

**ULTRASONOGRAPHIC FEATURES AND COMPLICATIONS OF RENAL
GRAFTS AS SEEN AT KENYATTA NATIONAL HOSPITAL**

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**A DISSERTATION AS A PARTIAL FULFILLMENT OF THE REQUIREMENTS OF
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OF MEDICINE IN DIAGNOSTIC IMAGING AND RADIATION MEDICINE.**

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DECLARATION

I solemnly declare that this is my own original work, and it has not been presented to any other academic institution for similar or any other award of master's degree.

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DEDICATION

I would like to dedicate this work to my parents for their unconditional love, support and prayers.

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I am eternally grateful to God for His grace and blessings that enabled me to start and complete this work.

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TABLE OF CONTENTS

DECLARATION	ii
APPROVAL BY SUPERVISORS	iii
DECLARATION OF ORIGINALITY FORM.....	iv
DEDICATION.....	v
ACKNOWLEDGEMENT	vi
TABLE OF CONTENTS.....	vii
LIST OF FIGURES	ix
LIST OF TABLES.....	x
ABBREVIATIONS	xi
ABSTRACT.....	xii
1.0 CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW	1
1.1 Renal Health in Kenya.....	1
1.2 Anatomy of the Kidney.....	1
1.3 Vasculature	2
1.4 Function	2
1.5 Ultrasound Technique of Renal Grafts	3
1.6 Grayscale Evaluation of the Renal Graft	3
1.7 Doppler Evaluation of the Transplanted Kidney	3
1.8 Post Renal Transplant Complications.....	5
1.9 Parenchymal Abnormalities.....	5
1.11 Collecting System Complications.....	14
1.12 Perinephric Fluid Collections.	16
1.13 Review of Studies on Post Renal Transplant Complications.....	19
2.1 Research Question	23
2.2 Objectives	23
2.2.1 Broad objective	23
2.2.2 Specific objectives	23
3.0 CHAPTER THREE: STUDY DESIGN AND METHODOLOGY	24

3.1 Study Site and Design.....	24
3.2 Study Population.....	24
3.3 Sample Size Estimation	24
3.4 Sample Procedure	25
3.4.1 Inclusion criteria:	25
3.4.2 Exclusion criteria:	25
3.5 Study Tools, Equipment and Data Collection.....	25
3.5.1 Surgical Technique	25
3.6 Data Management	26
3.6.1 Data Collection	26
3.6.2 Data Analysis	27
3.6.3 Descriptive Analysis	27
3.7 Ethical Consideration.....	27
4.0 CHAPTER FOUR: RESULTS	28
4.1 Cases	30
5.0 CHAPTER FIVE: DISCUSSION.....	36
5.1 Conclusion	39
5.2 Recommendations.....	39
5.3 Renal Transplant U/S protocol.....	40
REFERENCES	41
APPENDICES	46
Appendix A: Data Collection Form.....	46
Appendix: B Informed Consent to Renal Graft Ultrasound	47
Appendix C: Budget	49
Appendix D: KNH/UON-ERC Letter of Approval	50

LIST OF FIGURES

Figure 1: Kidney Anatomy and Vascularity.	2
Figure 2: Grayscale U/S image of a Normal transplant kidney.	4
Figure 3: Acute tubular necrosis (ATN).	6
Figure 4: Acute rejection.	7
Figure 5 : Emphysematous pyelonephritis.....	9
Figure 6 : Renal Artery Stenosis: donor portion.....	10
Figure 7: Renal Artery Stenosis: recipient portion.	11
Figure 8: Renal artery thrombosis.....	12
Figure 9: External iliac vein thrombosis extending into the transplant vein.	13
Figure 10: Intrarenal Arteriovenous fistula.....	14
Figure 11: Hydronephrosis Secondary to a Stricture at the Ureteropelvic Junction.....	15
Figure 12: U/S of a renal graft showing mild dilatation of collecting system.....	15
Figure 13: Postoperative perirenal hematoma	16
Figure 14: Grayscale U/S image showing an anechoic collection.....	17
Figure 15: Urinomas	17
Figure 16: Lymphoceles	18
Figure 17: Sagittal U/S scan showing the abscess	19
Figure 18: Renal artery and venous anastomoses.	26
Figure 19: Normal Grayscale Image of a Renal Graft.	30
Figure 20: Graft Demonstrating Normal Color and Spectral Doppler Study.	30
Figure 21: Acute Rejection.	31
Figure 22: Impending Renal Artery Stenosis.....	31
Figure 23: Hematoma.	31
Figure 24: Lymphocele.....	32
Figure 25: Urine leaks and Urinoma.....	32
Figure 26: Urinary obstruction.....	32
Figure 27: Demographic Characteristics.	33
Figure 28: Demographic Characteristics	33
Figure 29: Post Renal Transplant Patients With and Without Complications.....	34
Figure 30: Post Renal Transplant Complications.	34
Figure 31: Peritransplant Fluid Collections Specific Findings.....	35
Figure 32: Post renal transplant Specific Complications.....	35

LIST OF TABLES

Table 1: Specific Post kidney Transplant Complications	5
Table 2: Social Demographic Characteristics of the Patients	28
Table 3: Post Kidney Transplant Complications	28
Table 4: Distribution of Specific Post Kidney Transplant Complications	29
Table 5 : Test of Association between Sex and Development of Complications.....	29

ABBREVIATIONS

KNH	-	Kenyatta National Hospital
KRA	-	Kenyan Renal Association
US	-	Ultrasound
ESRD	-	End Stage Renal Disease
CKD	-	Chronic kidney disease
BP	-	Blood pressure
RBC	-	Red Blood Cell
HIV	-	Human immune deficiency virus
RI	-	Resistive Index
PI	-	Pulsatility Index
ATN	-	Acute Tubular Necrosis
CAN	-	Chronic Allograft Nephropathy
RAS	-	Renal Artery Stenosis
RVT	-	Renal Vein Thrombosis
AVF	-	Arteriovenous Fistula
PA	-	Pseudo Aneurysm
UON	-	University of Nairobi
KNH/UON-ERC	-	Kenyatta National Hospital / University of Nairobi ethics & research committee

ABSTRACT

Background

Renal transplantation is considered a treatment of choice for end-stage renal disease (ESRD) since the 1960s. It is cost effective and provides better long-term survival and better quality of life in comparison to hemodialysis or peritoneal dialysis.

Two-dimensional ultrasound (U/S) scan was introduced in the evaluation of renal transplants in the early 1970s, while the application of Doppler techniques in routine practice was established in the following years.

Ultrasound is a relatively cheap, noninvasive, and non nephrotoxic imaging modality, which can be applied for diagnostic and monitoring purposes in the post transplant period, thus establishing a baseline for follow-up scanning. Its role in the evaluation of early graft complications is of great significance as besides detecting complications it is also utilized in an interventional procedure like fluid aspiration.

Objective

To evaluate the Ultrasonographic findings and complications of the renal grafts seen at Kenyatta National Hospital.

Study design

Retrospective descriptive

Study setting

The study was carried out in the Renal unit, Kenyatta National Hospital.

Study population

The study included all the adult patients who underwent the renal transplant at KNH after satisfying the inclusion criteria.

Study period

Study period was two (2) years (March 2014 to March 2016)

Methodology

A data collection sheet was used to manually record the demographic data, type of wide range of complications seen post renal transplant. These records were available in the patient's files of those who underwent the renal transplant in Kenyatta National Hospital from the period of March 2014 to March 2016. The data was entered into an MS Excel database and analyzed using a 20th version of Statistical Package for Social Scientists (SPSS). Patient's longevity and graft survival were not evaluated as, this was beyond the scope of this study.

Results

A total of 46 subjects were enrolled into the study. The Mean age of the study subjects was 41.2 ± 1.8 years (SD = 12.1years). Majority of the study participants were male 34(73.9%) and 12 (26.1%) were female. Twenty-three(eighteen males and five females) out of the forty-six patients developed post transplant complications taking overall complication rate to 50%.The most common complication seen was the peritransplant fluid collection(72.5%) followed by parenchymal(10.3%), vascular(10.3%) and collecting system(6.9%) complications. Among the peritransplant fluid collection hematoma (44.8%) was the commonest finding.

Conclusion

The diagnostic yield of ultrasound in detecting the renal graft complications are high and with the absence of nephrotoxicity and radiation, ultrasound is often the first and only imaging modality used to monitor grafts during routine follow-up and assess for mild to serious complications. With many complications occurring at predictable period post transplant, awareness of these pathologies and their imaging features are vital to ensure there are early detection and timely intervention to prolong the graft survival.

1.0 CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW

1.1 Renal Health in Kenya

In Kenya with a population of approximately 40 million, an estimated 6000 patients suffer from kidney failure annually according to Kenya Renal Association (KRA). Renal transplantation services are offered at Kenyatta National Hospital (KNH) and a few private hospitals in the country. The first renal transplant was performed in 1978 following erroneous nephrectomy of a pelvic horseshoe kidney in a young man [35]. Since then kidney transplants were sporadic and expensive with modest results.

From the year 2010 live kidney donations started in KNH through training of health care professionals by recognized kidney transplant specialists from Spain with a focus on enhancing surgical techniques in the country.

Initially, Kenyan hospitals did not have nearly enough specialists, nephrologists, nurses and epidemiologists to adequately cater to the kidney disease patients. However, these days though Kenyan doctors and specialists numbers are on a steady rise still the country suffers from acute shortage of kidney specialists with one nephrologist catering for a 100,000 people [37].

Earlier very few dialysis machines were used in KNH, but now there are approximately twenty machines in operation. This is still not sufficient for the patients to get even two sessions of dialysis per week.

Kenya has not developed an organized cadaver donation program and hence the transplants are performed using living donors.

Kenya, unfortunately, does not have a renal registry data collecting system. Most of the information got is from the dialysis units and centers within the various parts of the country [38].

However, Kenyatta National Hospital's renal unit has maintained the records of the patients.

1.2 Anatomy of the Kidney

The kidneys are paired retroperitoneal organs that are located normally between the transverse processes of T12-L3 vertebrae. An adult kidney normally measures 10-12 cm in length and 3-5 cm in width.

The kidney can be divided into renal parenchyma, consisting of renal cortex and medulla. The renal sinus contains renal pelvis, calyces, renal vessels, nerves, lymphatics and perirenal fat.

The renal cortex lies peripherally beneath the capsule while the renal medulla is made up of 10-14 renal pyramids. The renal hilum is the entry to the renal sinus and it typically emerges posterior to the renal vessels, with the renal vein lying anterior to the renal artery.

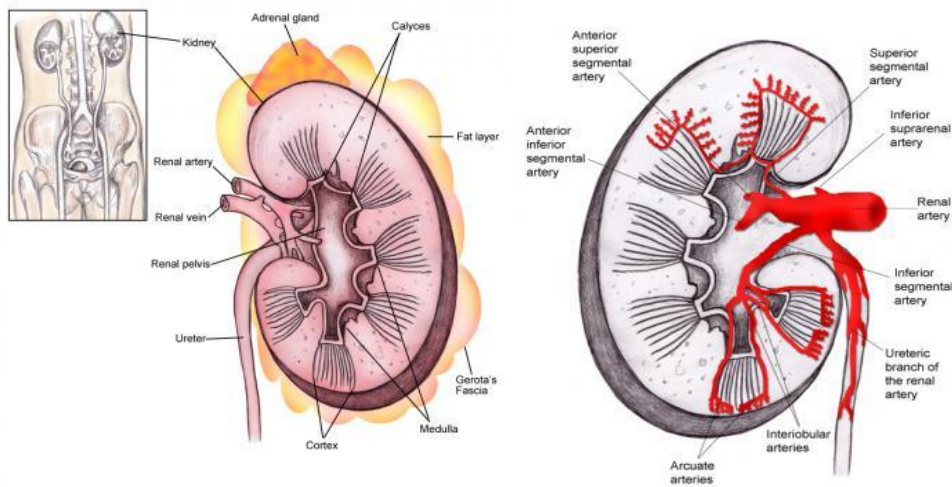


Figure 1: Kidney Anatomy and Vascularity.
Pic courtesy : [45]

1.3 Vasculature

The Kidneys together receive roughly 25% of, the cardiac output. At the level of L2, the blood supply to the kidneys arises from the paired renal arteries. They enter into the kidney through renal hilum, with the renal vein being anterior to the renal artery and the pelvis.

