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Original Research Article

The Split-Function Effect of Renal Scintigraphy for the Evaluation of Renal Disorders Due to Tc- DTPA Pharmaceutical

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Purpose: The purpose of this study was to clarify renal disorders on the split-function effect of renal scintigraphy due to Tc- DTPA pharmaceutical.

Methods: The experiments were carried out in the Centre for Nuclear Medicine and Ultrasound, Rajshahi. 18patients were taken under our study. The patients were given 5 mCi intravenously 99mTc injections. The exam was performed using a gamma camera equipped with a low energy and high resolution collimator. On the day of the exam, the patients drank 600 ml of water before radioisotope injection. The bladder was emptied immediately before the exam and the patients were then positioned with the gamma camera in contact with their back. Sequential images were acquired and fed to the computer for 20 min.

Results: In this research, Split function, increased with patient age (Normal), kidney depth, Time of ½ Max, Kidney Counts (Abnormal) and patient height. On the other hand, Split- function, decreased with patient age (normal), Time of Max, Kidney Counts (Normal) and patient weight. Therefore, split-function does influence great role for diagnosis various renal disorders.

Conclusion: ^{99m}Tc DTPA can evaluate renal disorders with more findings and provided that split function can measure an early investigation for clinical diagnosis of renal disorders.

Key words: Renal disorder, 99mTc-DTPA, Renal differential function, Kinetic behavior.

INTRODUCTION

Renal Artery Stenosis, Renal hypertension, Acute Tubular Necrosis (ATN), renal obstruction and renal failure etc. are renal disorders. Renal Artery stenosis is a narrowing of the renal artery, which restricts blood flow to the kidneys. Following Goldblatt *et al.,* [1] experiments and the first confirmed surgical cures in humans, the relationship of human hypertension to renal artery stenosis (RAS) was explored in many elegant investigations. The physiology of the rennin- angiotensin system, in particular, was revealed. A crude renal extract having pressor properties was first identified 1898 [2]. The active component of the extract, named ranin, was found to act upon angiotensinogen, a liver protein, to produce angiotensin I (AI). AI, in turn, is converted to angiotensin II (AI), [3] primarily in the lung, [4] by angiotensin converting enzyme fixed within the pulmonary vasculature. Reduction in the renal blood flow may lead to Acute Tubular Necrosis (ATN) [5]. Obstructive Uropathy is the blockage on the interference of the flow of urine [6-7]. Renal failure is characterized by an abrupt reduct of renal function, the urine output, reducing to less than 500 ml 24 hrs [8]. Such disorders of the kidney can be identified. Radioisotope scans have been established as a routine method for the evaluation of individual renal function [9-10]. Renograms using technetium labeled (^{99m}Tc)-diethylene triamine pentaacetic acid (DTPA) are used to assess the degree of obstruction and to quantify unilateral renal function [11]. The 2 most frequently used radiotracers for evaluation of renal function are ^{99m}Tc-DTPA and ^{99m}Tc-MAG3 [12–20]. Renal differential function covers split-function for left and right kidney. On the basis of split-function, diseases or disorder of the kidney can be evaluated. The aim of the present study was to evaluate renal disorders on the split-function effect of renal scintigraphy due to Tc- DTPA pharmaceutical.

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MATERIAL AND METHODS

Radiotracer preparation

^{99m}Tc solution was collected by using a Technetium generator in the Centre for Nuclear Medicine and Ultrasound, Rajshahi (CNMU). A technetium-^{99m} generator is a device used to extract the metastable isotope ^{99m}Tc of technetium from a source of decaying molybdenum-99. The daughter radionuclide can be separated from the parent isotope by chemical means. In the case of the ^{99}Mo/^{99m}Tc generator, ^{99m}Tc is separated from ^{99}Mo by passing saline through the column. The 99mTc is eluted of the generator column as sodium pertechnetate (Na^{99m}TcO4), but the ^{99}Mo immobilized on the column. Alternative separation techniques include solvent extraction and sublimation. DTPA was to be mixed with ^{99m}Tc as a carrier agent for renal scintigraphy.

Patient preparation and injection

The experiments were carried out in the Centre for Nuclear Medicine and Ultrasound, Rajshahi; 18patients were taken under our study. The patients were given 5 mCi intravenously ^{99m}Tc injections.

Scintigraphy assessment

Clinical histories of the patients who came to select Nuclear Medicine Center (CNMU, Rajshahi) for diagnosis and therapeutic treatment were recorded. Patients in this study were referred for evaluation of differing entnephrologic disorders. All were first investigated with DTPA -^{99m}Tc gamma camera renography. The exam was performed using a gamma camera equipped with a low energy and high resolution collimator. On the day of the exam, the patients drank 600 ml of water before radioisotope injection. The radioligand dose was 185 MBq (5 mCi) administered intravenously. The bladder was emptied immediately before the exam and the patients were then positioned with the gamma camera in contact with their back. Sequential images were acquired and fed to the computer for 20 min. Furosemide (Lasix) was administered intravenously for 20 min at the dose of 40 mg. The normal value for the percent renal function was considered to be 50 ± 6% [21]. The split differential function should normally be 50%:50%. Errors in calculation, patient anatomical variations and the fact that the calculation is not an absolute measurement, but a difference in the ratio will mean that a variation of 10% is acceptable [22]. Depending on the uptake value of split differential function, patients were divided into classified as a normal and abnormal patient. A variation of 10% was introduced as normal patient. On the other hand, moreover variation of 10 % was identified as abnormal patient. Split function influenced great role for classifying patients on the basis of the spilt uptake value of ^{99m}Tc DTPA. Therefore more emphasis had been done on the split function interaction among other factors.

