RENAL RESISTIVE INDEX FINDINGS AMONG PATIENTS UNDERGOING RENAL DOPPLER ULTRASOUND AT MUHIMBILI NATIONAL HOSPITAL

Anganile Bernard Kalinga (MD)

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School of Medicine
Department of Radiology and Imaging

RENAL RESISTIVE INDEX FINDINGS AMONG PATIENTS UNDERGOING RENAL DOPPLER ULTRASOUND AT MUHIMBILI NATIONAL HOSPITAL.

By

Anganile Bernard Kalinga

A Dissertation Submitted in (Partial) Fulfillment of the Requirement for the Degree of Master of Medicine (Radiology) of
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CERTIFICATION

The undersigned certify that he/she has read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled ***Renal Resistive Index Findings Among Patients Undergoing Renal Doppler Ultrasound At Muhimbili National Hospital,*** in (Partial) Fulfillment of the requirements for the degree of Master of Medicine (Radiology) of Muhimbili University of Health and Allied Sciences.

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Dr. Fredrick Lymo

(Supervisor)

Date:____________________________

DECLARATION AND COPYRIGHT

I, **Anganile Bernard Kalinga,** declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature: ______________________ Date: _______________________________

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Lastly but not least I am thankful to my fellow classmates for their cooperation and support during the study period.

DEDICATION

This dissertation is dedicated to my beloved husband, Dr. Joseph C. Masanja, and my dear parents Mr. Bernard and Mrs. Odina Kalinga for their tireless support towards accomplishing this work.

ABSTRACT

Background: Renal sonography has been used for years in many clinical settings like the assessment of chronic renal allograft rejection, diagnosis and management of renal artery stenosis, assessment of risk progression in chronic kidney disease, differential diagnosis in acute and chronic obstructive renal diseases and as a predictor of renal and global outcome in the critically ill patient. Recent evidence shows that an increased renal resistive index reflects changes in intra-renal perfusion and presence of subclinical atherosclerosis. There is increased renal Doppler ultrasound at Muhimbili National Hospital and minimal research data on the subject contributed to this study been proposed.

Purpose: To document renal resistive index findings among patients undergoing renal Doppler ultrasound at Muhimbili National Hospital from January 2018 to June 2019.

Methods: Retrospective cross sectional hospital based study was conducted; data was collected from patients who have undergone renal ultrasound in ultrasound unit of Muhimbili National Hospital.

The sample was selected by convenience consecutively from every eligible patient's records for the study from the renal Doppler ultrasound records, during working hours. Data was collected by using a structured questionnaire. Socio-demographic patterns of patients, clinical indications for renal sonography and Doppler parameters and other renal sonographic findings was analyzed using SPSS version 23.0 to compute for descriptive statistics. $P<0.05$ was cut off value for statistical significance level.

Results: Two to four percent of the native kidneys had raised renal resistive index while **s**ixteen percent of transplanted kidneys had raised renal resistive index. The mean age of the patients who had renal Doppler ultrasound was 40.8years. Renal resistive index was statistically significantly associated with ESRD. Other sonographic factors such as renal size, hydronephrosis, CKD and CMD were significantly associated variably with native and allograft RRI.

Conclusion: Majority of patients who had renal allograft had more raised renal resistive index compared to those with native kidneys.

Recommendation: Renal Doppler study be done in patients suspected of renal disease particularly those with end stage renal disease contrary to other imaging modalities which use contrast. Further studies into this topic are suggested and strongly encouraged.

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LIST OF ABBREVIATIONS

No.	Abbreviation	Description
1.	CDUS	Color Doppler Ultrasound
2.	CKD	Chronic Kidney Disease
3.	CTA	Computed Tomography Angiography
4.	EDV	End Diastolic Volume
5.	ESRD	End Stage Renal Disease
6.	MHZ	Mega Hertz
7.	MNH	Muhimbili National Hospital
8.	MRA	Magnetic Resonance Angiography
9.	MUHAS	Muhimbili University of Health and Allied Sciences
10	RRI	Renal Resistive Index
11	RI	Resistive Index
12.	SD	Standard Deviation
13.	SPSS	Statistical Package for Social Sciences
14.	STGs	Standard Treatment Guidelines

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DEFINITION OF TERMS

1. **Renal Sonography** is the ultrasound imaging of the kidneys.
2. **Renal Doppler** is interrogation of Doppler settings in ultrasound imaging of the kidneys. This include color Doppler which is sensitive to signal from moving red blood cells after assigning color based on direction of the moving blood and duplex Doppler which includes the use of gray scale imaging and pulse Doppler frequency shift on the vertical axis and time on the horizontal axis.
3. **Primary hypertension**: is elevated blood pressure of no known secondary cause.
4. **Chronic Kidney conditions** in this study include Chronic Kidney Disease and End stage Renal Disease.

Key words:

Renal Sonography, Renal Doppler, Primary hypertension, Chronic Kidney conditions.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Ultrasound is firmly established as a primary imaging modality for comprehensive evaluation of the abdomen including the abdominal organs, the peritoneal cavity, and the retro peritoneum (1,2).

Ultrasound and Doppler imaging has also traditionally been used in the assessment of chronic renal disease. Indeed, the Doppler-derived renal resistive index (RRI) has been used for years in a variety of clinical settings such as the assessment of chronic renal allograft rejection (3), detection and management of renal artery stenosis (1,4) , evaluation of progression risk in chronic kidney disease (CKD) (5), differential diagnosis in acute and chronic obstructive renal disease, and more recently as a predictor of renal and overall outcome in the critically ill patient (1) .

Recent clinical and experimental evidence indicates that an increased RRI in patients with primary hypertension not only reflects changes in intra-renal perfusion, but that it is also associated with systemic hemodynamics and atherosclerosis, and may provide useful prognostic information and possibly have therapeutic implications (1).

Although the functional and structural factors that contribute to renal blood flow patterns and changes are still not completely understood, intra-parenchymal arterial waveform is believed to be the result of both vascular compliance and resistance. Doppler-derived indexes may thus reflect one or more pathogenesis mechanisms such as arteriolosclerosis and interstitial fibrosis, which contribute to determining vascular elasticity (1).