The first branch off of the renal artery is the inferior suprarenal artery. The renal artery then branches off into 5 segmental branches. These segmental arteries branch into interlobar arteries, which travel in between the major calyces and further into arcuate arteries that run within the cortex. They then radiate into interlobular arteries, which extend into the cortex of the kidney to finally become afferent arterioles, then peritubular capillaries to efferent arterioles.

1.4 Function

Important functions of the kidneys include filtration and excretion of metabolic waste products, regulation of necessary electrolytes, fluid, and acid-base balance and stimulation of RBC production. They regulate BP via the renin-angiotensin-aldosterone system, by controlling reabsorption of water and maintaining intravascular volume. The kidneys also reabsorb glucose and amino acids and have hormonal functions via erythropoietin, calcitriol, and vitamin D activation.

1.5 Ultrasound Technique of Renal Grafts

Patient's position is usually supine or lateral decubitus. A relatively superficial location of the transplant allows the usage of higher frequency transducers [4].

Grayscale, color Doppler, and spectral Doppler examinations of the renal transplant must be performed.

1.6 Grayscale Evaluation of the Renal Graft

A detailed grayscale U/S evaluation includes renal size, parenchymal echogenicity, collecting system, ureter condition and finally evaluation of any postoperative collections.

Longitudinal and transverse views of the transplanted kidney, as well as bladder, must be obtained. Renal length should be measured. The renal collecting system should be assessed for hydronephrosis, and if present, the level of obstruction should be determined. The perinephric space should be evaluated for any fluid collections. If a ureteral stent is in place, proximal and distal extent of the stent should be determined [15].

The normal transplant kidney has the same sonographic features as a native kidney, although the parenchymal detail is typically much clearer. The renal cortex makes up most of the renal tissue, forming an outer peripheral rim of mid-gray echoes that surround the relatively echo-poor medullary pyramids. If measured, the renal dimensions are similar to that of a native adult kidney and in the new transplant, a gradual increase in these dimensions is seen over the first few weeks by up to 32% of the initial length by the fourth week [8,15].

The collecting system of a normal functioning graft can show mild dilation because of the combination of an increased urine volume and loss of the ureter's tonicity from denervation.

1.7 Doppler Evaluation of the Transplanted Kidney

Doppler evaluation of the transplanted kidney should be performed to assess transplant vascularity. Global assessment of the intraparenchymal perfusion can be done by Color Doppler study and it is useful in localizing the main renal artery and vein. The renal parenchyma should be screened initially with color Doppler to check for focal regions of hypoperfusion and locate the interlobar arteries for spectral interrogation [33]. Upper-pole, middle-pole, and lower-pole spectral traces of the interlobar arteries should be obtained with low filter settings, maximal gain, and the smallest scale demonstrating the peak systolic velocity.

The normal waveform is low impedance with a brisk upstroke and continuous diastolic flow; RI of 0.6 to 0.8 is normal. Provided that flow in the recipient common iliac artery is normal, the velocity of the transplanted main renal artery should be less than 200 cm/sec.

An intraparenchymal RI of 0.8 to 0.9 is considered equivocal, and greater than 0.9 is classified as abnormal, suggesting increased intraparenchymal resistance. Generally, a higher resistive index is a nonspecific marker of malfunctioning transplant and is not helpful in determining the cause of the dysfunction [20].

The intraparenchymal and extraparenchymal renal veins show either continuous monophasic flow or phasicity with the cardiac cycle. There are no accepted normal peak velocity values for these vessels. Presence or absence of the blood flow within the transplant as well as the main renal vein, with an appropriate velocity gradient across the venous anastomosis, should be well documented as this is of prime importance in the management of these patients.

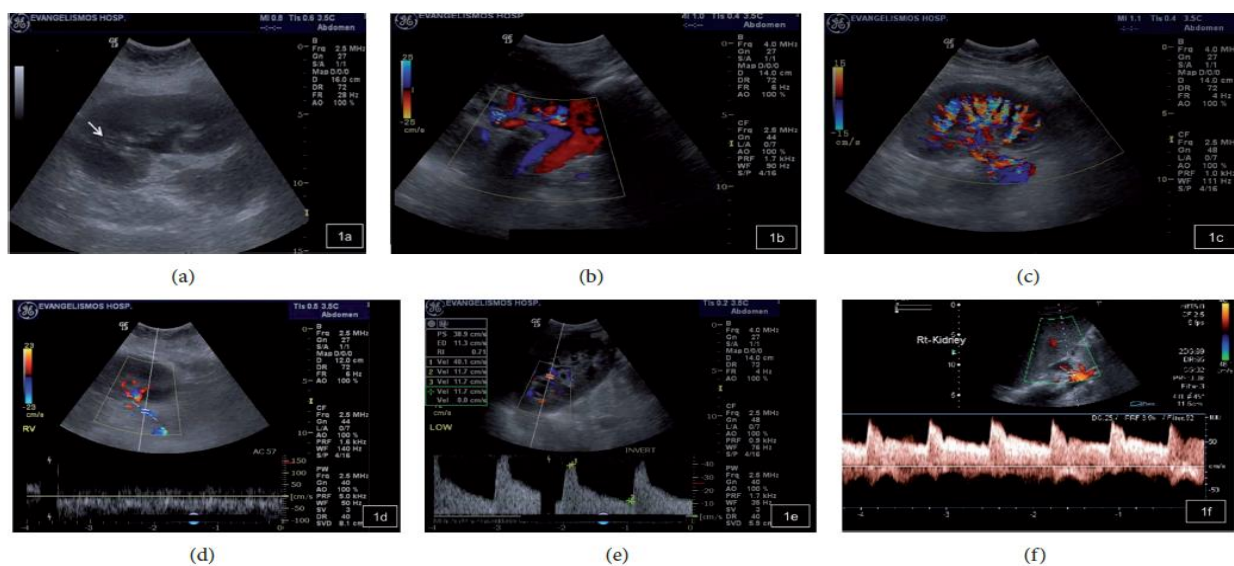


Figure 2: Grayscale U/S image of a Normal transplant kidney.

“(a) Grayscale U/S image of a Normal transplant kidney showing normal cortical medullary differentiation. (b) Normal renal artery and vein of the transplanted kidney on color Doppler U/S. (c) Normal blood flow throughout the transplant kidney on color Doppler U/S.(d) Normal renal vein waveform on spectral Doppler U/S. (e) Normal intrarenal artery waveform on spectral Doppler U/S showing a brisk systolic upstroke and high diastolic flow. Resistive index is normal (RI = 0.71). (f) Normal waveform of the renal artery on spectral Doppler U/S.” Pic courtesy : [36]

1.8 Post Renal Transplant Complications

It can be divided into

1. Parenchymal
2. Vascular
3. Collecting system
4. Peritransplant fluid collections

Table 1: Specific Post kidney Transplant Complications

Specific Post kidney Transplant Complications
Parenchymal complications
Acute tubular necrosis
Rejection
i) Acute rejection
ii) Chronic rejection
Drug toxicity
Infection
Vascular complications
Renal artery stenosis
Renal vein thrombosis
Infarction
Arteriovenous fistula and pseudo aneurysms
Collecting systems complications
Urinary obstruction
Peritransplant fluid collections
Hematomas
Urinomas
Lymphoceles
Perinephric abscesses

1.9 Parenchymal Abnormalities.

Diseases of the renal parenchyma are quite diffuse, leading to graft dysfunction.

Differential diagnosis is difficult by imaging alone and U/S is not very sensitive nor specific in this task [1]. Distinction still relies on biopsy [3]. Though U/S has not proved to be very

accurate in the evaluation of parenchymal dysfunction it still has a central role in the qualitative assessment of graft.

A) Acute Tubular Necrosis.

ATN results from donor kidney ischemia during transplantation and reperfusion injury [7].

It is a usual cause of early post transplant renal function impairment. Seen more commonly in cadaveric donors than in living related donors and it usually resolves in 2 weeks.

U/S is normal or only reveals nonspecific findings such as renal enlargement, altered echogenicity of parenchyma and pyramids, and reduced diastolic flow (elevated RI and PI Doppler indices) in the interlobar vessels.



Figure 3: Acute tubular necrosis (ATN).

“Acute tubular necrosis (ATN) of a cadaveric renal transplant a few days after transplantation. Grayscale U/S demonstrates edematous appearance and loss of normal cortical medullary differentiation in the transplanted kidney.” Pic courtesy : [36]

B) Rejection

Rejection, depending on the time of occurrence, is classified into hyperacute, acute, or chronic. Hyperacute rejection is rare, caused by preformed antibodies in the recipient’s serum. It occurs in the operating room, immediately post surgery [1]. As a result, these cases are rarely imaged.

i) Acute Rejection

It is the most common type of rejection, usually occurring 1–3 weeks after transplantation [13]. Recurrent episodes of rejection is an adverse long-term prognostic indicator of graft

failure [14]. The patient is often asymptomatic, but flu-like symptoms, pyrexia, and graft tenderness may be present.

On U/S, associated two-dimensional and Doppler features have been shown to be nonspecific. Kidney enlargement, hyper or hypoechogenicity, or even normal appearance is possible.

Doppler may reveal high PI and RI values (>0.9). In very serious cases, the renal artery can show reversed diastolic flow. These findings are similarly seen in ATN, however, they can be differentiated by the time course of the finding [5].

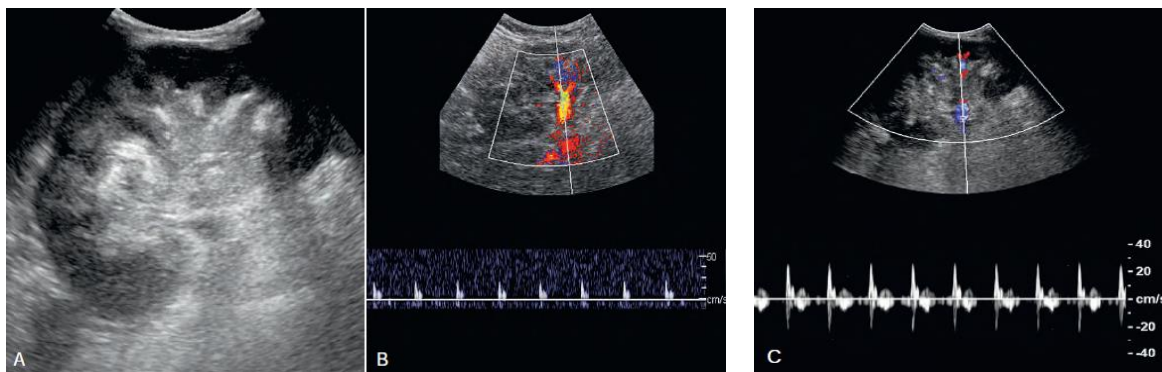


Figure 4: Acute rejection.

“Acute rejection.; A, Sagittal sonogram shows increased echogenic cortex. B, Spectral Doppler U/S initially shows no flow in diastole and thus a resistive index (RI) of 1.0. C, Spectral Doppler US 1 week later shows diastolic flow reversal , coinciding with the clinical deterioration of the patient .”Pic courtesy : [10]

ii) Chronic Rejection

Chronic allograft nephropathy (CAN) or chronic rejection is the commonest cause of late graft failure, beginning at least 3 months after transplantation [10]. Progressive renal function deterioration leads to graft failure eventually. Previous episodes of acute rejection are the main predisposing factor [11]. Therefore, efforts to prevent episodes of acute rejection can be an effective method of reducing chronic rejection. The definitive diagnosis is made histologically by demonstrating an overall fibrotic picture affecting the vascular endothelium, tubules, glomeruli, and interstitium [12]. U/S appearance is not typical, ranging from normal to hyperechogenic texture along with cortical thinning and a reduced number of intrarenal vessels.

C) Drug toxicity

Key immunosuppressive agents like the cyclosporine and tacrolimus are administered to avoid acute rejection. However, they are potentially nephrotoxic, causing vasoconstriction on the afferent glomerular arterioles and with long-term use they can cause interstitial fibrosis [10].

