linear relationship with GFR where GFR decreases by 58 ml/ one unit of PI; similarly the RI showed an inverse linear relationship with GFR where it decreased by 141 ml per one unit of RI. ***Conclusions:*** The results of GFR using renal scintigraphy can be predicted using RI and PI index and hence the patients who needed further investigation as renal scintigraphy can be identified based on the Doppler results.

Keywords: Glomerular Filtration Rate (GFR), Gamma Camera, Renal Scintigraphy, Doppler Ultrasound, Pulsatility Index (PI), Resistive Index (RI), Body Mass Index (BMI).

INTRODUCTION

Glomerular filtration rate (GFR) is defined as the total amount of ultrafiltrate produced by all glomeruli in both kidneys within 1 minute. It is considered to be the best overall indicator of kidney function in health and disease [1-3]. A normal GFR is ~130 mL/min/1.73 m^2 in males and ~120 mL/min/1.73 m^2 in females [4]. The rationale is that GFR is a property of the kidney, has a large range, and is affected by physiologic, pharmacologic, and pathologic conditions. Furthermore, GFR decline is associated with many physiologic and clinical consequences and is correlated with decline in other excretory functions, such as tubular reabsorption and secretion, as well as endocrine and metabolic functions. Decreased GFR is one criterion in the definition and staging of acute and chronic kidney diseases. GFR estimating equations are recommended for routine use for kidney function assessment in clinical Practice [5, 6]. The persistent reduction in the GFR to less than 60 ml per minute per 1.73 m^2 is defined as chronic kidney disease [7].

Renal scintigraphy is a nuclear medicine technique that uses medical radioactive isotopes for the evaluation of the renal function. Functional data complete clinical and anatomical data obtained through other imaging techniques and can assist the clinician in the diagnostic and management of various renal disorders. The most widely used radioactive isotope for medical imaging is ^{99m}-Technetium. In renal scintigraphy ^{99m}-Tc is coupled to a substance that is eliminated predominately by glomerular filtration (DTPA) or tubular excretion (MAG3) or which is attached to tubular proteins (DMSA). DTPA and MAG3 allow a dynamic study which result in the generation of a nephrographic curve for each kidney and the calculation of clearance parameters - glomerular filtration rate (GFR) or the effective renal plasma flow (ERPF), respectively [8].

Doppler ultrasound is essential for evaluation of the kidneys. and which assesses the patterns of renal and extrarenal vascularization. Doppler investigations must be performed properly to gain useful data. It allows information about the presence and direction of blood flow in renal vessels. The pulsatility index (PI) and the resistive index (RI) are used as pulsed-wave Doppler measurements of downstream renal artery resistance. PI and RI have been found to correlate with renal vascular resistance, filtration fraction and effective renal plasma flow in chronic renal failure [9, 10]. Therefore the general objective of this study was to estimate the GFR using RI and PI values.

MATERIALS AND METHODS

The data of this study was collected from 150 patients both gender suffering from renal disorder and referred to nuclear medicine department in Radiation and Isotopes centre -Khartoum (RICK) – Sudan who underwent renal scintigraphy. The patient's variables were age, weight, hight, BMI, and the data were analyzed by the Statistical Package for Social Studies (SPSS) program (version 20) and presented in tables and graphs.

This study was carried out using a dose calibrator to measure the activity of radiopharmaceutical before administration to the patient, as well the data acquired form the region of interest using SPECT gamma camera in the renal scintigraphy and ultrasound system general electric GE. Transducer: highest frequency curved linear array probe possible, start with 5 MHZ and work down to 2 or 3 MHZ for larger patients with ultrasound Doppler capabilities as follows:

Firstly in Doppler ultrasound: The patient should be lie supine, for the right kidney have the patient lie supine and place the probe in the right lower intercostal space in the mid axillary line. And the liver as your acoustic window and aim the probe slightly posteriorly toward the kidney. Gently rock the probe up and down or side to side to scan the interior kidney. Obtain longitudinal (long axis) and transverse (short axis) views. For the left kidney the patient has lie supine or in the right lateral decubiti position, place the prob in the lower intercostal space on the posterior axial line. The placement will be more cephement and posterior than when visualizing right kidney, and again rock the probe to scan the entire kidney to obtain longitudinal and transverse view.