Statistical analysis

Correlate bivariate was applied for data analysis with IBM SPSS statistic software. Spearman correlation has been used for data analyzed.

RESULTS AND DISCUSSION

The fractional renal uptake of intravenously administered ^{99m}Tc- DTPA, within 2 to 3 minutes following radiotracer arrival in the kidneys, is proportional to the glomerular filtration rate (GFR).Due to renal disorders the uptake of 99mTc-DTPA varies with time. To evaluate renal disorders, some parameters came to be considered under this research. These factors are patient age, patient weight, patient's height, Kidney Depth, Kidney counts, Body surface area, Split-function, Time of Max (min), Time of ½ Max (min) etc. So, the Split functions greatly influenced by these factors. We focused those parameters with split-function effectively to evaluate renal disorders using 99mTc DTPA.

Patient age

Renal disorders can be evaluated at any age of people. In this research report, patient age had played an important role for a renal differential function such as split-function. Patient age had influenced highly negative significant on Time of Max (min) for Right Kidney (TMR) and Time of ½ Max (min) for right Kidney (THMR) (Table 3). But it affected negatively significant on counts for right Kidney (KCRK) (Table 4). It was noted that the Split-function, increased with patient age for normal patient, but decreased for abnormal patient [Figures 1(a) & 1(b)]. We conclude that the split function varied for renal disorders with patient age.

Patient height

Patient height affected highly significant on Body surface (BS), Kidney Depth for left Kidney (KDL), Kidney depth for right kidneys (KDR) & Time of Max (min) for the left kidney (TML) (Table 4). Patient height, significant on Body surface (BS). Split function, increased with patient height for all patients [Figure 2(a) & 2(b)].

Patient weight

Patient weight depends on patient growth and habit of his behavior. It was influenced in some parameters. The interaction of patient height (PW) with (Body surface) BS, Kidney depth for left Kidney (KDL), Kidney depth for the right kidney (KDR) and Time of Max (min) for the left kidney (TML) was statistically highly significant at 0.01 level (Table 3). It was noted that patient height influenced statistically significantly on BS, KDL and KDR (Table 4). Split- function, decreased with a patient weight [Figure 3(a) & 3(b)]. We may focus that the split function, decreased statistically significantly with patient weight due to renal disorders.

Table 1: Data summary of Normal patient

Descriptive Statistics

Parameters of Patients	Mean	Std. Deviation	N
Age (A)	20.1667	12.78150	6
Height (H)	141.3833	22.87430	6
Weight (W)	37.2667	12.64431	6
Body surface (BS)	1.2100	.31540	6
Reference Area (R)	1.6433	.21229	6
Split-function for left Kidney (SFL)	49.8500	3.80986	6
Split-function for right Kidney (SFR)	50.1500	3.80986	6
Kidney counts for left Kidney (KCL)	48279.3333	26989.60080	6
Kidney counts for right Kidney KCR	47339.0000	24402.95129	6
Kidney Depth for left Kidney (KDL)	4.0763	.81357	6
Kidney Depth for right Kidney KDR	4.1020	.81984	6
Time of Max (min) for left Kidney (TML)	7.2842	6.89864	6
Time of Max (min) for right Kidney TMR	6.3508	3.40830	6
Time of ½ Max (min) for left Kidney (THML)	12.5000	1.53623	5
Time of ½ Max (min) for right Kidney (THMR)	14.3213	4.02973	6

Table 2: Data summary of Normal patient

Descriptive Statistics

Parameters of Patients	Mean	Std. Deviation	N
Age (A)	36.3333	19.05176	12
Height (H)	157.9000	8.16745	12
Weight (W)	49.2583	6.04355	12
Body surface (BS)	1.4742	.10875	12
Reference Area (R)	1.6836	.16079	12
Split-function for left Kidney (SFL)	52.1608	36.44246	12
Split-function for right Kidney (SFR)	47.8308	36.43685	12
Kidney counts for left Kidney (KCL)	44222.0561	39900.33088	12
Kidney counts for right Kidney KCR	56935.8500	60519.86528	12
Kidney Depth for left Kidney (KDL)	4.8210	.52132	12
Kidney Depth for right Kidney KDR	4.7107	.77114	12
Time of Max (min) for left Kidney (TML)	4.2288	6.11891	12
Time of Max (min) for right Kidney TMR	4.3969	5.66648	12
Time of ½ Max (min) for left Kidney (THML)	4.8943	5.86579	10
Time of ½ Max (min) for right Kidney (THMR)	9.7201	5.64355	11