U/S can be either normal or demonstrate nonspecific feature like increased RI values on Doppler study. The findings must be correlated with the serum drug levels. Nephrotoxic effects of cyclosporine are dose-dependent.

D) Infection

At least one episode of infection can be seen in more than 80% of the patients undergoing renal transplant especially in the initial 6 months, There is a high risk of opportunistic infections secondary to immunosuppressive medications. Main risk factors are indwelling catheters and frequent glycosuria. Early diagnosis of infections and prompt administration of antibiotics prevent graft loss and improves patient outcome [13].

Patients can present with pyrexia of unknown origin, pain, or can be asymptomatic due to their immunosuppressed state, which in turn may cover the clinical features of a pyelonephritis [14].

On U/S focal or diffuse granular echogenic renal cortex associated with loss of cortical medullary junction, increased echogenicity and thickness of perirenal fat secondary to extension of inflammation is seen contrary to infarction where graft may appear diffusely hypoechoic and enlarged with an absence of arterial and venous flow on color Doppler.

Echogenic material within a dilated pyelocaliceal system is clinically significant and suggestive of pyonephrosis, while focal rounded, weakly shadowing, and echogenic structures seen within the collecting system are suggestive of fungus balls.

Gas in the renal graft parenchyma may produce an echogenic line with distal reverberation artifact in case of emphysematous pyelonephritis.

Abscesses can appear as a complex cystic structure and may be associated with fluid-fluid levels or intraluminal air appearance on U/S. It can be treated with U/S guided percutaneous drainage and systemic antibiotics [13].



Figure 5 : Emphysematous pyelonephritis.

“U/S image demonstrates mildly increased cortical echogenicity and echogenic lines with distal reverberation artifacts due to the gas in renal graft parenchyma”. Pic courtesy: [36]

1.10 Vascular Complications

Less than 10% of renal transplant recipients suffer from vascular complications, however, they are a significant cause of graft dysfunction associated with high morbidity and mortality. Vascular complications compared to other causes of graft dysfunction, once identified, are usually easily repaired by radiological intervention.

Color Doppler U/S is still considered as a very good noninvasive technique in the evaluation of vascular pathology [4,15]. Knowledge of the surgical anatomy is a prerequisite for correct interpretation of the findings.

A) Renal Artery Stenosis

RAS is seen in about 10% of renal transplant recipients making it the most common vascular complication occurring within the first 3 months [6,16-18].

Stenosis may affect the iliac artery proximal to the anastomotic site (secondary to inherent atherosclerotic disease in the donor vessel or surgical clamping), at the anastomosis itself (due to perfusion injury or surgical techniques), or the proximal renal artery (mainly due to intimal ischemia).

Almost half of the renal artery stenosis can be located next to the anastomosis. The end-to-end anastomoses have a threefold higher risk of stenosis than the end-to-side anastomoses [19].

Renal artery patency should be evaluated in clinical scenarios like severe hypertension refractory to medical therapy, high BP along with an audible bruit over the graft and unexplained graft dysfunction with associated hypertension [3]. Color Doppler techniques are

used to map the renal artery. Focal color aliasing is demonstrated in the stenotic segments due to increased flow velocity.

Doppler criteria for significant stenosis include peak systolic velocities greater than 200-250 cm/s and PSV ratio between stenotic and pre-stenotic segments to be more than 2:1. The spectral trace just downstream of a stenosis will demonstrate spectral broadening reflecting the turbulent flow emerging from a tight stenosis. Tardus-Parvus waveform abnormalities may be observed in the segmental branches of the transplant, it is often seen as an indirect sign of a significant proximal arterial stenosis. The Doppler indices used to define this waveform include prolonged acceleration time of more than 0.07 s and acceleration index of less than 300 cm/s². Decreased RI (<0.56) of interlobar branches may be the first indicator to suggest a possible inflow problem [18, 20–22]. The combination of both direct as well as indirect Doppler measurements gives an accuracy of 95% in detecting renal artery stenosis [19].

If the patient is clinically doing well despite the findings mentioned, only conservative monitoring should be done [20]. Percutaneous transluminal angioplasty with or without stent placement is done when treatment becomes a necessity [24]. Success rates of about 73% have been reported following a definitive treatment.

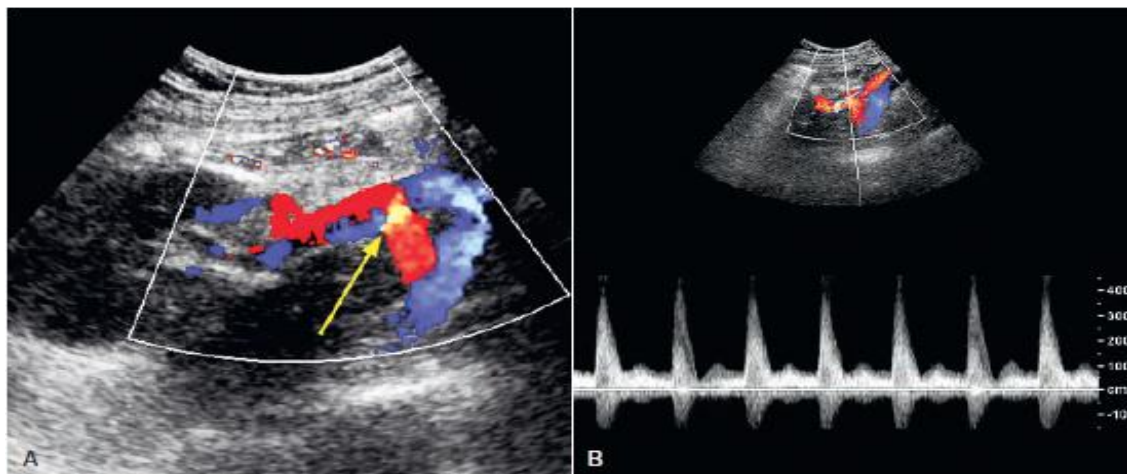


Figure 6 : Renal Artery Stenosis: donor portion.

“A, Color Doppler U/S of donor renal artery anastomosis shows focal area of aliasing (arrow).B, Power Doppler shows area of narrowing in the region (arrow). C, Spectral Doppler shows elevated angle corrected velocities at the site of the arrow, greater than 400 cm/sec.” Pic courtesy : [10]

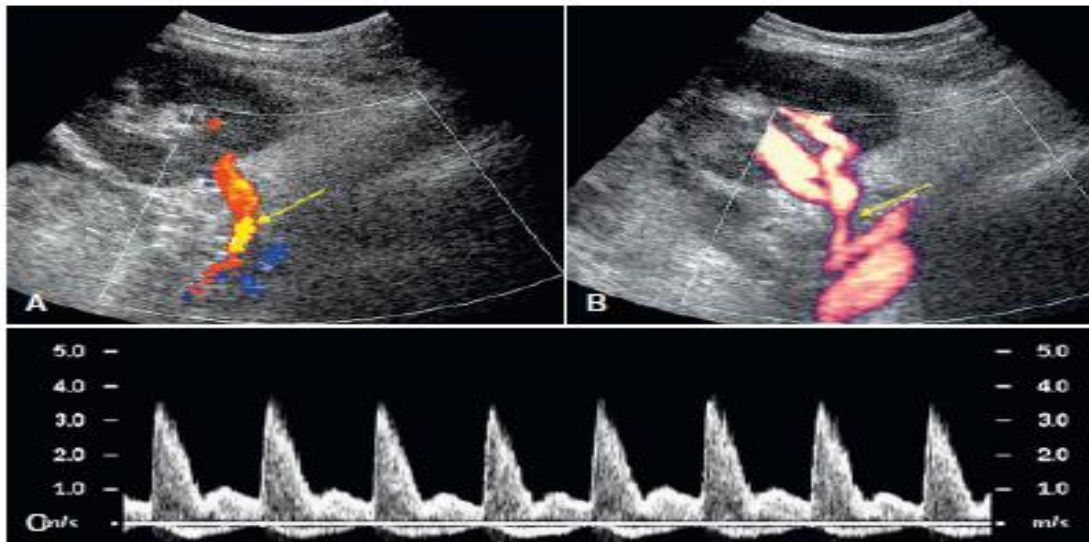


Figure 7: Renal Artery Stenosis: recipient portion.

“A, Color Doppler U/S image shows focal area of aliasing (arrow) proximal to the renal artery anastomosis. B, Spectral Doppler of the region of aliasing seen in image A shows angle-corrected peak velocities of 400 cm/sec” Pic courtesy : [10]

B) Infarction

Main renal artery thrombosis occurs very rarely (<1% of cases) in the early postoperative period usually leading to a graft loss. Infarction may result from, tight anastomotic stricture, arterial kinking, intimal flap or severe rejection. Renal transplant infarction patients usually present with anuria and often with tenderness and swelling over the graft [10].

Occlusive thrombosis of the main renal artery results in global infarction with no perfusion to the renal parenchyma and on grayscale U/S image graft appears hypoechoic and diffusely enlarged.

No arterial and venous flow is seen distal to the thrombus and intrarenal vessels on color Doppler. Severe rejection can present with similar findings. Therefore, angiography or MR angiography may be performed for further investigation. An accessory renal artery or intrarenal arterial branch thrombosis will result in segmental infarcts.

On U/S a segmental infarct produces a focal, hypoechoic, typically a wedge-shaped area with perfusion defects seen on Color-Doppler and postinjection of contrast agents. Severe pyelonephritis or transplant rupture can present with similar findings. Main artery thrombosis results in nephrectomy usually. However few instances of infarct treated successfully with percutaneous angiographic thrombolytic techniques have been reported. Early diagnosis with the timely intervention is important for allograft survival [25].

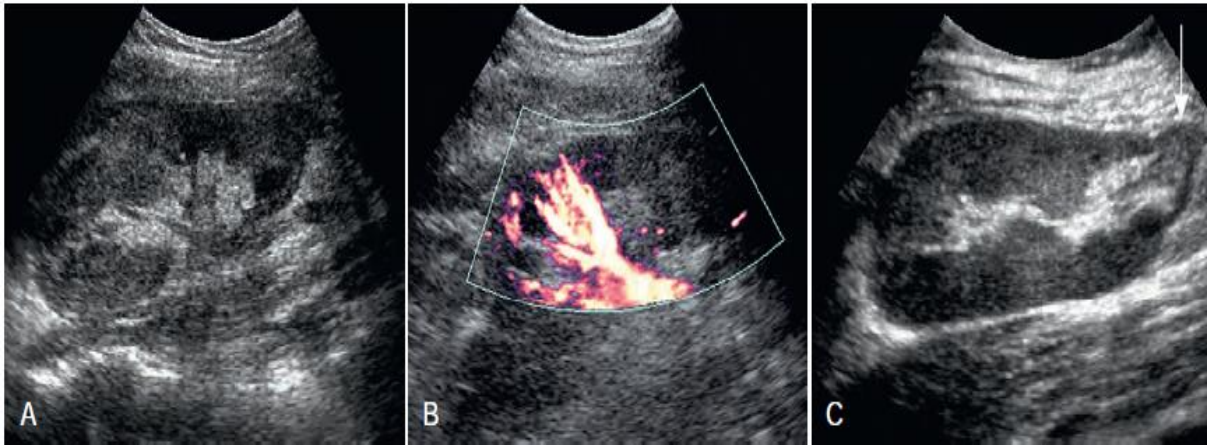


Figure 8: Renal artery thrombosis.

“A, Sagittal grayscale U/S image shows renal graft on postoperative day 1. B, Power Doppler shows no flow in the lower pole due to thrombosis of a segmental artery. C, Three months later, there is secondary scarring of the entire lower pole (arrow).” Pic courtesy : [10]

C) Renal Vein thrombosis

Renal vein Thrombosis (RVT) is a rare complication of transplantation often resulting in early graft loss. Within the first postoperative week, less than 5% of patients are diagnosed with renal vein thrombosis [36]. Clinical findings are similar to infarction presenting with abrupt anuria, tenderness and swelling over the graft.