For Renal scintigraphy: as patient preparation instruct the patient to hydrate well and void just before test, before start the scan should be measure the count of syringe before and after injection to calculate the GFR. The patient should be lie in supine position and the camera posterior to the patient, in the pelvic kidney we use two detectors one anterior and one posterior to the patient. the position camera by point source over xiphoid, umbilicus, pubic symphysis, and sides in field of view. Insert intravenous butterfly with 3-way stopcock, inject normal saline flush, inject 5 mCi ^{99m}Tc-DTPA intravenously in one bolus, wait until they see activity blush in the abdomen (the "umbrella" effect caused by the heart-liver-spleen and descending aorta) then start the camera. Inject furosemide after 15 to 20 minutes the start of the scan, Acquire serial (dynamic) 1-minute images for 30 minutes.

RESULT AND DISCUSSION

Pulsatility Index (PI) showed inverse linear relationship with GFR where GFR decreases by 58 ml/ one unit of PI starting at 134 ml similarly the RI also showed an inverse linear relationship with GFR where it decreased by 141 ml per one unit of RI; but using linear regression relationship only the PI got a significance relation with GFR, therefore in order to predict the GFR from Doppler results PI can give a significant value for GFR using the following equation: *GFR = 134.31- (57.72×PI).* body characteristics represented by body mass index has no significance influence in PI or RI as shown in figure (3) and (4) respectively.

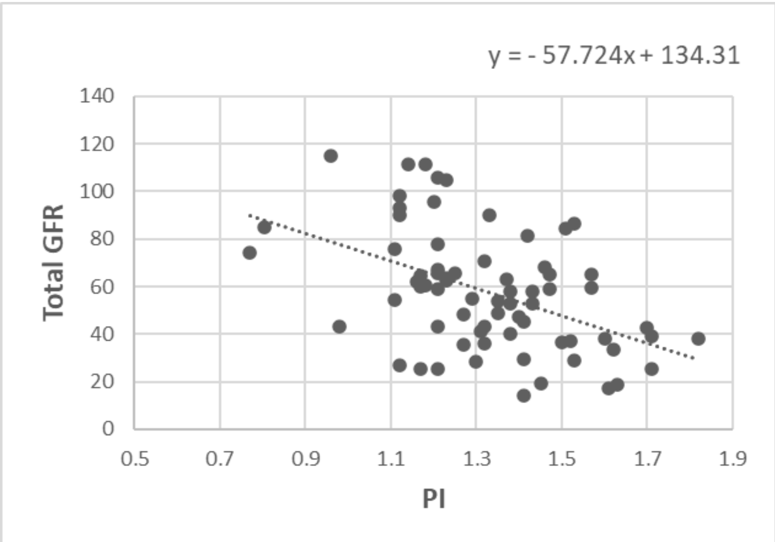

Fig-1: A scatter plot shows an inverse linear relationship between GFR result using renal scintigraphy and PI index.

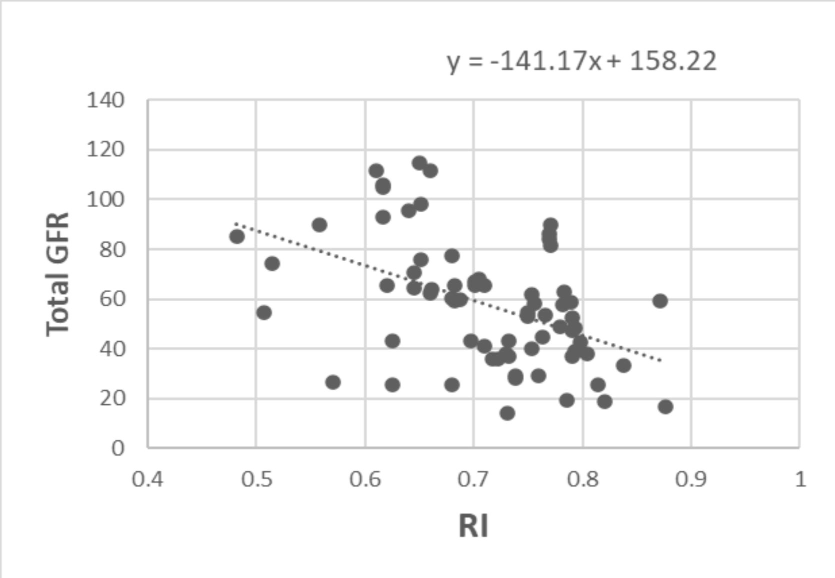

Fig-2: A scatter plot shows an inverse linear relationship between GFR result using renal scintigraphy and RI index.