Table 3: Analysis of Variance (ANOVA) for normal patient

Correlations

	A	H	W	BS	R	SFL	SFR	KCL	KCR	KDL	KDR	TML	TMR	THML	THMR
A	1	.727	.795	.761	.313	-.369	.369	.557	.734	.775	.776	-.752	-.929**	.141	-.931**
H		1	.966**	.990**	.036	-.524	.524	.207	.360	.939**	.939**	-.976**	-.595	-.364	-.459
W			1	.992**	-.013	-.459	.459	.347	.492	.993**	.993**	-.927**	-.616	-.573	-.581
BS				1	.000	-.494	.494	.276	.425	.977**	.977**	-.957**	-.600	-.560	-.518
R					1	.534	-.534	.576	.556	-.109	-.109	.020	-.381	.109	-.386
SFL						1	-1.000**	.475	.272	-.485	-.485	.669	.409	-.643	.156
SFR							1	-.475	-.272	.485	.485	-.669	-.409	.643	-.156
KCL								1	.971**	.338	.338	-.130	-.514	-.233	-.625
KCR									1	.480	.480	-.313	-.695	-.124	-.770
KDL										1	1.000**	-.906*	-.592	-.601	-.568
KDR											1	-.907*	-.592	-.601	-.568
TML												1	.681	-.446	.471
TMR													1	-.522	.842*
THML														1	-.037
THMR															1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4: Analysis of Variance (ANOVA) for abnormal patient

Correlations

	A	H	W	BS	R	SFL	SFR	KCL	KCR	KDL	KDR	TML	TMR	THML	THMR
A	1	-.349	.258	-.024	.039	.542	-.541	.206	-.623*	.409	.472	.353	-.481	.325	.088
H		1	.275	.731**	-.181	-.038	.038	.076	-.074	-.153	-.406	-.252	.337	.076	-.380
W			1	.856**	.201	.291	-.291	.332	-.296	.907**	.597*	-.512	-.036	.111	-.579
BS				1	.070	.189	-.189	.284	-.243	.560	.205	-.507	.159	.147	-.620*
R					1	.451	-.451	.349	-.288	.265	.122	.176	.083	.244	.086
SFL						1	-1.000**	.747**	-.915**	.300	.252	.339	.142	.772**	-.068
SFR							1	-.747**	.915**	-.300	-.253	-.339	-.142	-.772**	.068
KCL								1	-.539	.293	.314	.157	.304	.400	-.029
KCR									1	-.266	-.085	-.387	-.087	-.686*	.036
KDL										1	.778**	-.432	-.171	.038	-.421
KDR											1	-.171	-.301	.200	-.281
TML												1	.082	.845**	.553
TMR													1	.261	.137
THML														1	-.599
THMR															1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