RVT is likely to occur following surgical difficulty with the venous anastomosis, hypovolemic episodes, peritransplant collection compressing the vein, or sluggish flow secondary to rejection. In the left lower quadrant allografts, the predominance of renal vein thrombosis may be attributed to compression of the left common iliac vein between the sacrum and the left common iliac artery which is also known as silent iliac artery compression syndrome [19].

On grayscale U/S, the graft may appear large and hypoechoic with loss of cortical medullary differentiation. The renal vein may contain echogenic thrombus. Reduced or no flow is demonstrated in the main renal vein on color Doppler study and increased resistance is seen on the arterial channel, often resulting in diastolic flow reversal in the main renal artery and intrarenal arteries [19,26,27]. High RI may be seen in case of partial thrombosis [1]. Focal venous velocity increase may be noted in the events of partial thrombosis, kinks, and external compression by fluid collection.

Diastolic flow reversal can also be seen in ATN or acute rejection but the combination of this finding with absent venous flow at the hilum is virtually diagnostic for this condition hence early recognition of this pattern is vital because the graft might sometimes be salvaged by a prompt thrombectomy.

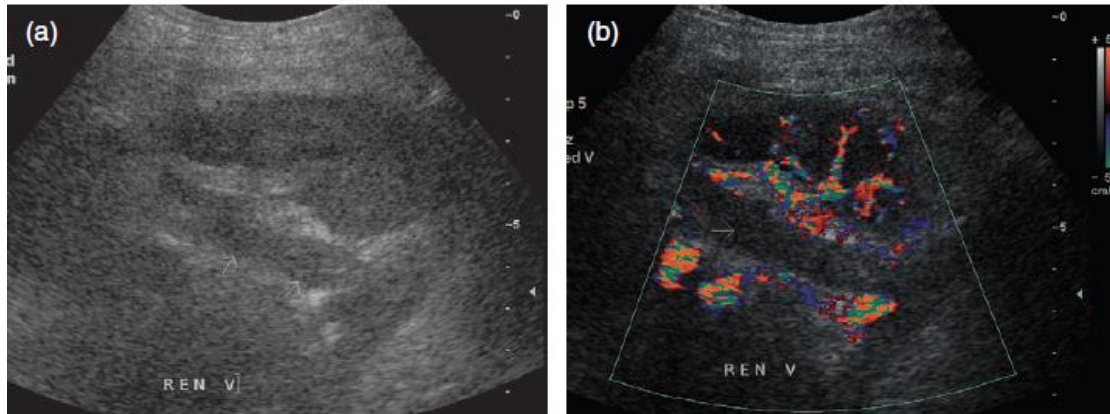


Figure 9: External iliac vein thrombosis extending into the transplant vein.

“Dilated renal vein containing low level echoes (a) with absent flow on Doppler images (b) (arrows) post transplant day 5, in a patient with an External iliac vein thrombosis extending into the transplant vein.” Pic courtesy : [43]

D) Arteriovenous Fistulas and Pseudoaneurysms

AVF's are well-recognized complications of renal biopsies (1%–16% of biopsies), usually following a self-limiting course and resolving spontaneously [28]. AVFs form when the biopsy needle strikes both arterial and venous walls. Color Doppler reveals an area of turbulent flow and aliasing, with very high velocity and low RI of feeding artery as well as “arterialized” flow of draining vein [29]. AVFs have no hemodynamic consequence and are simply observed, but occasionally they can bleed or increase in size and result in renal ischemia due to “steal phenomenon” requiring radiological embolization.

A pseudoaneurysm (PA) is a rare complication (6% of biopsies) and is due to arterial wall injury from the biopsy needle. It appears as a cystic structure on U/S with turbulent, swirling flow, whereas a characteristic to-and-fro waveform may be seen at the neck of the PA on spectral Doppler. Most of them thrombose spontaneously, but if there is a significant increase in size (>2 cm) transcatheter embolization should be considered. An extrarenal PA is very rare, usually occurring at the site of arterial anastomosis due to surgical technique or infection. It is accompanied with high mortality rate if ruptured [30].

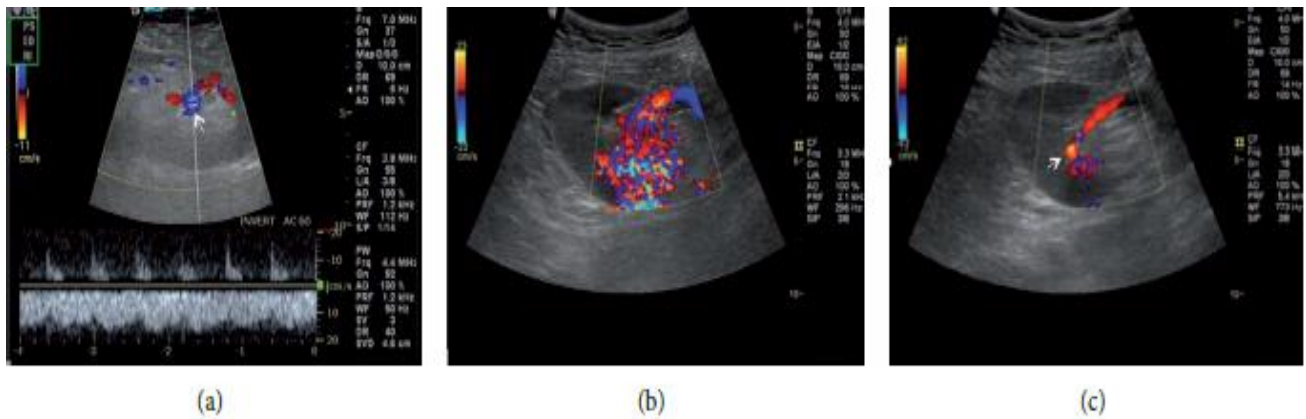


Figure 10: Intrarenal Arteriovenous fistula.

“Intrarenal Arteriovenous fistula. color Doppler US demonstrates a highly vascular lesion (arrow) with aliasing. Spectral Doppler image shows the characteristic mixed arterial venous waveform, with high velocities and low impedance.” Pic courtesy : [36]

1.11 Collecting System Complications

A) Urinary Obstruction

It occurs in approximately 2% of transplantation. The distal third of the ureter accounts for more than 90% of stenosis, due to a relatively poor blood supply. Narrowing at the ureterovesical junction may be caused by scarring secondary to ischemia, rejection, surgical technique or kinking. Less common causes include peritransplant fluid collections compressing the ureter, pelvic fibrosis, papillary necrosis, calculi, fungus balls and clots [36]. Due to kidney and ureter denervation, there is no typical renal colic [1]. Patients with urinary obstruction are typically asymptomatic and the diagnosis is made by a rising level of serum creatinine.

Minor collecting system dilatation can be a normal finding in the early transplant kidney, due to tonicity loss secondary to denervation and increased flow through the single functioning kidney. The evaluation of any moderate degree of collecting system dilatation should be made in the presence of an empty bladder, as a distended bladder alone can be the underlying cause.

Internal echoes in the collecting system suggest pyonephrosis, fungal infections, clots, or tumor [1]. U/S shows peritransplant fluid collections that may cause external ureteral compression. Percutaneous nephrostomy is usually done to relieve obstruction and allow the deployment of other interventional procedures like ureteral stent placement and balloon urethroplasty. U/S guided drainage of fluid collections is used to correct the extrinsic

compression they exert on the collecting system. For long or recurrent strictures surgical reconstruction may be required [31].

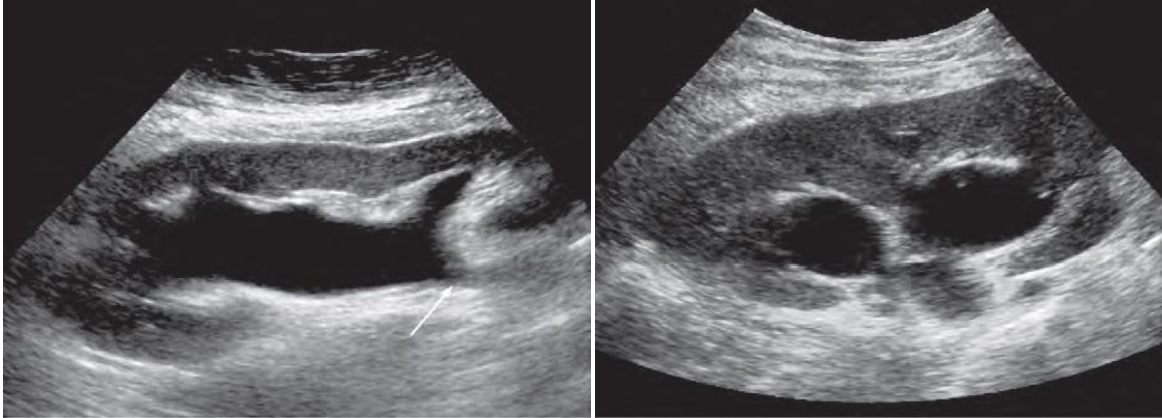


Figure 11: Hydronephrosis Secondary to a Stricture at the Ureteropelvic Junction.

“Ureteral strictures. Sagittal U/S showing grade 3 and grade 4 hydronephrosis secondary to a stricture at the ureteropelvic junction (arrow). The distal ureter was not seen on ultrasound.”Pic courtesy : [10]

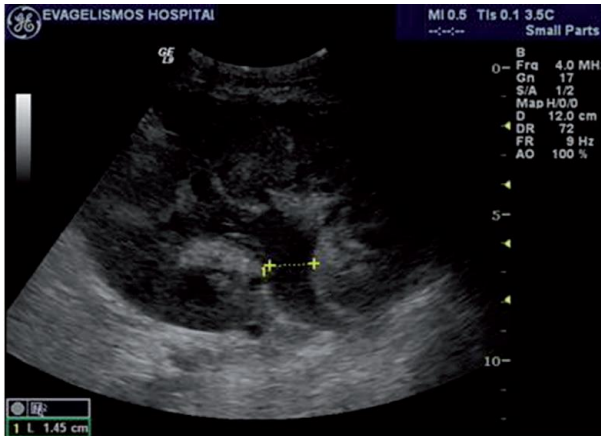


Figure 12: U/S of a renal graft showing mild dilatation of collecting system

Grayscale U/S of a renal graft showing mild dilatation of collecting system , the loss of ureter’s tonicity due to denervation, and ischemia. Pic courtesy: [36]

1.12 Perinephric Fluid Collections.

Perinephric fluid collections are observed in half of transplant recipients and it includes hematomas, lymphoceles, seromas, urinomas, and abscesses. The clinical significance of these collections largely depends on their size, location, and possible growth. Hematomas, urinomas and seromas are usually expected in the immediate postoperative period. Around 4 to 8 weeks after the transplant surgery is when lymphoceles generally occur. Furthermore, growing collections may represent urine leaks, abscesses, or vascular injury [13].

The U/S features of perinephric fluid collections are nonspecific and percutaneous aspiration can be used to diagnose them accurately [32].

A) Hematomas

Hematomas are more common in the immediate post transplant period but can also develop spontaneously or after traumatic injury. They are usually located within the subcutaneous tissues or around the transplant with most resolving spontaneously. Larger hematomas can compress the collecting system and compromise the vascular supply [13,32]. It may displace the graft producing hydronephrosis.

On U/S, acute hematomas appear complex and echogenic. With time they become more defined, cystic and often develop fibrous septations along with clot debris. These collections should be measured on the baseline U/S scan because any increase in size may indicate surgical intervention. Complex collections detected later in the postoperative period with clinical evidence of infection may suggest abscesses [2].



Figure 13: Postoperative perirenal hematoma

“Postoperative perirenal hematoma. D , Sagittal U/S shows hematoma 1 day post surgery, appearing as a solid echogenic heterogeneous mass. E, Four weeks later, hematoma begins to liquefy, with interspersed solid components. F, Six weeks later, hematoma is almost completely liquefied; arrows mark the junction of the hematoma and renal cortex.”Image courtesy :[10]

B) Urine Leaks and Urinomas

Due to the surgical technique, ureteral ischemia and necrosis the urine might extravasate from the renal pelvis, ureter or ureteroneocystostomy site. Urinomas are variable in size and commonly found in the first few weeks of post transplant period, between the renal graft and the bladder. Decreased urine output is seen in patients with urine leakage. They typically present with tenderness around the graft. Discharge from the wound or ipsilateral leg swelling with scrotal or labial edema can also be seen.