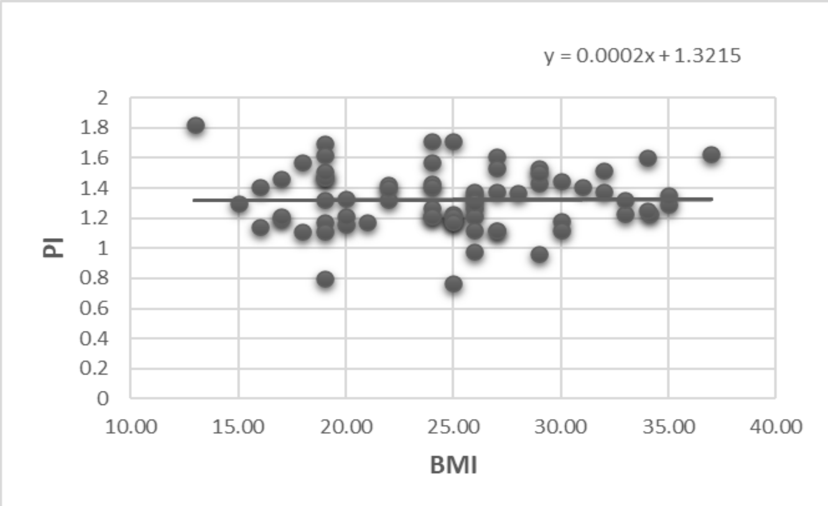

Fig-3: A scatter plot shows a direct linear relationship between PI index and patient BMI.

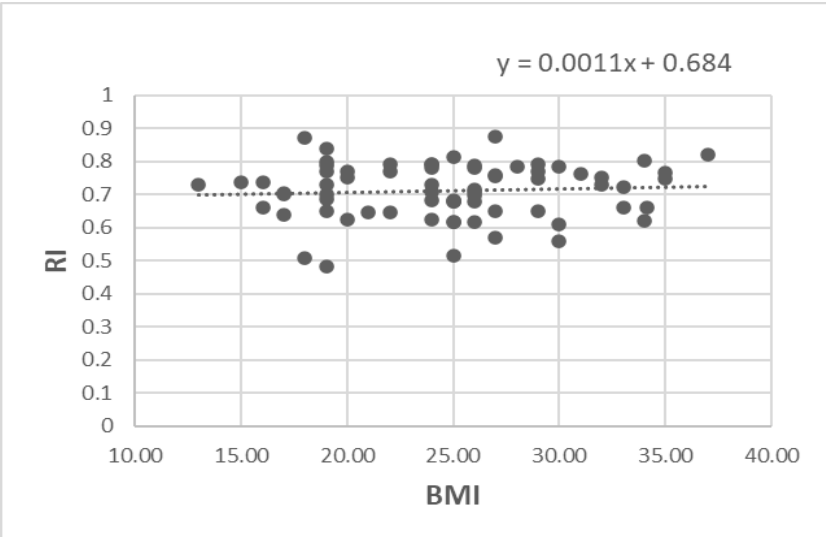

Fig-4: A scatter plot shows an direct linear relationship between RI index and patient BMI.

CONCLUSION

This study was carried out in order to relationship of GFR using Gamma Camera with Resistive and Pulsatility Index (RI & PI) of renal artery using doppler ultrasound and hence make it possible to predict the results of GFR renal scintigraphy using doppler ultrasound results.

The data of this study collected from 150 patients their renal function was assessed using renal scintigraphy and Doppler ultrasound in Radiation and Isotope Centre in Khartoum (RICK).

The results of this study showed that a pulsatility Index (PI) in doppler ultrasound result got a significance relation with GFR result using renal scintigraphy. so the results of GFR using renal scintigraphy can be predicted using Pulsatility Index (PI) in doppler results objectively by applying the following equation: $GFR = 134.31 - (57.72 \times PI)$, and hence can send the patients to renal scintigraphy if needed based on the doppler results.

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