Renal Artery stenosis (RAS) is mostly caused by atherosclerosis or fibro muscular dysplasia. RAS may present asymptomatically, or as renal-vascular hypertension and renal insufficiency (ischemic nephropathy) or both. Atherosclerosis cause has become a concern for end stage renal disease (ESRD) particularly in elderly population due to hypertension and renal ischemia (6). Atherosclerosis is progressive disease particularly in diabetic patients or other manifestations of atherosclerosis. The prevalence of ESRD implicated by atherosclerosis ranges from 5% to 22% and the prevalence of RAS ranges 1-5% among hypertensive patients (6). However early diagnosis and radiological intervention of RAS is the most potential cure for secondary hypertension and renal failure. Studies elsewhere have documented on the Doppler findings and RAS (1,6–8). However scantly is documented about such findings in our settings where the prevalence of ESRD is 11% and above 80% amongst diabetic outpatients in Tanzania (9) .

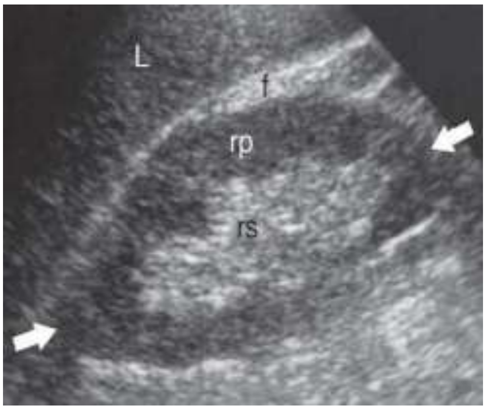
The ideal imaging procedure should identify the main and accessory renal arteries, localizing the site of the disease and provides evidence of haemodynamic significance of stenosis, associated pathologies such as renal mass, abdominal aortic aneurysm. That may have effects on treatment of RAS. Angiography is considered a gold standard of imaging the RAS, however it is invasive hence it is not regarded as a screening tool but rather used as intervention procedures such as transluminal renal angioplasty. Thus, in recent years many less invasive or noninvasive diagnostic methods, such as captopril renal scintigraphy, color-Doppler ultrasonography (CDUS), computed tomography angiography (CTA) and magnetic resonance angiography (MRA) have been tested and compared to arteriography. Among these different methods, CDUS has been selected by many institutions as the principal screening tool used to detect RAS (6,10).

The native adult kidneys are imaged with curvilinear 2-5 Mega Hertz (MHz) probe and the higher frequency linear of curvilinear probe for the transplanted kidneys for the gray scale findings. The normal sonographic renal length measures 11+/- 2 cm (2). The normal sonography of the renal cortex is isoechoic or hypoeichoic to the liver but hypoechoic to the spleen with renal medullary pyramids hypoeichoic conned shaped surrounded by more echogenic cortex. The central echogenic renal sinus contains blood vessels collecting system and lymphatics. In newborns renal cortex is relatively hypoeichoic to the liver (figure 1) (2).

Renal arteries arise from the lateral aspect of aorta at the level 1-2cm below the junction of Superior mesenteric artery. The renal arteries travel posterior to respective renal veins and the right renal artery is posterior to inferior vena cava.

Most of the renal arteries obstructions occur near by their point of birfucation from aorta. The gray scale, color and power doppler may be used to locate and sample the renal arteries from the origin/ proximal portion to hilum for spectral doppler while keeping the doppler angle (between direction of blood flow and applied Doppler ultrasound signal) not more than 60 degrees the maximum possible, optimizing the velocity scale for the waveform to avoid aliasing by adjusting the scale and baseline) (6,11).

Resistive Index is calculated with the formula= (peak systolic velocity – end diastolic velocity)/peak systolic velocity, and the mean value of three measurements at each kidney is usually considered. An RRI value 0.60±0.01 (mean±SD) is usually taken as normal with a value of 0.70 being considered the upper normal threshold by most authors (1,6) . In order to maximize waveform size, the lowest pulse repetition frequency without aliasing, the highest possible gain without noise and the lowest wall filter is emphasized (2).

A 

B 

Image above showing normal kidneys **A.** Adult kidney. A long axis US view of the right kidney (between *arrows*) obtained through the liver (*L*) demonstrates echogenicity of the normal renal parenchyma approximately equal to the echogenicity of the normal liver. The renal sinus (*rs*), containing vessels, the collecting system, and fat, is hyperechoic compared to the renal parenchyma (*rp*). The margins of the kidney are outlined by echogenic perirenal fat (*f*). Morison pouch is a recess of the peritoneal cavity between the kidney and the liver that usually fills with fluid when ascites is present. **B.** Newborn kidney. In newborns and infants, the renal cortex is more echogenic than in older children and adults, causing the medullary pyramids (*arrowheads*) to appear more lucent and resemble hydronephrosis. Note that the lucent pyramids correspond anatomically to the location of the renal medulla, that the pyramids do not interconnect, and that the renal pelvis is not dilated. The adrenal gland (*A*) is normally prominent in size in the newborn (2).

1.2 LITERATURE REVIEW

Several studies have been done in Europe, Asia, North America and Africa, specifically Tanzania about prevalence, associated factors and burden of CKD among diabetics patients to be more than 80% (9). The leading cause of ESRD among diabetes is atherosclerosis (3). There is significant renal artery stenosis among patients with atherosclerosis, who have risk factors of malignant hypertension and diabetes (3). The prevalence of RAS ranges 1-5% among hypertensive patients (6) in one study in Europe. In one meta-analysis study the prevalence of ESRD in Sub Saharan Africa was 14% and Eastern Africa was 11% (2).

Clinical factors associated with atherosclerosis induced RAS among others include malignant hypertension, diabetes mellitus, and ESRD. Socio-demographic and economic factors influencing RAS include, age, sex, marital status, knowledge about factors influencing CKD and prevention of CKD among diabetes patients in Tanzania (9,12,13).

Literature shows that ESRD is an emerging global public health problem (12). Two studies done in Italy and Taiwan revealed the prevalence of ESRD as high as 30% amongst highly selected referral population (6,14). Italy and Taiwan are developed countries with increasing the possibility for more advanced screening procedures for RAS yet there have high prevalence of ESRD. Similarly Tanzania has ESRD prevalence as high as 80% amongst diabetic patients (13). This calls for a need to assess the sonography patterns among patients undergoing renal Doppler scan in our country in which there is equally limited screening procedures for RAS for risk patients.