Urine leak or urinoma appears as an anechoic fluid collection with fairly well-defined borders and without any septations on U/S image. Its size increases briskly, often requiring an U/S guided drainage to relieve compression and urinary ascites. The higher creatinine level of the fluid compared with its serum concentration differentiates a urine leak from a seroma or lymphocele [13]. Urinomas can get infected and in due course form abscesses . Percutaneous nephrostomy and stent placement are used to treat urine leaks.



Figure 14: Grayscale U/S image showing an anechoic collection

Grayscale U/S image showing an anechoic collection between the inferior pole of the transplant and the bladder on post transplant day 10.” Image courtesy : [43]



Figure 15: Urinomas

“Grayscale U/S image showing two anechoic areas, without septations, next to a renal transplant. U/S guided aspiration revealed increased levels of creatinine, compatible with Urinomas.” Pic courtesy : [36]

C) Lymphoceles

Lymphoceles are one of the most usual peritransplant fluid collections affecting up to 20% of the patients [4]. It usually occurs 1-2 months postoperatively secondary to the surgical disruption of the lymphatic channels along the iliac vessels or around the hilum of the graft.

Lymphoceles are usually anechoic on U/S but may contain septations and are typically seen between the bladder and the medial aspect of the transplant. Most lymphoceles are incidental findings and it may require monitoring, as they have a potential to exert a mass effect on the collecting system of the transplant resulting in hydronephrosis. They may also compress the vascular pedicle of the transplant or the iliac vessels of the recipient causing oedema of the lower limb, abdominal wall, scrotum, or labia [3]. Larger lymphoceles should be percutaneously or surgically drained [2, 13, 15].

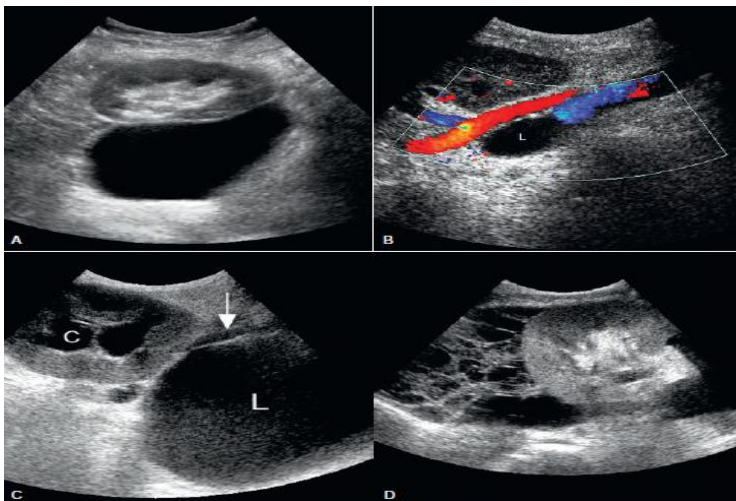


Figure 16: Lymphoceles

“Sterile Lymphoceles in four patients. A, Sagittal U/S image shows large, simple lymphocele abutting the transplant. B, Sagittal scan shows small lymphocele (L) adjacent to the external iliac artery and vein. C, Anechoic lymphocele (L) causing obstruction of the midureter (arrow) and dilation of the calyceal system (C).D, Transverse US image shows septated perinephric lymphocele.” pic courtesy : [10]

D) Perinephric Abscesses

Peritransplant abscesses are not observed frequently and usually develop within the first few weeks post transplant [13]. Perinephric collections can become infected and turn into an abscess, which often makes it difficult to distinguish from a hematoma. Furthermore, as the

transplanted patient is on immunosuppressive medications clinical features of infection may be absent.

U/S cannot always differentiate an abscess from other collections. The typical image findings of a fluid collection with low-level echoes and a thick irregular wall are very rarely found.

However, if gas is seen, an abscess is probable. Power or color-Doppler may additionally illustrate increased vascularity of the wall and the surrounding tissues [34].

To conclude, in the pyrexial patient, any perinephric collection should be considered infected until proven otherwise through the appropriate imaging and guided diagnostic aspiration.

Ultrasonography, as stated earlier can be an effective modality to guide percutaneous drainage [15].



Figure 17: Sagittal U/S scan showing the abscess

**“Sagittal U/S scan showing the abscess (A) abutting the lower pole of the transplant.”
pic courtesy : [10]**

1.13 Review of Studies on Post Renal Transplant Complications

Since the beginning of 1960s renal transplantation is considered as a treatment of choice for end-stage renal disease (ESRD). A study done by W. M. Vollmer et al in England in the year 1983 showed that, renal transplantation is cost effective and provides better long-term survival as well as the quality of life in comparison to hemodialysis or peritoneal dialysis [2].

Schnuelle P, Lorenz D et al did a comparative study in Germany analyzing mortality between two groups, the first group being the patient who had the renal transplant and the second one who were on the waiting list. The study period was from 1989 to 1997 and results were found to be that patient who had received transplant had substantial survival advantage compared to another group [39].

Sonographic evaluation of renal transplants had routinely begun in the 1970s, with the Doppler techniques introduced 10 years later [15].

S.B park et al in Seoul, Korea in the year 2006 alluded that renal transplantation being a serious surgical procedure the transplant recipients can only benefit from ultrasonographic follow-up imaging and monitoring strategies [4].

E.D Brown et al emphasized that U/S is not only cheap and noninvasive but also a non nephrotoxic imaging modality, which can be applied for diagnostic and monitoring purposes early on, in the post transplant period and she concluded U/S is the excellent noninvasive method for screening [2].

In the first 48 hours after renal transplantation, a baseline U/S evaluation of the graft is always performed. A complete examination protocol includes renal size and echogenicity, collecting system, the condition of the ureter and evaluation of any postoperative collections. Color and spectral Doppler imaging are used to assess graft perfusion.

Post-transplant evaluation of the graft can be normal or associated with complications.

Complications are mainly divided into parenchymal, vascular, and collecting system abnormalities and perinephric fluid collections [36].

Clinically, the presentation of most transplant complications is rather nonspecific, with the possibility of poorly controlled hypertension, diminishing urine output, rising serum creatinine, elevated inflammatory markers, pain over the transplant site, and fever [15].

Delayed functioning of the graft is a common occurrence following transplantation. It's mostly seen in the cadaveric transplant and is often because of acute tubular necrosis caused by donor kidney ischemia during transplantation and reperfusion injury [29].

Rejection is classified into hyperacute, acute or chronic depending on the time of occurrence. Hyperacute rejection is rare, caused by preformed antibodies in the recipient's serum. It occurs in the operating room, immediately postsurgery [1]. As a result, these cases are rarely imaged.

Among rejection, the acute type is the commonest, which usually occurs 1-3 weeks post transplant.

Study done by Chrysafoula Kolofousi et al in Greece in the year 2013 showed that more than eighty percent of renal transplant recipients suffered from at least one episode of infection during the first year after transplantation due to increased risk from immunosuppressive medication, indwelling catheters, and frequent glycosuria.

G. D. Dodd, M. E. Tublin et al showed that the vascular complications associated with renal transplants are an important cause of graft failure. The arterial, venous stenosis, as well as thrombosis were the usual complications. Among others, RAS was found to be the most common vascular complication, seen up to 10% occurring within the first 3 months after transplantation [16].

A prospective comparative study done by M. L. Jordan, G. T. Cook et al showed that that end to end anastomoses had a threefold risk of developing stenosis compared to end to side vascular anastomoses [19].

A study by Mark E. Lockhart et al in Birmingham in the year 2007 showed that diastolic flow reversal seen in the patients less than 24 hours post transplantation required an emergent exploration as correction of the treatable causes resulted in recovered function. However longstanding renal grafts with diastolic flow reversal were not likely salvageable [40].

Syed Akbar, S Jafri et al did a study in Boston in the year 2005 which revealed that peritransplant fluid collections are very common, occurring in approximately 50% of renal transplant patients [13]. Among these collections, 15% to 20% grew to be clinically significant. Pain at graft site was typical in these patients and compression of the vascular structures of the graft or the ureter resulted in transplant dysfunction [13,19]. Early postoperative fluid collections were urinomas, hematomas and seromas. His study also revealed lymphocele to be the most commonly occurring peritransplant fluid collection.

Aneeta Parthipun J Pilcher et al did a similar study in the UK in the year 2010 which showed peritransplant fluid collections to occur at different timings. They found out Hematoma and urinoma occurring immediately and lymphocele was seen 4 to 8 weeks post transplant. Additionally, hematomas and lymphoceles were the most common peritransplant fluid collections when compared to urinoma and abscess.

Cosgrove et al and Chrysafoula Kolofousi had used U/S as a first-line imaging modality in the evaluation of the renal transplants. They established that U/S not only helped in detecting the pathology but also proved to be the best method for guided renal biopsies and aspiration of fluid collections [3,36].

Sung Bin Park et al alluded that U/S can accurately illustrate and characterize many potential complications of renal transplantation. He emphasized the fact that familiarity with the clinical features and ultrasonographic appearance of renal transplant complications, will facilitate prompt diagnosis and treatment. However, imaging findings with clinical correlation and graft age were vital in providing an accurate diagnosis and timely intervention to prolong graft survival [4].

2.0 CHAPTER TWO PROBLEM STATEMENT AND JUSTIFICATION OF THE STUDY

Ultrasound (U/S) is commonly used to evaluate the renal graft, yet there is no locally documented evidence of the value of U/S in postoperative monitoring and diagnosing renal graft complications.

The study is first of its kind in Kenya and to the best of my knowledge, there is no evidence of a similar study conducted in East Africa.

The study is therefore designed to evaluate the ultrasonographic findings and complications of renal grafts who underwent renal transplantation at Kenyatta National Hospital.

2.1 Research Question

- What is the diagnostic yield of U/S scan in patients with renal graft complications seen at Kenyatta National Hospital?

2.2 Objectives

2.2.1 Broad objective

- To evaluate the ultrasonographic findings and complications of the renal grafts seen at Kenyatta National Hospital.

2.2.2 Specific objectives

- To determine the incidence of the specific renal transplant complications namely;
 - Parenchymal
 - Vascular
 - Collecting system
 - Perinephric fluid collection.
- To establish the most common graft complication seen in post renal transplant patients at KNH.

3.0 CHAPTER THREE: STUDY DESIGN AND METHODOLOGY

3.1 Study Site and Design

This was a descriptive retrospective study, conducted at the Renal unit in the Kenyatta National Hospital, between March 2014 to March 2016.

3.2 Study Population

The study participants included all the adult patients who underwent the renal transplant at Kenyatta National Hospital between March 2014 to March 2016 after satisfying the inclusion criteria.

3.3 Sample Size Estimation

For populations that are large (i.e. 10,000 and above), sample size for prevalence is estimated as:

$$n_0 = \frac{Z^2 * p(1 - p)}{e^2} \quad [\text{Cochran (1963)}]$$

Where

n_0 is the sample size for target population >10,000

Z^2 is the abscissa of the normal curve that cuts off an area α at the tails ($1 - \alpha$ equals the desired confidence level, e.g., 95%),

e is the desired level of precision,

p is the estimated proportion of an attribute that is present in the target population which is obtained from a previous similar study,

The study will desire a 95% confidence level and $\pm 5\%$ precision. The study assumed $p=0.5$ since there is no similar study conducted in regions similar to our settings.

Substituting the above parameters, the sample size becomes:

$$n_0 = \frac{1.96^2 * 0.5(1 - 0.5)}{0.05^2} = 385$$

Since the target population is less than 10,000 (i.e. study population =172) then the sample size was adjusted downward.

The sample size (n_0) was adjusted using:

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where

n is the adjusted sample size

N is the target population size.

Therefore the adjusted sample size becomes:

$$n = \frac{385}{1 + \frac{(385 - 1)}{45}} = 41$$

All the 46 eligible participants were enrolled into the study.