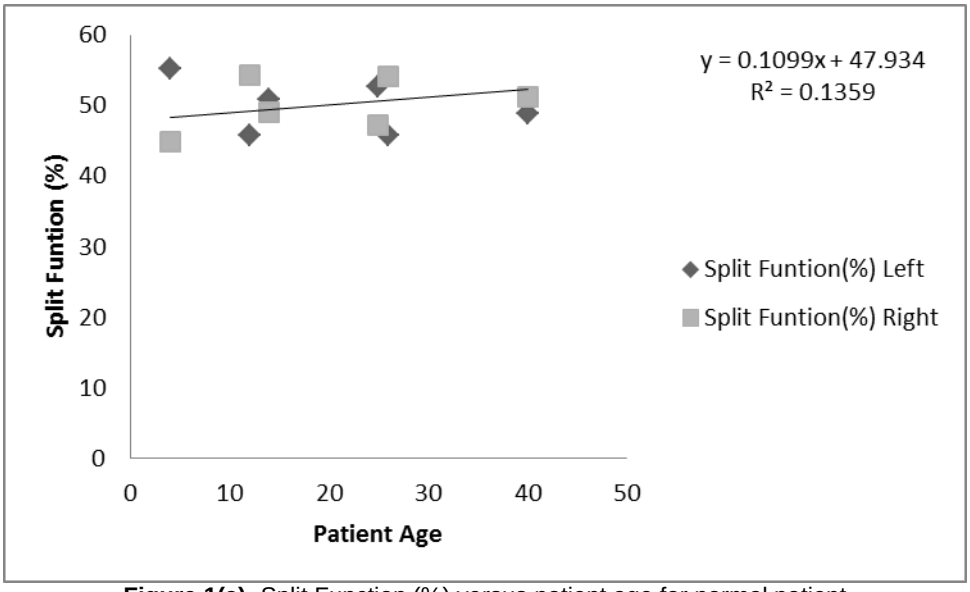

Figure 1(a): Split Function (%) versus patient age for normal patient

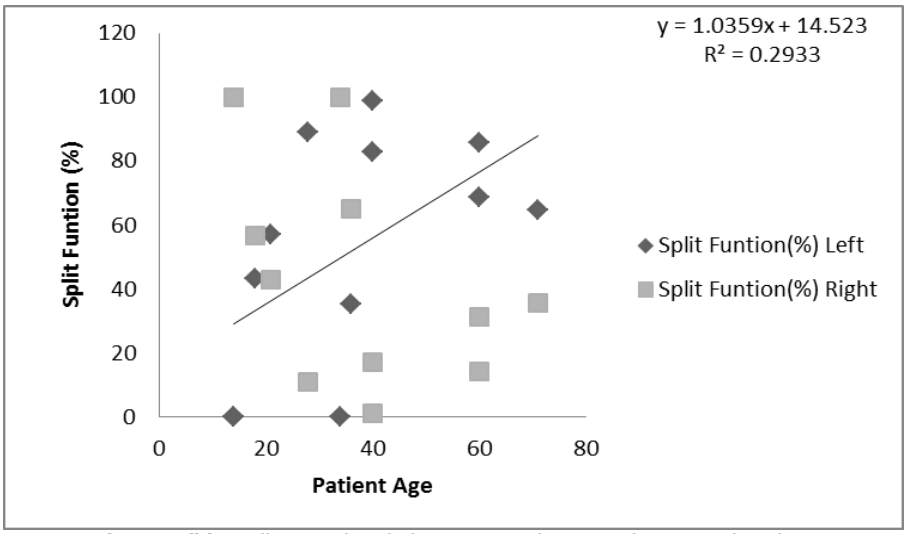

Figure 1(b): Split Function (%) versus patient age for normal patient

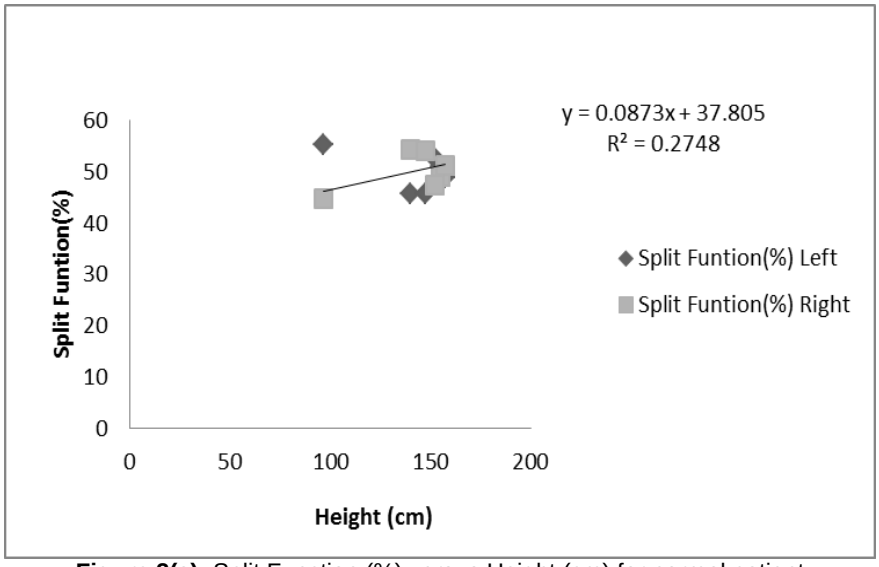

Figure 2(a): Split Function (%) versus Height (cm) for normal patient

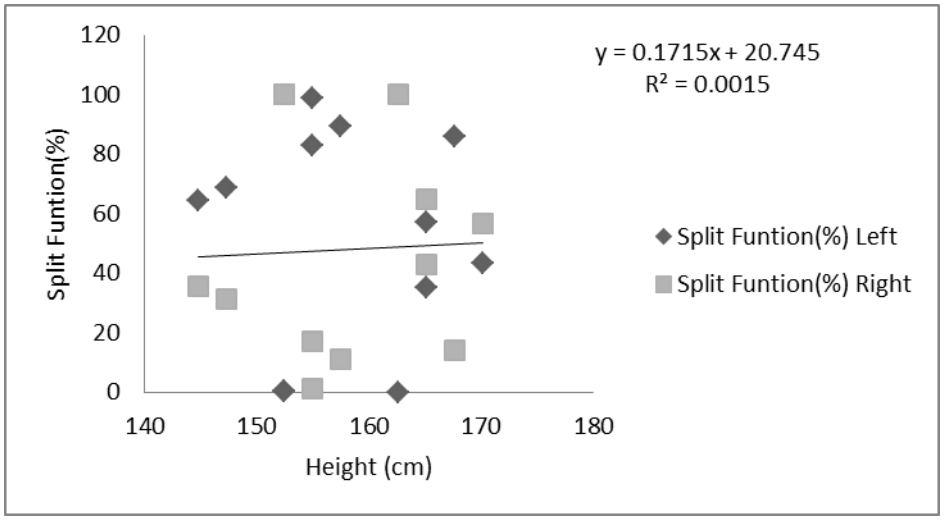

Figure 2(b): Split Function (%) versus Height (cm) for abnormal patient

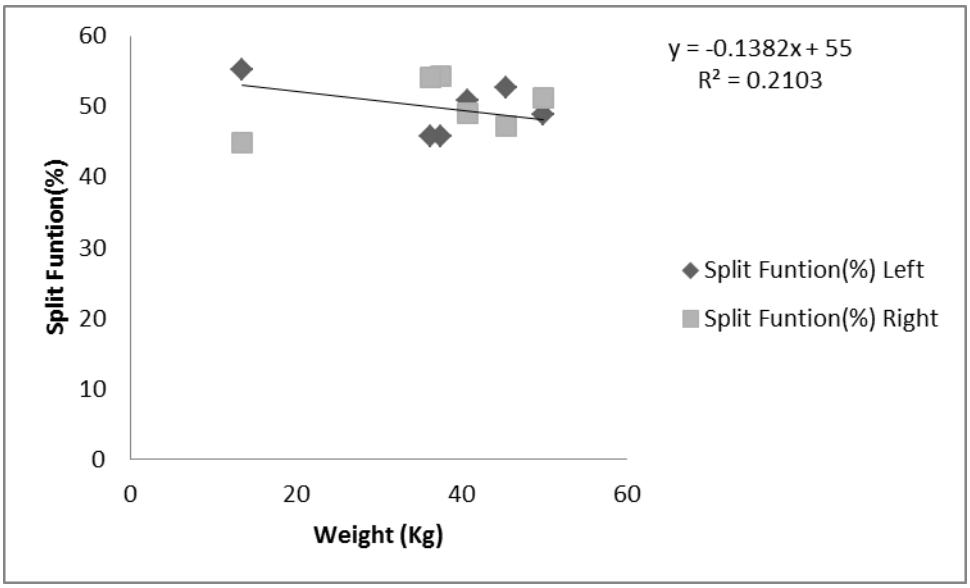

Figure 3(a): Split Function (%) versus Weight (Kg) for normal patient

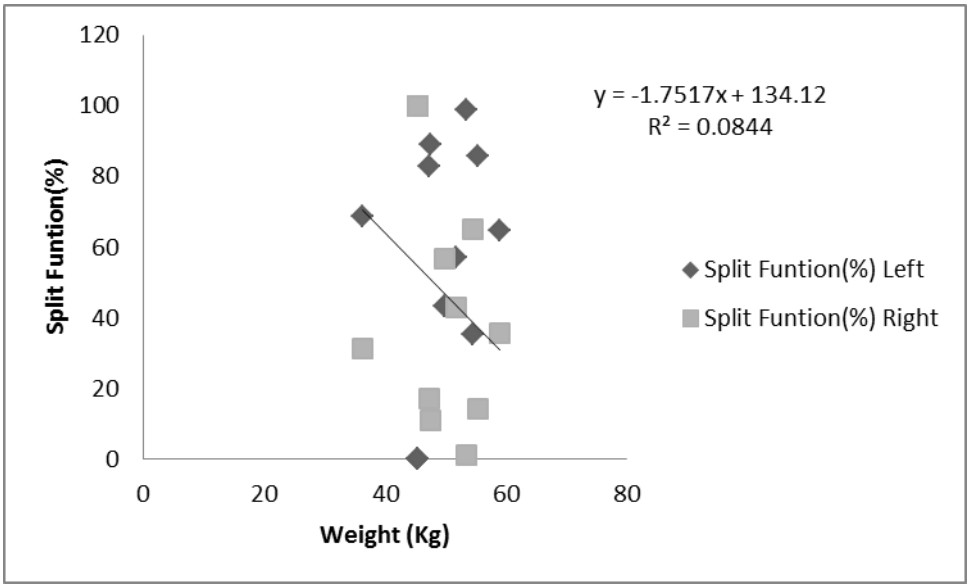

Figure 3(b): Split Function (%) versus Weight (Kg) for abnormal patient

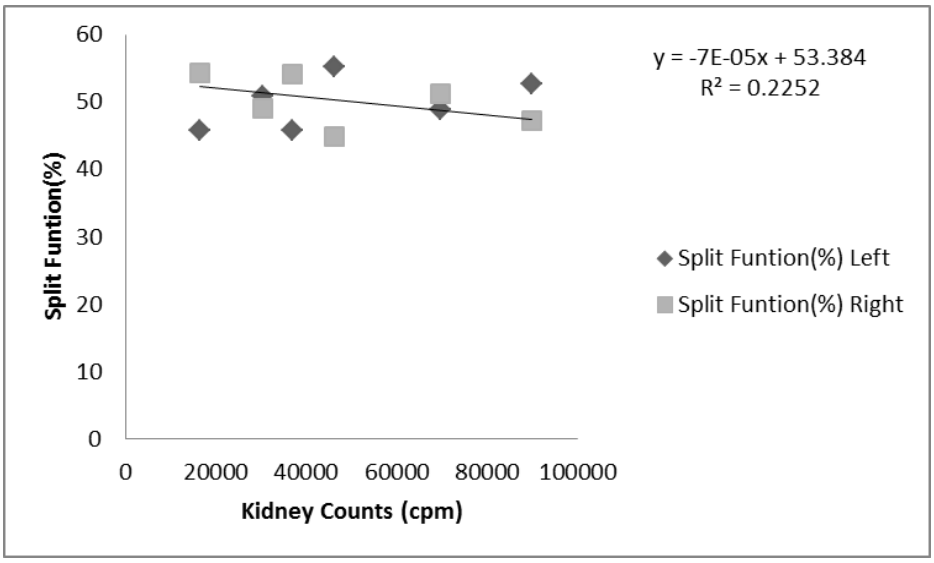

Figure 4(a): Split Function (%) versusKidney Counts (cpm) fornormal patient