A study carried out in Tanzania came up with very high prevalence rate of CKD among diabetes patients with justification of inadequate screening procedures amongst indicated patients (13). Several studies propose close correlation of ESRD, hypertension and diabetes (6,9,10,12–14). Similarly there is significant RAS among patients with atherosclerosis with risk factors of malignant hypertension and diabetes (6). The leading cause of ESRD among diabetes is atherosclerosis (6,13).

Resistive Index has been fruitfully used to gain diagnostic and prognostic insights into a variety of clinical conditions from renal vascular disease to CKD and renal transplant (1).

Increased renal resistive index (RRI) is a marker of atherosclerotic and hypertensive organ damage both at the renal and systemic level. It is a predictor of cardiovascular and renal outcome. Measurements of RRI may have therapeutic implications in the management of hypertensive patients in particular. Radermacher et al. (6) found that intra-renal RI 0.8 obtained in segmental renal arteries was highly predictive of treatment failure in patients with atherosclerotic RAS. More recently, an increased RRI has been shown to be a marker of renal and extrarenal organ damage in primary hypertension. Several studies indicate that this abnormality may in part reflect systemic vascular stiffness and entail a worse cardiovascular prognosis (6).

High resistive index may be caused by intrinsic renal diseases (i.e. nephroangiosclerosis, hypertension, tubular interstitial disease, diabetes mellitus, and severe bradycardia) despite normal serum creatinine levels (6). Further non-renal factors have an impact on the intra-renal RI of the kidneys. For example, tachycardia induces low values of RI, simply because the systolic peak begins earlier than in the case of normal heart rate. Similarly, bradycardia (heart rate<60 beats/min) induces high values of RI (5,6).

The stiffness of the supplying arteries, e.g. the aorta or the iliac artery, has a significant impact on the RI derived in renal allografts. Acute swelling of the kidney leads to an increase in vascular resistance. Therefore, high RI is registered in patients with significant renal obstruction, with haemolytic uraemic syndrome, as well as in those with acute transplant rejection (6).

.3 CONCEPTUAL FRAMEWORK

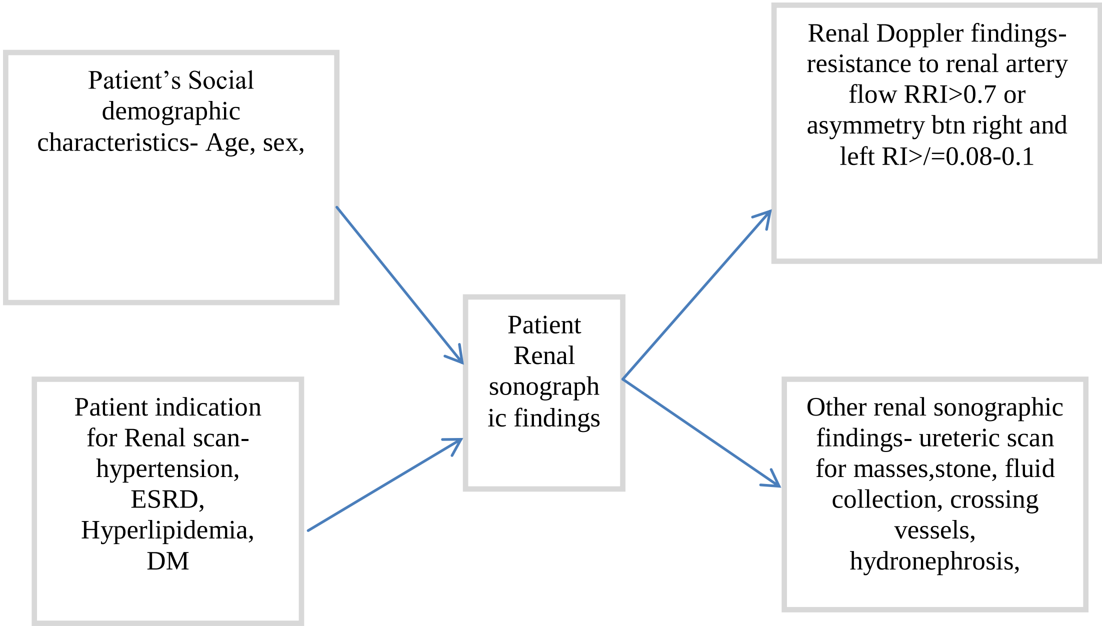


Figure 1: Conceptual Framework

Sonographic findings of patients undergoing renal scan ware renal Doppler and other grey scale findings. The clinical indicators for renal sonography ware hypertension, ESRD, Hyperlipidaemia, DM and Patients' Social demographic characters are age and sex was evaluated in this study.

1.4 STATEMENT OF THE PROBLEM

The Renal Artery Stenosis refers to narrowing of the renal artery that impairs blood flow to the kidney. The two most patho-physiologies are fibro-muscular disease and atherosclerosis. Atherosclerosis accounts for up to 90% of renal vascular lesions (10). Atherosclerosis is highly associated with diabetes and ESRD. The prevalence of RAS ranges 1-5% among hypertensive patients (6). The prevalence of CKD in US was approximately 47% among elderly more than 70 years and 6.71% among 40-59 years in general population. Similarly high prevalence was found in Japan 20% and Beijing 13% populations (15). In one meta-analysis study the prevalence of ESRD in Sub Saharan Africa was 14% and Eastern Africa was 11% (12). ESRD prevalence among out-patients diabetics at Bugando hospital Tanzania was estimated to be 80%. Despite these findings, a little is known about the renal Doppler sonographic patterns of patients with ESRD, diabetes and hypertension risks.

High RRI is also reported in coronary artery disease, hypertension, hyperlipidemia, aorto-iliac occlusive disease and elderly(10,14).

Among sonographic patterns of ESRD renal resistive index is one of the parameter used to provide prognosis insight to patients with ESRD and post renal transplants (1).

Literature shows that there exists high RRI among diabetics, hypertensive and in allograft rejection cases (10,14) but none of the studies was done in Tanzania.

Compared to conventional angiography in assessment of Renal Resistive index, renal Doppler is less invasive and less expensive relative to the cost of CTA or MRA. However very little is known about ultrasound findings among patients suspected to have renal artery stenosis.