3.4 Sample Procedure

The sample size included all the adult patients who underwent the renal transplant at KNH between March 2014 and March 2016 after satisfying the inclusion criteria. The study used systematic sampling with a random start to select 46 participants whose clinic files were used for data abstraction. Medical records were consecutively sampled along with the ultrasound reports of the grafts from the Department of Renal Unit, Kenyatta National Hospital until the sample size was attained.

3.4.1 Inclusion criteria:

- All adult patients who underwent renal transplants and ultrasound examination of the graft at KNH from the period of March 2014- March 2016.
- Ultrasound scans of the renal grafts which were done following the standard protocol.

3.4.2 Exclusion criteria:

- Patients who received the renal transplant in other center but following up in KNH.
- Patients younger than 18 yrs who are on follow-up in the renal clinic.
- Ultrasound scans of the renal grafts where the standard protocol was not followed.

3.5 Study Tools, Equipment and Data Collection

3.5.1 Surgical Technique

The transplanted kidney is placed extraperitoneally in the recipient's iliac fossa. Usually, a left kidney is placed in the right iliac fossa and vice versa to ease the vascular anastomoses. It results in the anterior renal pelvis, with the renal artery posterior to it and the renal vein the

most posterior structure at the hilum (the reverse of the normal position of these structures). When a cadaveric kidney is used, an aortic patch (Carrel patch) is removed with the renal artery and anastomosed to the external iliac artery. In live donors, renal artery is anastomosed end-to-side with the external iliac artery, but it can also be anastomosed end-to-end with the internal iliac artery. The renal vein is commonly anastomosed end-to-side to the external iliac vein. The transplanted ureter may be implanted into the bladder simply, or using a submucosal tunnel (Politano–Ledbetter technique) to reduce the incidence of vesicoureteric reflux.

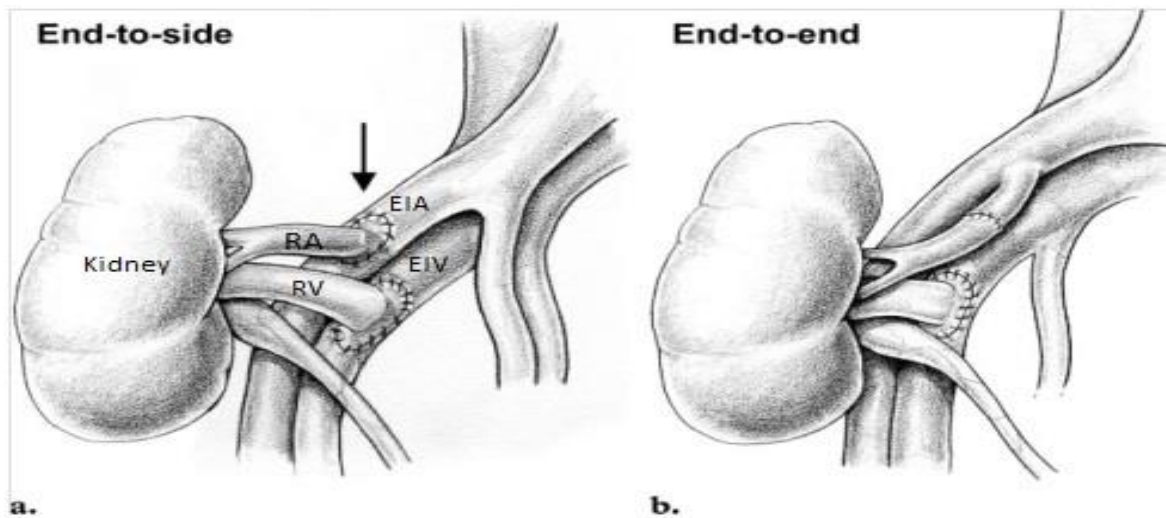


Figure 18: Renal artery and venous anastomoses.

“The renal artery is anastomosed either end-to-side to the external iliac artery (a) or end-to-end to the internal iliac artery (b). Note that a portion of the aorta (Carrel patch) is harvested with the renal artery in the end-to-side procedure (arrow). Renal veins are anastomosed end-to side to the external iliac vein.” Image courtesy : [46]

The GE and Phillips U/S machines were used to scan the grafts of the transplanted patients.

3.6 Data Management

3.6.1 Data Collection

Data was collected from the eligible medical records by the principal investigator and the trained assistants. The following data was collected from the patient’s registers; social demographic data (age and sex), post transplant clinical symptoms, specific timings of graft scans done postoperatively, ultrasound imaging findings of the renal grafts (Grayscale , Color Doppler and Spectral Doppler) and finally the specific complications seen. Data of the patients who died during the study period were also collected, provided they had satisfied the inclusion criteria.

3.6.2 Data Analysis

All the data collection forms identified with a participant ID number were entered into an MS Excel database and analyzed using the 20th version of Statistical Package for Social Scientists (SPSS).

3.6.3 Descriptive Analysis

Descriptive analysis of the data obtained from the study was summarized and presented in the form of proportions and measures of central tendencies (mean or median). Descriptive data such as Demographic data, renal transplant patients at KNH and Post renal transplant complications data were presented in tabular and graphical formats.

3.7 Ethical Consideration

- Kenyatta National Hospital ethical and research committee approved the research.
- The patient's personal information e.g names were not used in the study in order to uphold the confidentiality.
- The study commenced after the approval by the ethical and research committee.
- Confidentiality and care was upheld when handling the patient's files.
- Information acquired was used for the intended purpose.

4.0 CHAPTER FOUR: RESULTS

A total of 52 files were reviewed and 46 eligible patient files who met the inclusion criteria, were enrolled into this study. The following table illustrates the patient demographics and complications of the renal grafts.

Table 2: Social Demographic Characteristics of the Patients

Characteristics	N	%
Sex		
Male	34	73.9%
Female	12	26.1%
Age (Mean (SD))	41.2 ± 1.8	(SD = 12.1 years)
Median	39.50	

Table 3: Post Kidney Transplant Complications

Post kidney Transplant Complications	No of cases	%
Parenchymal	3	10.3%
Vascular	3	10.3%
Collecting systems complications	2	6.9%
Peritransplant fluid collections	21	72.5%

Table 4: Distribution of Specific Post Kidney Transplant Complications

Specific Post kidney Transplant Complications	No of cases	%
Parenchymal complications		
Rejection	3	
i)Acute rejection	1	3.4%
ii)Chronic rejection	2	6.9%
Vascular complications		
Renal artery stenosis	3	10.3%
Collecting systems complications		
Urinary obstruction	2	6.9%
Peritransplant fluid collections		
Hematomas	13	44.8%
Urine leaks and urinomas	3	10.3%
Lymphoceles	4	13.8%
Perinephric abscesses	1	3.6%
TOTAL	29	100%

Table 5 : Test of Association between Sex and Development of Complications

Gender	Total	Complications		95% CI for OR				
		Yes	No	Chi-Square	p-value	OR	Lower	Upper
Male	34(74%)	18(53%)	16(47%)	0.451	0.505	1.58	0.416	5.96
Female	12(26%)	5(42%)	7(58%)					

P-value = 0.505 > 0.05 depict that there is no association between sex and development of complications. However, odds of male developing complication is 58% higher than for female with 95% confidence level.

4.1 Cases

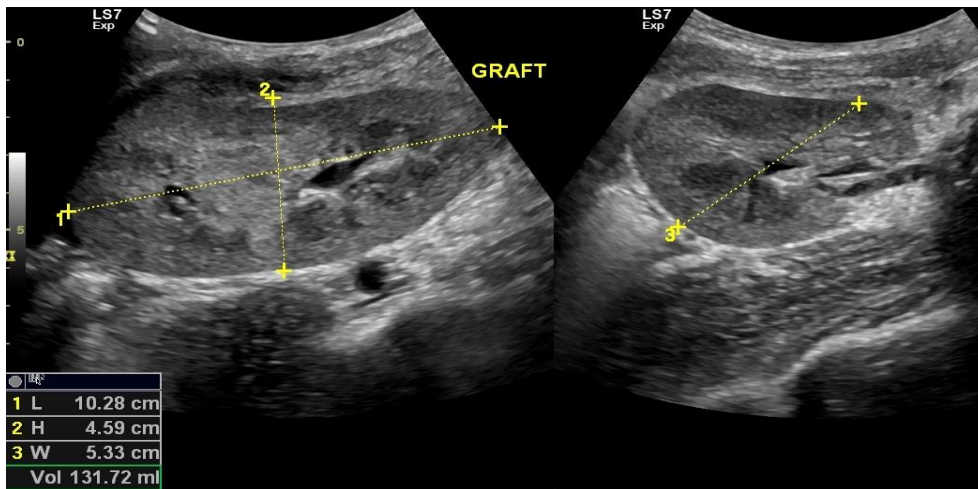


Figure 19: Normal Grayscale Image of a Renal Graft.

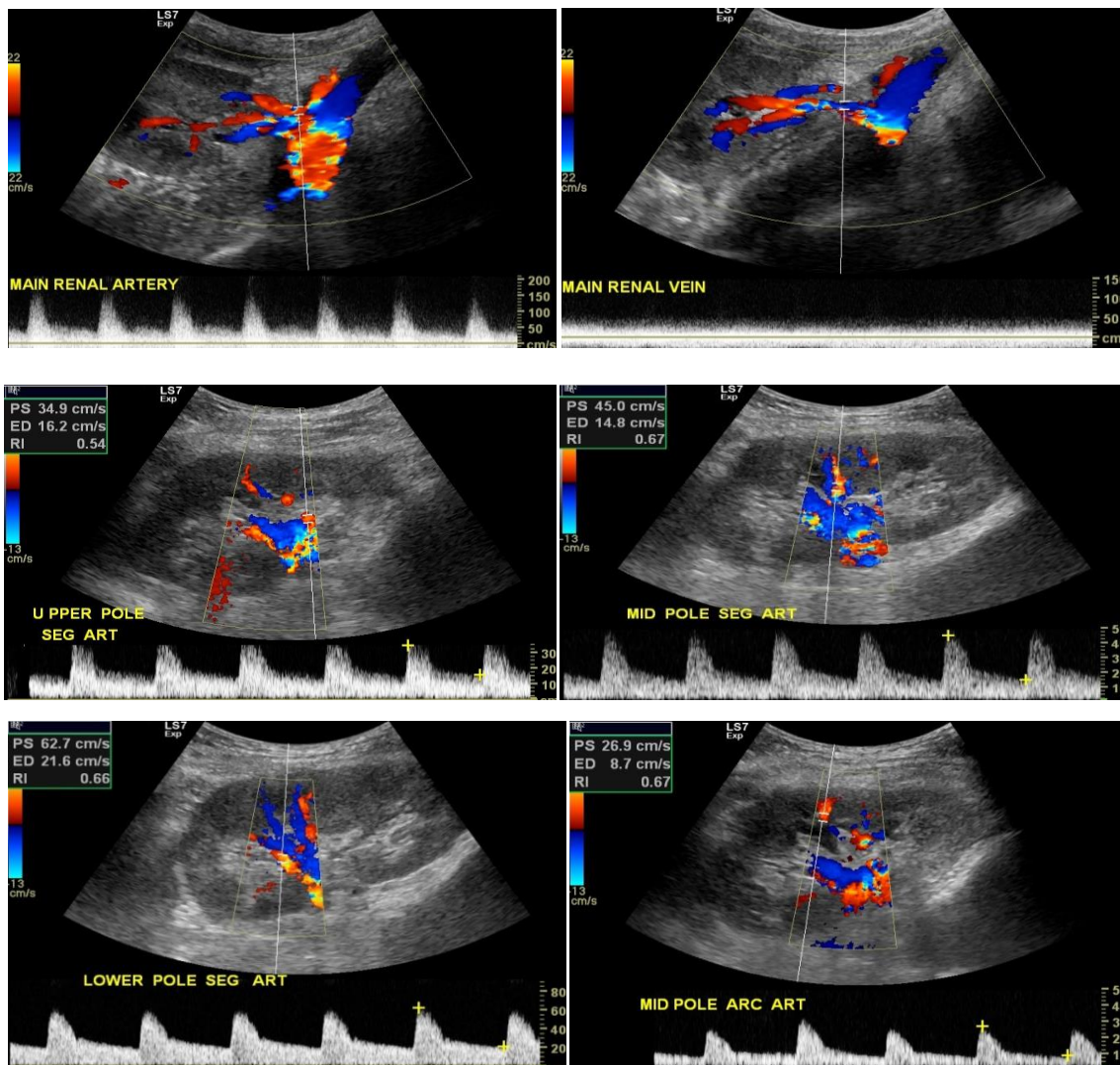


Figure 20: Graft Demonstrating Normal Color and Spectral Doppler Study.