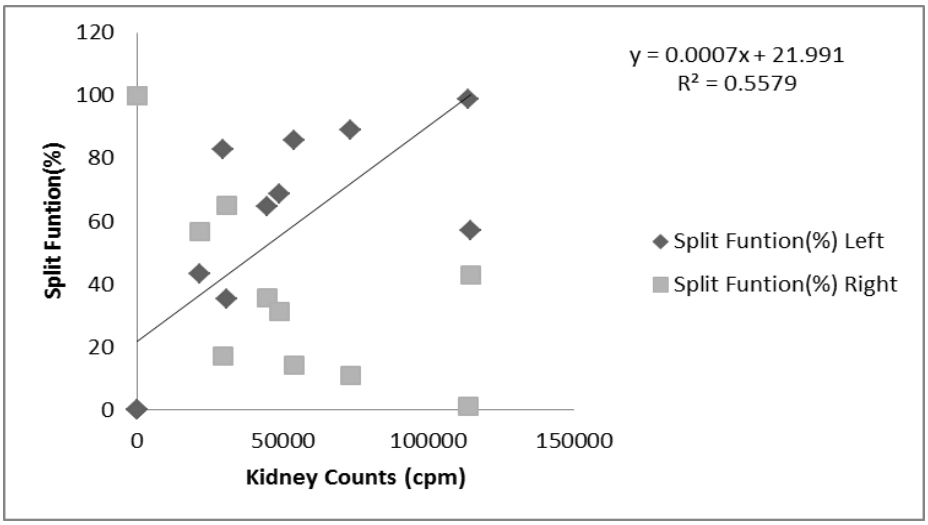

Figure 4(b): Split Function (%) versusKidney Counts (cpm) for abnormal patient

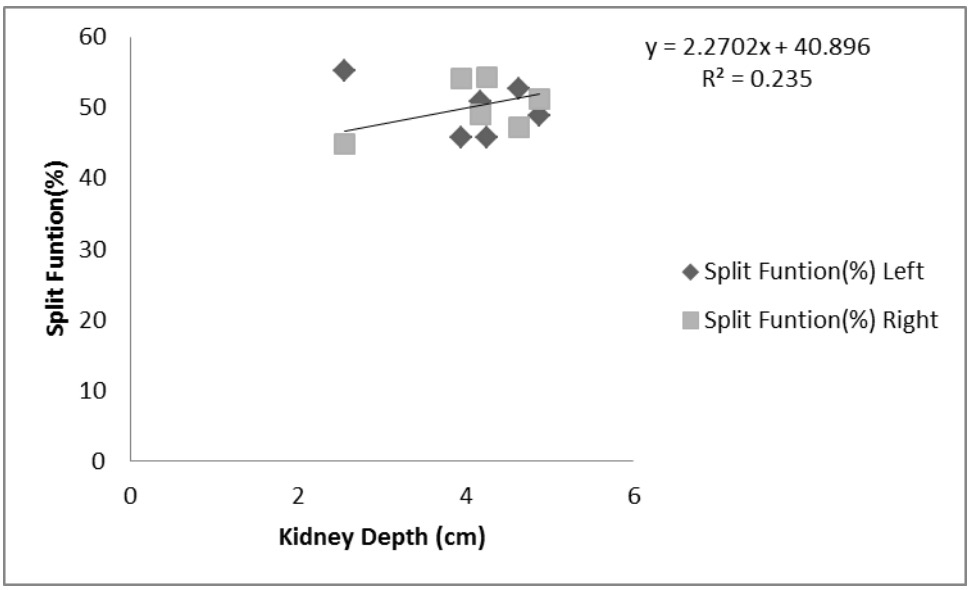

Figure 5(a): Split Function (%) versusKidney Depth (cm) for normal patient

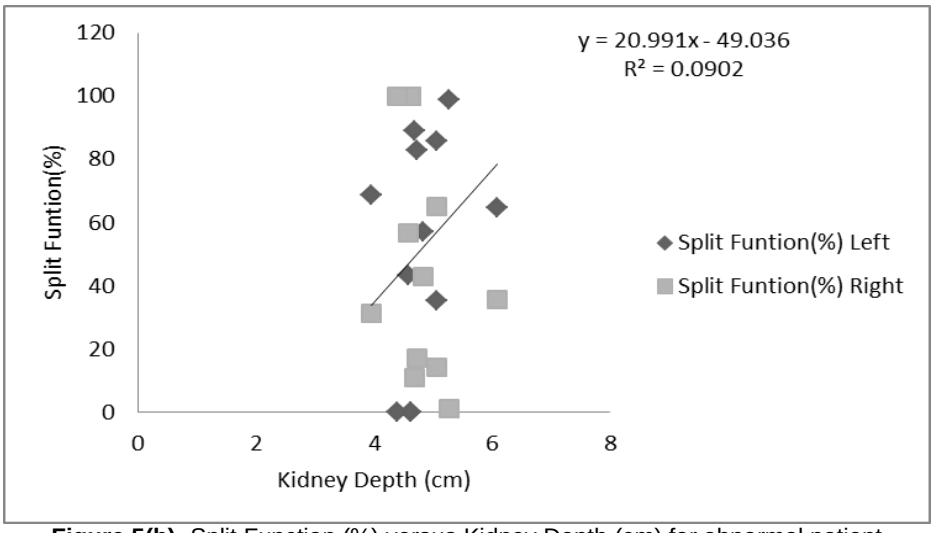

Figure 5(b): Split Function (%) versus Kidney Depth (cm) for abnormal patient

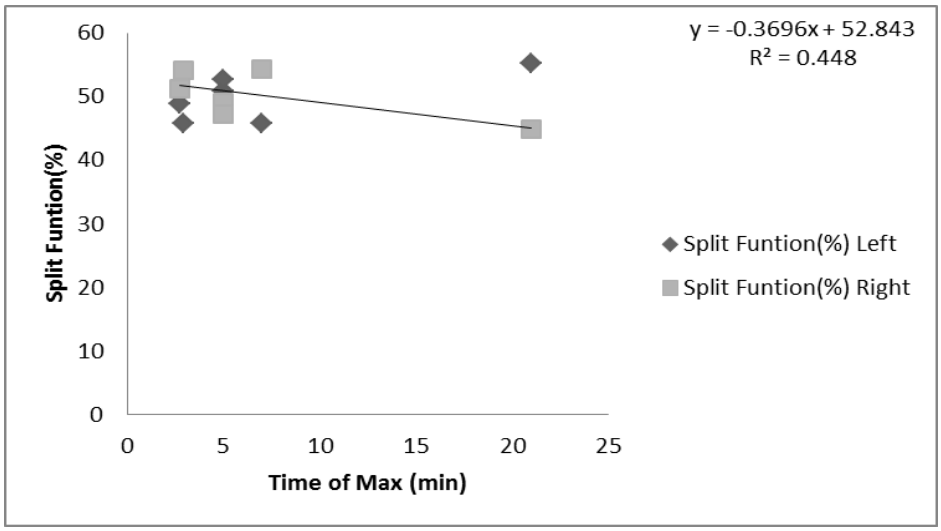

Figure 6(a): Split Function (%) versusTime of Max (min) for normal patient

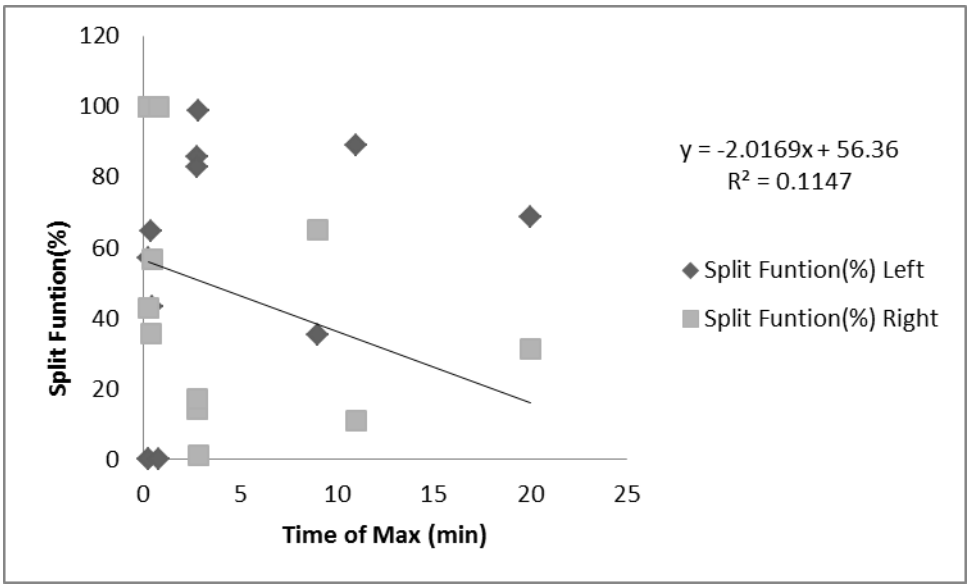

Figure 6(b): Split Function (%) versusTime of Max (min) for abnormal patient

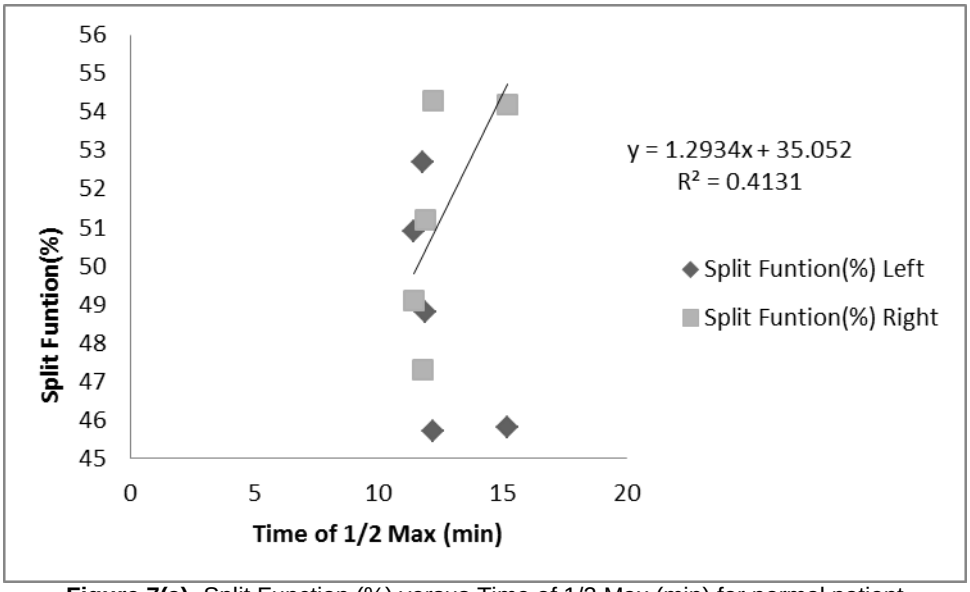

Figure 7(a): Split Function (%) versus Time of 1/2 Max (min) for normal patient

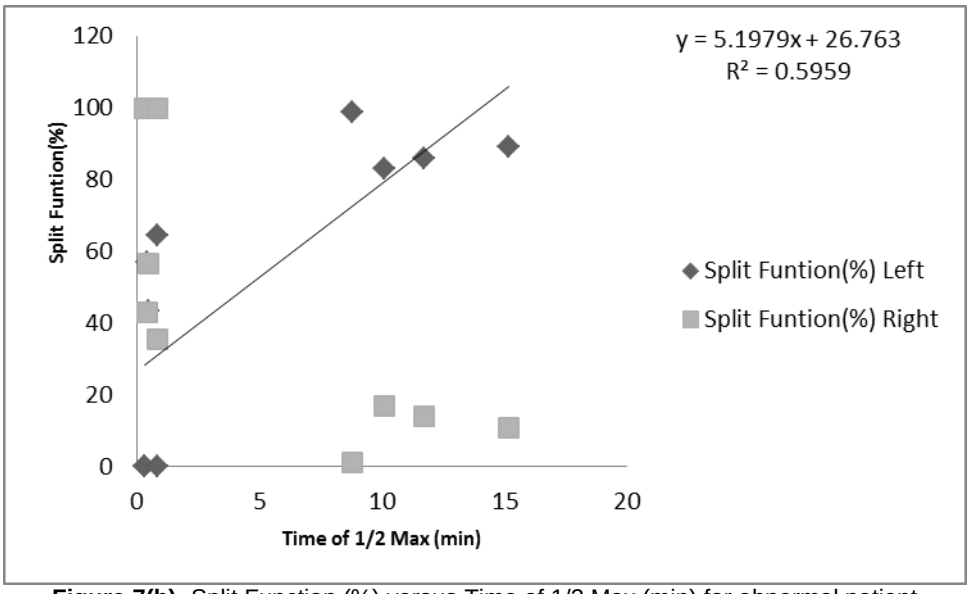