1.5 RATIONALE

Despite renal Doppler ultrasound been done in Tanzania, little or nothing was known on patterns of sonographic findings. This study has contributed to understanding of how social demographic and health factors related to patients undergoing renal Doppler ultrasound at MNH.

The findings of this study has gained understanding of the sonographic patterns of renal Doppler scan and created the baseline platform data for future studies.

1.6 RESEARCH QUESTIONS

1. What are socio-demographic factors of patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019?
2. What are the indications of renal Doppler among patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019?
3. What are the Doppler findings among patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019?
4. What are other renal sonographic findings in patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019?
5. What is the association between the socio-health characters and renal resistive index findings among patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019?

1.7.0 OBJECTIVES

1.7.1 Broad Objective

To determine renal resistive index findings among patients under undergoing renal Doppler ultrasound at Muhimbili National Hospital from January 2018 to June 2019.

1.7.2 Specific Objectives

1. To determine demographic factors of patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019.
2. To identify the indications of renal Doppler among patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019.
3. To determine the Doppler findings among patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019.
4. To determine other renal sonographic findings in patients undergoing renal Doppler ultrasound at MNH from January 2018 to June 2019.
5. To determine the association between socio-health characters and the renal resistive index findings from January 2018 to June 2019.

CHAPTER TWO

2.0 METHODOLOGY

2.1 STUDY DESIGN

A hospital based descriptive retrospective cross sectional study..

2.2 STUDY AREA

The study was conducted in the radiology department, ultrasound section, at Muhimbili National Hospital. Muhimbili National Hospital (MNH) is a tertiary level government hospital and it is the highest referral Centre in the country with about 1500 bed capacity and attending about 1200 outpatients and 1200 inpatients per week. It is a research Centre and a university teaching hospital. MNH is situated in the Eastern zone of Tanzania at Upanga west in Dar es Salaam city. It receives referral patients from all over the country including private hospitals and three local regional referral hospitals namely Amana, Temeke and Mwananyamala hospitals. Muhimbili National Hospital being a tertiary level hospital has capable of acting as a potential source for expertise data for renal Doppler scan study.

2.3 STUDY PERIOD

Retrospective data between January 2018 and June 2019 was collected to reach a minimum sample of 150 records.

2.4 SOURCE OF POPULATION AND INCLUSION CRITERIA

Participants for the study came from the patients referred for renal ultrasound in radiology department at MNH. The following were the inclusion criteria:

- Patients referred to ultrasound unit for renal Doppler scan between January 2018 and June 2019.
- Patients aged 18 years and above.

2.5 STUDY VARIABLES

Independent variables included Demographic factors like age, sex, Clinical indications like hypertension, diabetes, chronic kidney disease, hyperlipidemia and fibro-muscular disease.

Dependent variables : Renal Resistive Index, Kidney size, other sonographic pathologies like hydro-nephrosis, hydro-ureter, ureteric stone, blood vessel crossing the ureter , retroperitoneum mass, loss of cortico-medullary differentiation.

2.6 SAMPLING TECHNIQUE

Study participants' records were consecutively enrolled as they were recorded in the stored files of renal Doppler scan available in the computer at Ultrasound unit provided they have reached the inclusion criteria.

2.7 SAMPLE SIZE DETERMINATION

Sample size estimation for proportion was used to calculate for minimum sample size of study participants.

$$n= z^2p\ (1-p)/\varepsilon^2$$

Where n= the minimum sample size

z= standard normal deviate=1.96 for 95% confidence level

p = expected proportion with characteristic of interest= 11% (ESRD from different renal causes prevalence of 11% in East Africa)

ε = margin of error= 0.05

By substitution,

n= 1.96X 1.96X0.11X (1- 0.11)/ (0.05X0.05)

n= 150

The minimum sample size was 150.

Therefore the proposed study was to involve a total of 150 patients' recorded data.

2.8.0 DATA COLLECTION

Data was collected by the Principal Investigator assisted by trained renal sonographer using questionnaire with structured questions to record the provided information from the stored renal Doppler files.

2.8.1 RENAL DOPPLER TECHNIQUE

Comprehensive examination includes the use of Doppler and color flow imaging, as well as specialized techniques during scanning. Real time gray scale images use amplitude of the returning echoes, Doppler analyses the frequency of the returning echoes where frequency towards the transducer is higher than those moving away from the transducer. The Doppler shift is the difference between transmitted echo by the object and received echoes by the transducer. Using standard gray scale to sample the vessel of interest, the pulse Doppler shift signal, wave form, can be obtained from specific Doppler gate or sample volume. Combination of gray scale and Doppler is called duplex Doppler. Color Doppler provides direction of blood flow in tissues with specific color calibration. Power Doppler reflects the intensity or strength of the Doppler shift. It is very sensitive to motion artifact (2). In this study gray scale was useful to locate the renal anatomy, Color Doppler was used to identify small renal vessels and identify their flow or focal areas of flow disturbance and pulse Doppler for their waveform.

The ideal imaging procedure should identify the main and accessory renal arteries, localizing the site of the disease and provides evidence of a haemo-dynamic significant stenosis, associated pathologies such as renal mass, abdominal aortic aneurysm. That may have effects on treatment of RAS.

The native adult kidneys were imaged with curvilinear 2-5 Mega Hertz (MHz) probe and the higher frequency linear of curvilinear probe for the transplanted kidneys for the gray scale findings. The kidneys are normally supplied by renal arteries arising 1-2cm below the point Superior mesenteric artery branching off from the abdominal aorta. The gray scale, color and power doppler were used to locate and sample the renal arteries from the origin/ proximal portion to hilum for spectral doppler while keeping the doppler angle (between direction of blood flow and applied Doppler ultrasound signal) not more than 60 degrees, the maximum possible, optimizing the velocity scale for the waveform to avoid aliasing by adjusting the scale and baseline (6,11).

Resistive Index was calculated using the formula= (peak systolic velocity – end diastolic velocity)/peak systolic velocity, and the mean value of three measurements at each kidney was considered. In order to maximize waveform size, the lowest pulse repetition frequency without aliasing, the highest possible gain without noise and the lowest wall filter is emphasized (2).