Figure 21: Acute Rejection.

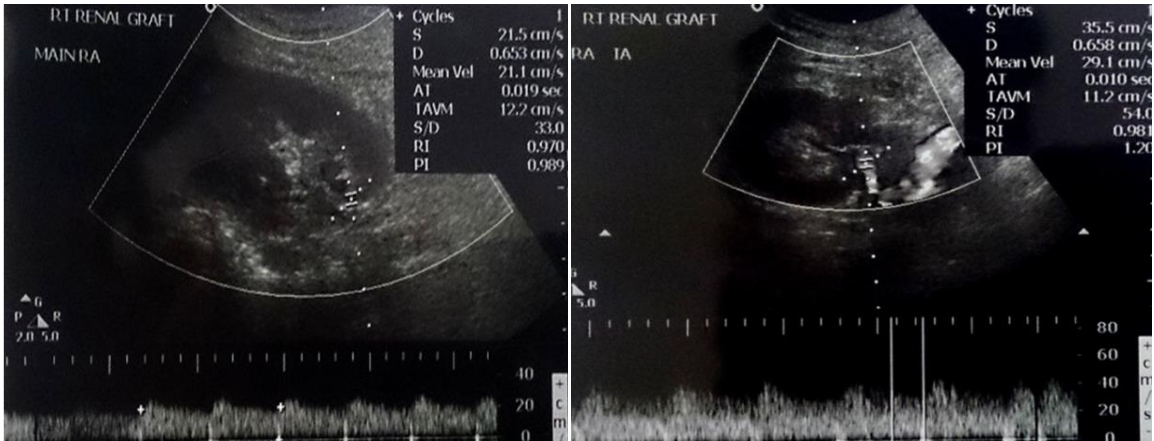


Figure 22: Impending Renal Artery Stenosis.



Figure 23: Hematoma.

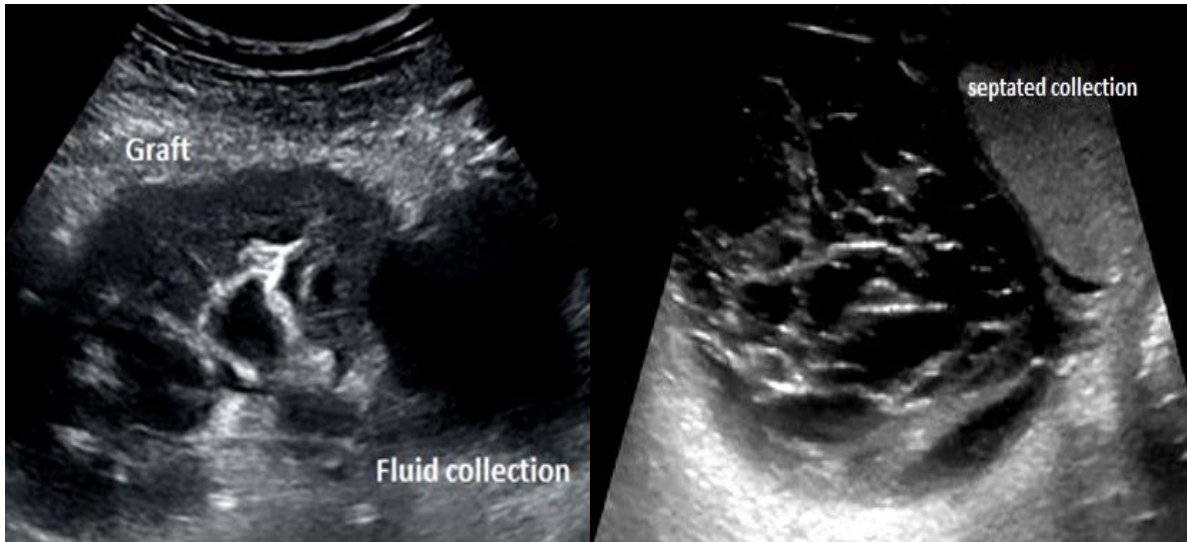


Figure 24: Lymphocele.

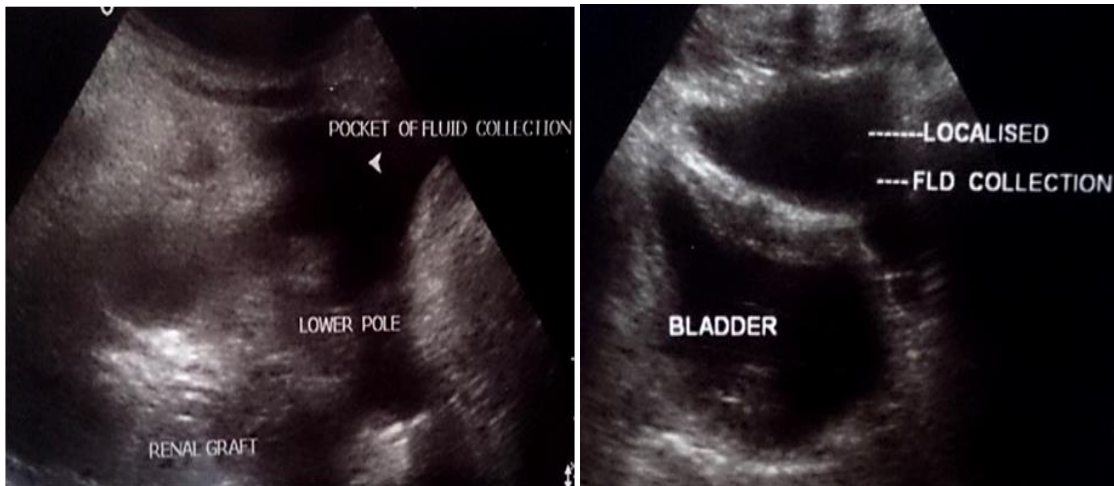


Figure 25: Urine leaks and Urinoma.

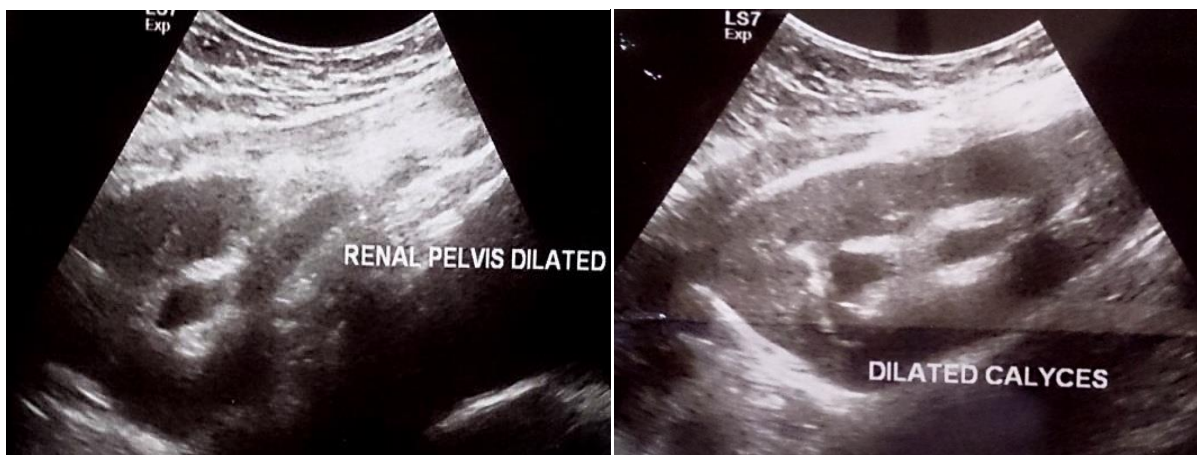


Figure 26: Urinary obstruction.

**TOTAL NUMBER OF SUBJECTS ENROLLED INTO THE STUDY
AT KNH FROM MARCH 2014 - MARCH 2016**

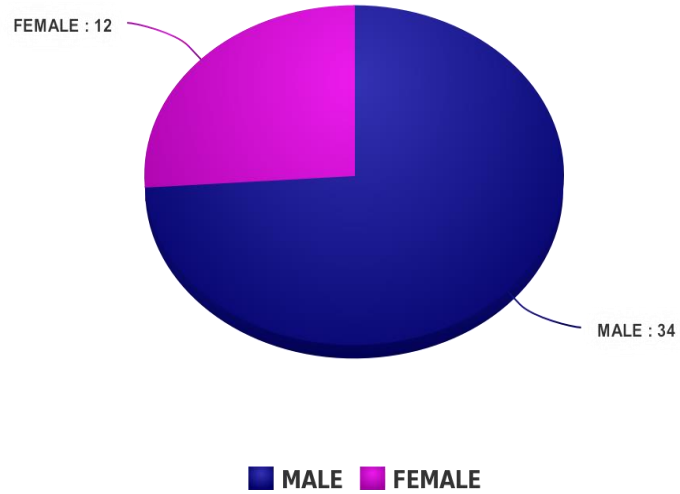


Figure 27: Demographic Characteristics.

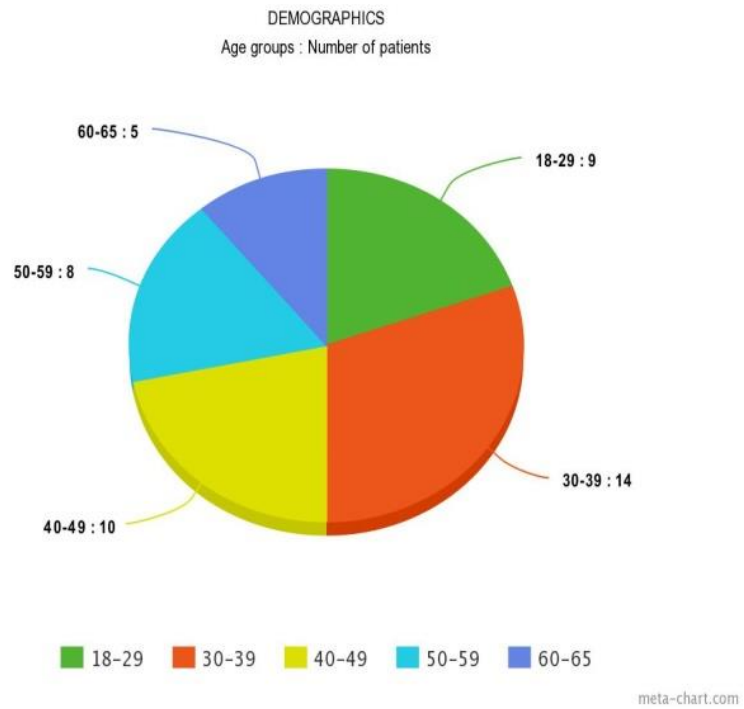


Figure 28: Demographic Characteristics

POST RENAL TRANSPLANT PATIENTS
 AT KNH FROM MARCH 2014 - MARCH 2016

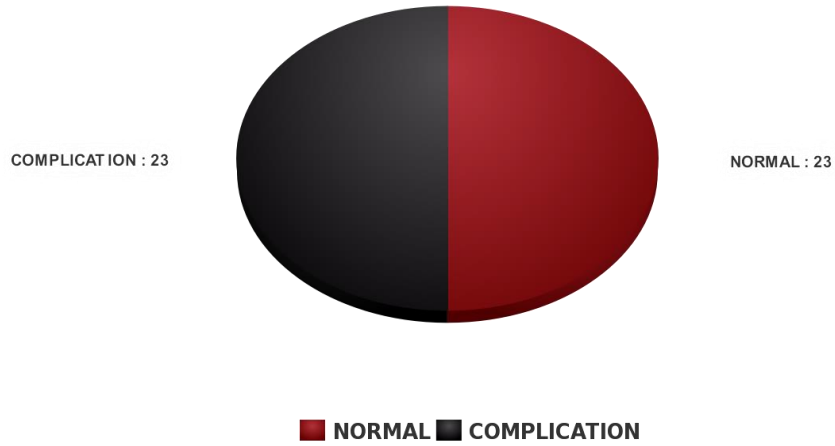


Figure 29: Post Renal Transplant Patients With and Without Complications.