Figure 7(b): Split Function (%) versus Time of 1/2 Max (min) for abnormal patient

Kidney Counts

Kidney counts for the left kidney (KCL) affected statistically highly significant on Kidney counts for right Kidney (KCR) and Kidney counts for left Kidney (KCL) was not influenced on split function (Table 3). On the other hand, no significant effect on split function by KCL(Kidney counts for left Kidney) but it did negatively effect on KCR(Kidney counts for right Kidney),Time of ½ Max (min) for left Kidney (THML) (Table 4).Split function, decreased with Kidney Counts (KC) for normal patient but increased for abnormal patient [Figure 4(a) & 4(b)] due to renal disorder function.

Kidney Depth

Kidney depth of each patient is not the same thickness. Kidney depth for left Kidney (KDL) does negatively high significance on Time of Max (min) for left Kidney (TML) for normal patient (Table 3) and on the Kidney depth for right Kidney (KDR) (Table 4). For both normal and abnormal patients, split-function, increased with kidney depth [Figure 5(a) & 5(b)].

Time of Max (minute)

Time of maximum (min) expressed as the highest peak value time of kidney counts. Time of Max (min) for the left kidney (TMR) was statistically significant with Time of ½ Max. (Min) for right Kidney (THMR) at 0.05 levels (Table 3) but Time of Max (min) for left Kidney (TML) influenced on Time of ½ Max (min) for left Kidney (THML) (Table 4). Split-function, decreased with Time of Max (TM) for all patients [Figure 6(a) & 6(b)].

Time of ½ Max (min)

The time that the radiotracer is reached half its original value expressed as Time of ½ Max (min). No significant effect on Time of half Max (min) for left kidney (THML) &Time of ½ Max (min) for right kidney (THMR) (Table 3& 4). Split-function,

increased with Time of ½ Max (min) (THM) for all patients [Figure 7(a) & 7(b)].

CONCLUSION

The research revealed that the Split function increased with patient age (Normal), kidney depth, Time of ½ Max, Kidney Counts (Abnormal) and patient height. On the other hand, Split-function, decreased with patient age (normal), Time of Max, Kidney Counts (Normal) and patient weight. ^{99m}Tc DTPA can evaluate renal disorders with more findings and provided that split function can be measured in early investigation for clinical diagnosis of renal disorders.

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