Patients were examined by B-Mode and Doppler US in the lateral decubitus position, following overnight fasting period of at least 6 hours. Ultrasound and Doppler US examinations were performed by a single experienced radiographer, the utilization a 3.5 MHz abdominal convex transducer. The kidneys morphology was assessed. The longest axes, parenchymal thicknesses and echogenicity's of both of the kidneys were recorded. Then, Doppler flow samples were obtained from the upper, mid and lower parts of the right and left main renal arteries, utilizing a Doppler angle of 30˚ - 60˚. Maximum systolic (RA PSV) and end-diastolic (RA EDV) flow velocities were recorded from the renal arteries. The mean value of three measurements of each kidney was taken. The resistivity index (RI) value from the renal arteries was assessed according to the (RA PSV-RA EDV)/RA PSV formula.

On this basis, the evaluation of RRI was used to complement other signs of renal abnormalities.

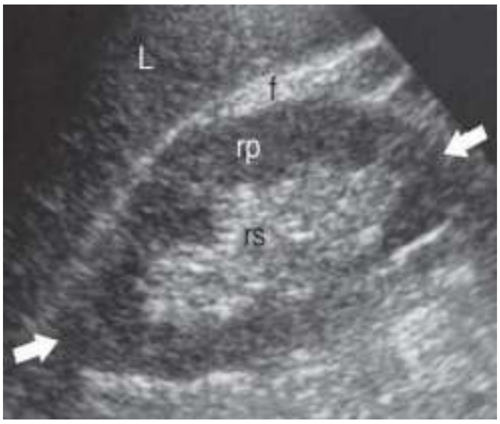


Image above showing normal adult kidney. A long axis US view of the right kidney (between *arrows*) obtained through the liver (*L*) demonstrates echogenicity of the normal renal parenchyma approximately equal to the echogenicity of the normal liver. The renal sinus (*rs*), containing vessels, the collecting system, and fat, is hyperechoic compared to the renal parenchyma (*rp*). The margins of the kidney are outlined by echogenic perirenal fat (*f*). Morrison pouch is a recess of the peritoneal cavity between the kidney and the liver that usually fills with fluid when ascites is present (2).

2.9.0 DATA PROCESSING, ANALYSIS AND STORAGE

The collected data was checked for completeness and consistency before processing. The obtained data was analyzed using Statistical Package for the Social Sciences (SPSS) version 23.0 to compute descriptive statistics to meet the study objectives.

Hard copies of the filled in questionnaires was kept such that were only accessed by the research team (the principal investigator, the supervisor and the trained research assistant).

Files that contain entered data were password protected and were stored in a password protected computer in a coded form and were only accessed by the research team.

Statistical Package for the Social Sciences (SPSS) version 23.0 was used for data analysis.

Frequency distributions of socio demographic and health characteristics of the patients' reports were computed. The proportion of high renal RI candidates were determined.

Cross tabulation of dependent variable resistive index (high or normal) against independent determinants to see the influence of social demographic characters, clinical indications (disease risks and associated other sonographic renal findings. P-value of 0.05 was considered to indicate statistical significance difference. Fisher's exact test was used on cells with values less than 5.

2.9.1 DISSEMINATION

The findings of this study was reported as part of the fulfillment of master of medicine in Radiology degree at MUHAS. The findings of this study will be presented in scientific conferences, published in scientific journals and MUHAS repository.

2.10 ETHICAL CONSIDERATION

Approval and permission was sought from Ethical Review Board of MUHAS.

An official letter to ask for permission was sent to the administration of the Muhimbili National hospital, where the study was conducted.

Patients' names were not used instead the renal Doppler scan reports were linked to study numbers to ensure confidentiality.

Data was collected from the stored patient's records in the computer system and there was no active interaction with the patients, consent form writing procedure was not involved.

CHAPTER THREE

3.0 RESULTS

3.1 Demographics characteristics of patients' reports

A total of 150 patients' reports were collected. Among them 67.3% were males and 32.7% females. About 28% of respondents were 30 years of age and below and 72% were above 30 years old. The mean age was 40.8 years. (Table 1).

Table 1: Socio-demographic characteristics of patients' reports (n=150)

Characteristic	Categories	Frequency	Percentage
Age group	18-30	42	28
	31-59	84	**56**
	60+	24	16
Sex	Male	101	**67.3**
	Female	49	32.7
	Total	150	100.0

3.2 The indications of renal Doppler among patients undergoing renal Doppler Ultrasound

All of the reports had medical indications. Among the indications; 0.7% was DM, 0.7% was ESRD, 42.7% was HTN, 52% was renal allograft done procedures. None of indications was Hyperlipidemia or FMD (Table 2). Other indicators included post renal transplant raised creatinine which was documented in 61.3% while urine symptoms (lower abdominal pain, hematuria) were reported in 10% of all study samples.

Table 2: Medical Indications of Renal Doppler among Patients Undergoing renal Doppler Ultrasound (n=150)

Indications	Frequency	Percentage
Diabetes Mellitus	1	0.7
Hypertension	**64**	**42.7**
Hypelipidemia*	0	0
FMD*	0	0
Post-transplant raised Creatinine	27	18
Urine symptoms	15	10
ESRD	1	0.7

*No patient with hyperlipidemia or FMD was involved in the study.

3.3 The Doppler findings among patients undergoing renal Doppler ultrasound

About 48% were for native and 52% were allograft kidneys. Among the native kidneys, 4% and 2.7% renal reports had raised right and left RRI respectively. Furthermore, 16.7% of the allografts had raised RI (table 3).

Table 3: The Doppler Findings among Patients Undergoing Renal Doppler Ultrasound (n=150)

Findings	Frequencies	Percentage
Native kidneys bilaterally	72	48
Right Renal RI above 0.7	**6**	**4**
Left Renal RI above 0.7	**4**	**2.7**
Renal allograft patients	78	52
Renal allograft RI above 0.7	**25**	**16.7**
Right renal abnormal size;n=72	6	8.4
Left renal abnormal size;n=72	6	8.4
Renal allograft abnormal size;n=78	14	18.0
Lost corticomedullary differentiation	26	17.3
Hydronephrosis presence	8	5.3
Ureterolithiasis*	0	0
Retroperitoneal mass*	0	0
Hydroureter presence	2	1.4
Crossing vessel*	0	0
CKD presence	14	9.3

*No patients with ureterolithiasis, blood vessel crossing the ureter, retroperitoneal mass findings were observed in this study.

3.4 Other renal sonographic findings in patients undergoing renal Doppler ultrasound

About 8.4% of non-allograft reports had abnormal (either increased or decreased) renal size both on the right and left sides while 18% of renal allograft reports had either increased or decreased renal sizes. Renal cortico-medullary differentiation was lost in 82.7% of all the study samples. Hydronephrosis was a finding in 5.3% of the entire study sample. About 1.4% of the study sample had hydro-ureter. CKD was commented in 9.3% of all the cases studied. (Table 3).

3.5 Patients' reports socio-health characteristics association with Renal resistive index

Tables 4 and 5 show that more males, 70.8% than female, 29.2% with native renal Doppler reports were involved in the study. About 83.3% males and 16.7% females had raised native renal right resistive index, likewise 100.0% and 0.0% among male and female respectively had raised left native RRI. Sex was not statistically significantly associated with native RRI ($p>0.05$).

The prevalences of age ranges among the native kidneys data sample were 41.7%, 52.8% and 5.8% for 18-30years, 30-59 years and 60 and above years respectively. Reports of raised native right renal RRI were 66.7%, 16.7% and 16.7 for those aged 18-30 years, 31-59 years and 60 years and above respectively likewise 50%, 25% and 25% of similar age groups had raised native left RRI. Age was not statistically significantly associated with native renal RI ($p>0.05$).

All of the reports with hypertension compared to none of the reports without hypertension had raised native both right and left RRI. Hypertension indicator was not statistically significantly associated with native RRI ($p>0.05$). (Tables 4 and 5).

Out of all native renal Doppler reports, none of those who had diabetes had raised both right and left native renal RRI. Diabetes mellitus was not statistically significantly associated with native RRI ($p>0.05$). (Tables 4 and 5).

About 16.7% and 25% of reports who had ESRD had raised native right and left RRI. ESRD indicator was statistically significantly associated with native RRI ($P<0.05$). (Tables 4 and 5).

Among the allograft reports, 65.4% were male and 34.6% were female. About 66% and 34% male and female allograft reports respectively had raised RRI.($p>0.05$). (Table 6).

Among 78 allograft reports, those who with age 18-30, 31-59 and above 60 years, 20.8%, 66% and 13.2% of each group respectively, had raised RRI. Age was statistically significantly associated with allograft RRI ($p<0.05$). (Table 6)

Table 4: Patients' report Socio-health characteristics by Right renal resistive index

Characteristics	Categories	Right renal RI			Pearson Chi-square	p value
		Normal. n(%)	**Raised n(%)**	**Total n(%)**		
Age group	18-30 years	26(39.4)	4(66.7)	30(41.7)	4.054	0.132
	31-59	37(56.1)	1(16.7)	38(52.8)		
	60+ years	3(4.5)	1(16.7)	4(5.6)		
Total		66(100)	6(100)	72(100)		
Sex	Male	46(69.7)	5(83.3)	51(70.8)	0.495	0.482
	Female	20(30.3)	1(16.7)	21(29.2)		
Total		66(100)	6(100)	72(100)		
Hypertension	Present	57(86.4)	6(100.0)	1(1.6)	0.935	0.334
	Not present	9(13.6)	0(0.0)	77(89.5)		
Total		66(100.0)	6(100.0)	78(100.0)		
DM	Present	1(1.5)	0(0)	1(1.4)	0.092	0.761
	Not present	65(98.5)	6(100)	71(98.6)		
Total		66(100)	6(100)	72(100)		
ESRD	Present	0(0.0)	1(16.7)	1(1.4)	11.155	**0.001**
	Not present	66(100.0)	5(83.3)	71(98.6)		
Total		66(100.0)	6(100.0)	72(100.0)		

Table 5: Patients' reports socio-health characteristics by Left renal resistive index

Characteristics	Categories	Left renal RI			Pearson's Chi-square	p value
		Normal. n(%)	Raised n(%)	Total n(%)		
Age group	18-30 years	28(41.8)	2(50.0)	30(42.3)	5.034	0.081
	31-59	37(55.2)	1(25.0)	38(53.5)		
	60+ years	2(3.0)	1(25.0)	3(4.2)		
Total		67(100)	4(100.0)	71(100.0)		
Sex	Male	46(68.7)	4(100.0)	50(70.4)	1.780	0.182
	Female	21(31.3)	0(0.0)	21(29.6)		
Total		67(100)	4(100.0)	71(100.0)		
Hypertension	Present	59(88.1)	4(100.0)	63(88.7)	0.538	0.463
	Not present	8(11.9)	0(0.0)	8(11.3)		
Total		67(100.0)	4(100.0)	71(100.0)		
DM	Present	1(1.5)	0(0)	1(1.4)	0.061	0.806
	Not present	66(98.5)	4(100.0)	70(98.6)		
Total		67(100.0)	4(100.0)	71(100.0)		
ESRD	Present	0(0)	1(25.0)	1(1.4)	16.989	**0.001**
	Not present	67(100.0)	3(75.0)	70(98.6)		
Total		67(100.0)	4(100.0)	71(100.0)		

Table 6: Patients' reports socio-health characteristics by Allograft renal resistive index

Characteristics	Categories	Allograft RI			Pearson Chi-square	p value
		Raised. n(%).	Normal n(%)	Total n(%)		
Age group	18-30 years	11(20.8)	1(4.0)	12(15.4)	14.468	**0.001**
	31-59	35(66.0)	11(44.0)	46(59.0)		
	60+ years	7(13.2)	13(52.0)	4(25.6)		
Total		53(100)	25(100)	78(100)		
Sex	Male	35(66.0)	16(64.0)	51(65.4)	0.031	0.860
	Female	18(34.0)	9(36.0)	27(34.6)		
Total		53(100)	25(100)	78(100)		
Hypertension	Not present	53(100.0)	25(100.0)	78(100.0)	*	
DM	Not present	53(100.0)	25(100.0)	78(47.7)	*	
ESRD	Not present	53(100.0)	25(100.0)	78(100.0)	*	

*No statistics are computed because hypertension, DM and ESRD were constant

3.6 The association between other sonographic characteristics with renal resistive index

Apart from renal resistive outcome, other sonographic outcomes collected were renal size, renal cortico-medullary differentiation, hydronephrosis, CKD, post-transplant raised creatinine and urine symptoms. The association of the other sonographic characteristics and right, left and allograft renal resistive index were analysed. (tables 7 and 8).

Raised native renal resistive index was signifiantly associated with abnormal renal sizes (increased or decreased) which was 50% on the right and 66.6% on the left.($p<0.05$). (Tables 7 and 8)

Hydronephrosis prevalence was 50% and 25% on the right and left raised renal Doppler resistive indices.Hydronephrosis was was significantly associated with raised right renal resistive index($p<0.05$) .(Tables 7 and 8).

Among the study population raised right and left renal resisitive index were 9.7% and 9.9% respectively amongst the CKD patients. CKD was statistically significantly associated with native RRI.($p<0.05$) (Table 7 and 8).

The right sided allograft increased renal size with raised RRI was 4.1% .Right sided allograft renal size was significantly associated with renal allograft RRI($P<0.05$).

Lost renal corticomedulary differentiation prevalence with raised allograft RRI was 10.3% compared with 89.7% reports with raised allograft renal RRI with maintained renal CMD.($p<0.05$).

Hyronephrosis prevalence with raised allograft RRI was 1.9% compared with 98.1% reports with raised allograft renal RRI without hydronephrosis.($p<0.05$).

Prevalence of Chronic kidney disease (CKD) with raised allograft RRI was 1.9% compared with 98.1% reports with raised allograft renal RRI without CKD.($p<0.05$).

Table 7: Patients' other sonographic findings by Right renal resistive index

Characteristics	Categories	Right renal resistive index			Pearson Chi-square	p value
		Normal n(%)	**Raised n(%)**	**Total n(%)**		
Right renal size	Normal	63(96.9)	3(50.0)	66(93.0)	18.906	**0.001**
	Decreased	1(1.5)	1(16.7)	2(2.8)		
	Increased	1(1.5)	2(33.3)	3(4.2)		
Total		65(100.0)	6(100.0)	71(100.0)		
Left renal size	Normal	63(96.9)	2(33.3)	65(91.5)	28.710	**0.001**
	Decreased	1(1.5)	2(33.3)	3(4.2)		
	Increased	1(1.5)	2(33.3)	3(4.2)		
Total		65(100.0)	6(100.0)	71(100.0)		
Renal corticomedullary differentiation	Lost	11(16.7)	6(100.0)	17(23.6)	21.176	**0.001**
	Preserved	55(83.3)	0(0.0)	55(76.4)		
Total		66(100.0)	6(100.0)	72(100.0)		
Hydronephrosis	Present	2(3.0)	3(50.0)	5(6.9)	18.777	**0.001**
	Not present	64(97.0)	3(50.0)	67(93.1)		
Total		66(100.0)	6(100.0)	72(100.0)		
Chronic kidney disease	Present	2(3.0)	5(83.3)	7(9.7)	40.409	**0.001**
	not present	64(97.0)	1(16.7)	65(90.3)		
Total		66(100.0)	6(100.0)	72(100.0)		

*No statistics are computed because the variables are constant

Table 8: Patients' other sonographic findings by Left renal resistive index

Characteristics	Categories	Left renal resistive index			Pearson Chi-square	p value
		Normal	**Raised**	**Total**		
		n(%)	**n(%)**	**n(%)**		
Right renal size	Normal	63(94.0)	3(75.0)	66(93.0)	4.596	0.1
	Decreased	2(3.0)	0(0.0)	2(2.8)		
	Increased	2(3.0)	1(25.0)	3(4.2)		
Total		67(100.0)	4(100.0)	71(100.0)		
Left renal size	Normal	63(94.0)	2(50.0)	65(91.5)	9.459	**0.009**
	Decreased	2(3.0)	1(25.0)	27(55.1)		
	Increased	2(3.0)	1(25.0)	0(0)		
Total		67(100.0)	4(100.0)	71(100.0)		
Renal corticomedullary differentiation	Lost	13(19.4)	4(100.0)	17(23.9)	13.464	**0.001**
	Preserved	54(80.6)	0(0.0)	54(76.1)		
Total		67(100.0)	4(100.0)	71(100.0)		
Hydronephrosis	Present	4(6.0)	1(25.0)	5(7.0)	2.088	0.148
	Not present	63(94.0)	3(75.0)	66(93.0)		
Total		67(100.0)	4(100.0)	71(100.0)		
Chronic kidney disease	present	4(6.0)	3(75.0)	7(9.9)	20.239	**0.001**
	not present	63(94.0)	1(25.0)	64(90.1)		
Total		67(100.0)	4(100.0)	71(100.09)		

Table 9: Patients' other sonographic findings by Renal Allograft resistive index

Characteristics	Categories	Renal allograft resistive index			Pearson Chi-square	p value
		Normal	**Raised**	**Total**		
		n(%)	**n(%)**	**n(%)**		
Right allograft renal size	Normal	17(73.9)	47(95.9)	64(88.9)	7.674	**0.006**
	Increased	6(26.1)	2(4.1)	8(11.1)		
Total		23(100.0)	49(100.0)	72(100.0)		
Left allograft renal size	Normal	1(50.0)	4(100.0)	5(83.3)	2.400	0.121
	Increased	1(50.0)	0(0.0)	1(16.7)		
Total		2(100.0)	4(100.0)	6(100.0)		
Renal corticomedullary differentiation	Lost	7(28.0)	1(1.9)	8(10.3)	12.585	**0.001**
	Preserved	18(72.0)	52(98.1)	54(76.1)		
Total		25(100.0)	53(100.0)	78(100.0)		
Hydronephrosis	Present	2(8.0)	1(1.9)	3(3.8)	1.717	**0.001**
	Not present	23(92.0)	52(98.1)	75(96.2)		
Total		25(100.0)	53(100.0)	78(100.0)		
Chronic kidney disease	Present	5(20.0)	1(1.9)	6(7.7)	7.849	**0.005**
	Not present	20(80.0)	52(98.1)	72(92.3)		
Total		25(100.0)	53(100.0)	78(100.0		

CHAPTER FOUR

4.0 DISCUSSION

This study aimed at assessing the Doppler findings among patients undergoing renal Doppler ultrasound at MNH and specifically assessing the demographic factors of patients undergoing renal doppler ultrasound, the medical indications for renal Doppler investigations, the resistive index findings and other renal sonographic outcomes of renal Doppler ultrasound. Furthermore statistical significance of the indicators and the outcomes findings were assessed.

More males than female underwent renal Doppler ultrasound. However sex was not statistically significant indicator in determining native and allograft RRI.This was similar to previous studies where gender was not significantly associated with RRI (5,7). The similarity in findings could be due to similar hospital based settings

In this study, age was not significantly associated with native RRI. This was in contrast to other study where age has been shown to influence native RRI. This study showed younger age group of 18-30years had more raised native RRI compared to the older age groups of above 30 years. This was different from literature where where RRI has been reported to increase in the healthy elderly population (15). The difference in results could be due to the difference in study populations involved where in this study patients suspected of renal disease were enrolled but in the other study healthy adults and patients with fatty liver disease were enrolled.

Age was significantly associated with allograft resistive index. This was was similar to one study where patients with higher resistive index were significantly older (3).
The renal Doppler ultrasound diagnosis indications found by this study included renal transplantation, hypertension, diabetes mellitus, ESRD, urine symptoms like hematuria, lower abdominal pain and post transplant raised serum creatinine. Such indicators were also studied in several studies (2,3,5,6,9,12,13).

Raised renal resistive index for native kidney was two to four percentages. Such response for RRI among hypertensive patients have also been reported elsewhere in studies done in Europe (6). Higher prevalence 16.7% of raised allograft resistive index was observed in this study. This was similar documented in literature where higher prevalence of RRI up to 10% is documented among allografts (2).

Hypertension was present in all reports with raised native RRI however hypertension was not significantly associated with raised native RRI. This is different from one article where higher prevalence of hypertension is significantly associated with raised RRI among hypertensives (16).

The difference in results could be due to difference in study sample size, where in this study relatively smaller smaple size of 150 was used and in the other study a sample size of 870 elders were involved.

Diabetes mellitus was not significantly associated with native RRI. This was different from literature where raised native RRI was significantly associated with diabetes nephropathy. The difference in results could be contributed by difference in study populations where in the present study the study population constituted all patients predicted of renal disease with different indicators including mainly hypertensives while in the previous studies diabetic populations were used (17,18). ESRD was significantly associated with native RRI. A study elsewhere commented on the rapidly growing segment of ESRD elderly population on dialysis with elevated RRI (19).

Left renal size was significantly associated with native left RRI however right renal size was not significantly associated with left RRI. Renal size was statistically significantly associated with ispilateral native rightRRI likewise renal size was significantly associated with raised native RRI values among chronic kidney disease patients (5).

In this study allograft RRI was statistically significantly associated with right sided renal transplanted kidneys however the significance was not observed on the left sided transpanted kidneys. Raised RRI in transpalnted kidneys was also noted in abnormal renal sizes particularly with increased renal size. Literature noted elevated RRI in swollen transplanted kidneys with loss of renal sinus fat and patchy cortical echogenicity (2). The difference in association between renal size with allograft RRI on the right from the left could be due to chance variation.

Hydronephrosis was significantly associated with right and allograft RRI however hydronephrosis was not significantly associated with left RRI. Similar results were obtained in study done by Mitchigan University where RRI was significantly higher in confirmed hydronephrotic kidneys than in non obstructed pelvicaliectasis. Moreover RRI values returned to normal after nephrostomy (22). The difference in significance on the left native renal RRI value could be due to chance which is in contrary to stated literature.

Chronic kidney disease (CKD) was significantly associated with both right and left RRI. Similar results are documented in literature where rapid decline in renal function in presence of increase in RRI in CKD may entail worse response to steroid tratment(8). CKD was significantly associated with allograft RRI. Similar finding was reported in literature(2).

Corticomedullary differentiation (CMD) was significantly associated with allograft RRI. Renal parenchymal disease was noted with increased RRI (2).

4.1 STUDY LIMITATION

Renal Doppler sonography study limitation included:

1. This was a hospital based study thus results might not reflect status on the general population.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Higher proportion of patients had raised renal allograft RRI than raised native RRI. The mean age of the study participants was 40.8 years. ESRD was significant determinant of native RRI. Other sonographic factors such as renal size, hydronephrosis, CKD and CMD were significantly associated variably with native and allograft RRI.

5.2 RECOMMENDATIONS

1. It is recommended Renal Doppler study be done in patients suspected of renal disease particularly those with end stage renal disease contrary to other imaging modalities which use contrast
2. It is important to note that RRI depends on many other factors, some of which are not investigated in this study. Further studies need to be done to explore other factors associated with renal resistive index of native and transplanted kidneys.

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APPENDICES

QUESTIONNAIRE

TITLE: DOPPLER FINDINGS AMONG PATIENTS UNDERGOING RENAL DOPPLER SCAN AT MUHIMBILI NATIONAL HOSPITAL FROM JANUARY 2018 TO JUNE 2019.

A. SOCIO DEMOGRAPHIC INFORMATION

1. Study number ___ ___ ___
2. Hospital number ___ ___ ___ ___ ___ ___ __
3. Age (Years) __ __ __
4. Sex
   a. Female
   b. Male

B. PATIENT'S MEDICAL RECORDS (Referral notes if applicable)

5. Is the renal scan indication written?
   a. Yes **(go to question 6)**
   b. No **(go to part D)**

C. PATIENT'S MEDICAL RECORDS

6. What was/were the indication(s) for renal Doppler scan **OR** what does the patient suffer from?

a. Diabetes Mellitus

b. Hypertension

c. Hyperlipidemia

d. Fibro-muscular dysplasia

e. ESRD

f. Renal allograft.

g. None

h. Others. Mention……………………………..

D. RENAL DOPPLER SCAN FINDINGS

7. Right renal resistive Index is……… (a)Above 0.7 (b) Equals to or Below 0.7
8. Left renal resistive index is……………(a)Above 0.7 (b) Equals to or Below 0.7

E. OTHER ULTRASOUND FINDINGS

9. Renal size (a) Right…………… (b) Left………………
10. Cortico-medullary differentiation…………. (a) Maintained (b) Lost
11. Hydronephrosis……..a. Yes b. No
12. Ureterolithiasis (ureteric stone) ……..a. Yes b. No
13. Retroperitoneal masses along ureter……..a. Yes b. No
14. Fluid collection along ureter (Hydroureter)……..a. Yes b. No
15. Crossing blood vessel along ureter……..a. Yes b. No
16. Other findings mention……………….................