POST RENAL TRANSPLANT COMPLICATIONS
 SPECTRUM OF FINDINGS

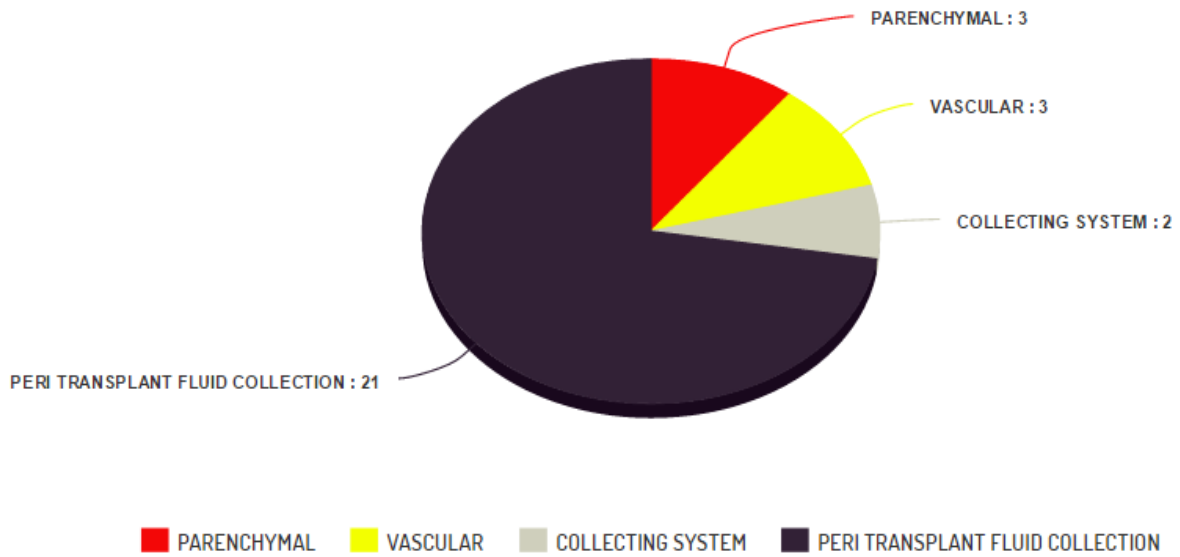


Figure 30: Post Renal Transplant Complications.

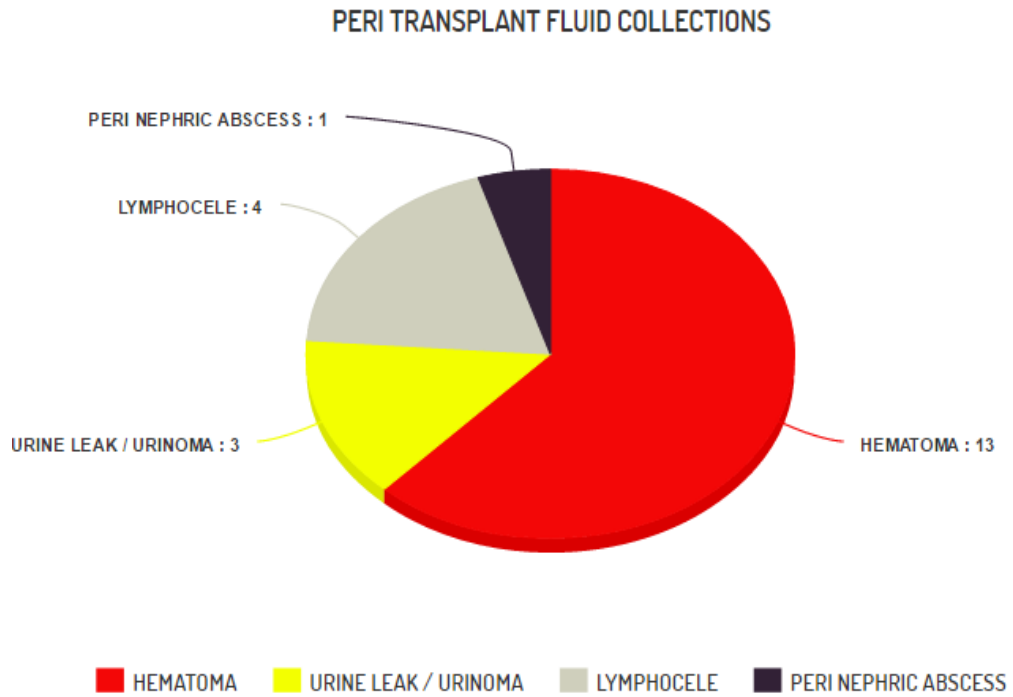


Figure 31: Peritransplant Fluid Collections Specific Findings.

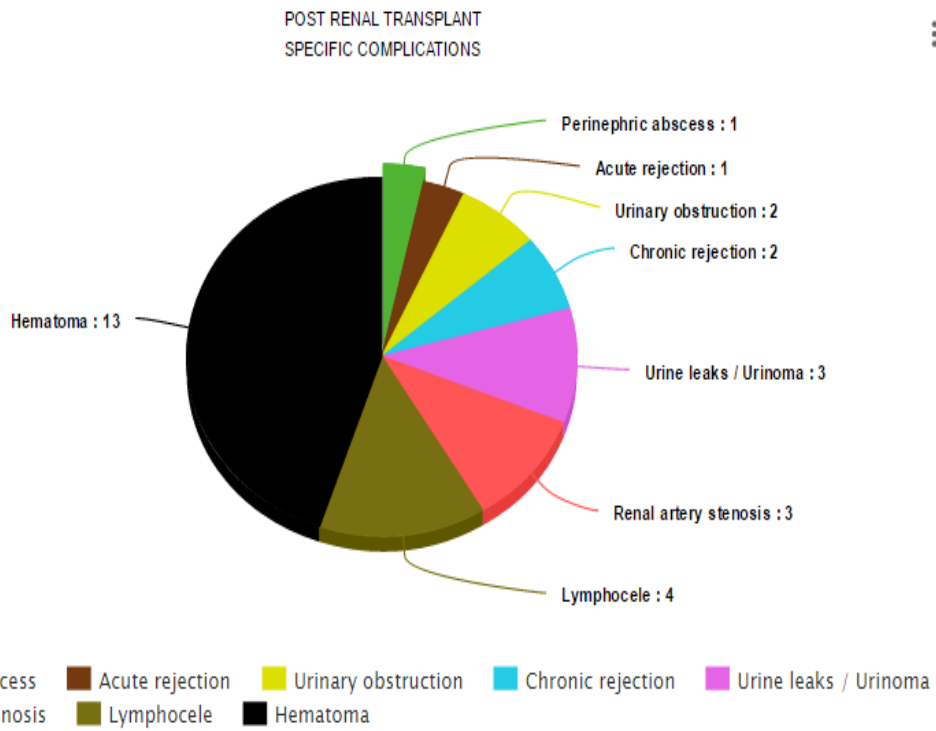


Figure 32: Post renal transplant Specific Complications.

5.0 CHAPTER FIVE: DISCUSSION

The prevalence of Chronic kidney disease (CKD) and end-stage renal disease (ESRD) in Kenya are on the rise. This could be attributed to the growing incidence of risk factors for CKD namely diabetes mellitus, hypertension and chronic glomerulonephritis among others. Rarely chronic mercury exposure from the use of skin whitening creams has also been reported to cause CKD [17]. Since renal transplantation is now considered the preferred method of treatment for chronic renal failure, It has become a common surgical procedure, with thousands performed yearly around the world. Morbidity associated with transplant procedure is common and the complication rate associated with surgery is quite substantial. Therefore detection and timely management of these complications are important as delay in the diagnosis or management of these complications can result in significant morbidity, with a high risk of graft loss and mortality.

The purpose of this study was to evaluate ultrasonographic findings and complications of the renal grafts seen in the patients who underwent the kidney transplant at Kenyatta National Hospital in the period of March 2014 to March 2016.

The study is first of its kind in Kenya and the whole of East Africa. A total number of the patients who were enrolled into the study after satisfying the inclusion criteria were 46. There was a male gender predominance with 34(73.9%) males and 12(26.1%) female patients. Similar gender inequality was seen in the studies done from other parts of the world which could be attributed to multiple psychosocial factors [18]. Previous studies have shown that ESRD incidence is higher in males than females, hence making them more eligible candidates to undergo kidney transplants [19]. Mean age of the patients in our study was 41.2 ± 1.8 years ($SD = 12.1$ years), the youngest transplant recipient was twenty-two years old and the eldest being sixty-five years.

A baseline US evaluation was performed for all the patients in the first 48 hours post transplant. However, in the patients who developed oliguria, anuria, bleeding at the anastomotic site or suspected arterial stenosis, were scanned immediately without any further delay. Depending upon the clinical scenarios and physician referrals, there were instances where more than one scan was performed to check the interval changes in cases such as impending renal artery stenosis, hematoma, urinoma or lymphoceles.

Twenty-three (eighteen males and five females) out of the forty-six patients developed post transplant complications taking the overall complication rate to 50%.

Post kidney transplant complications are divided into parenchymal, vascular, collecting system abnormalities and peritransplant fluid collections.

The ultrasound images of graft kidney in post renal transplant patients along with the consultant's report was analyzed by the principal investigator. The information regarding the clinical presentation during the scan time was provided in the patient's file.

From our study, we found that the parenchymal complication rate to be 10.3% which included three cases of rejection , one case of an acute rejection which was diagnosed early first week, whereas the other two cases of chronic rejection were detected between 6 to 11 months post renal transplant. The ultrasonographic features of the rejections were found to be nonspecific similar to the findings reported from other studies [5]. For instance, the acute rejection findings were of decreased perfusion and increased RI whereas, loss of the cortical medullary differentiation with increased RI was noted in chronic rejection cases. Other parenchymal complications like acute tubular necrosis, drug toxicity or infections were not seen in our study.

Among vascular complications, our study showed Renal Artery Stenosis (RAS) to be the most common complication which was identical to the findings reported from other parts of the world [11, 20-21]. It was detected by Doppler study at different intervals (post operative day one to three weeks).Totally three patients were found to have RAS, taking the vascular complication rate to a 10.3 % which is similar to the findings from the study done by Chrysafoula Kolofousi et al in Greece in the year 2013[5]. A patient with severe hypertension refractory to the medical therapy was referred for a scan on the same day of kidney transplant, before the usual protocol (Post operative day two) was diagnosed to have renal artery stenosis at the anastomotic site, timely diagnosis helped the surgeons to correct the stenosis and restore the patency, hence salvaging the graft. Besides RAS no other vascular complication was noted.

The collecting system complication solely included urinary obstruction secondary to the dislodged DJ stents seen in two patients. Many surgeons from different parts of the world including Kenya prefer DJ stents to maintain the patency of the ureter as it avoids kinking, however, dislodged DJ stent is one of the main causes of urinary obstruction [5].These patients were sent to the radiology department with complaints of anuria and high serum creatinine level. U/S findings were of hydronephrosis and dilated pelvicalyceal system.

Urinary obstruction was diagnosed in two patients in the interval of six months to one-year post kidney transplant. The collecting system complication rate was found to be 6.9, which

was slightly higher than the findings reported from the study done by Elizabeth D. Brown et al in the USA in the year 2000 [2].

From our study it was noted that twenty-one patients developed peritransplant fluid collections which by far was the most common post transplant complication, yielding an identical result to the studies done across the world, though the incidence rate of 72.5% was slightly on the higher side [3,5,9].

Hematoma and lymphocele were the most common peritransplant fluid collections diagnosed compared to urinoma and perinephric abscess. On ultrasound, the hematomas appeared to be complex, echogenic and with time they were found to be cystic. Hematoma was detected in thirteen and lymphocele in four patients. Similar studies done in other parts of the world showed lymphocele and hematomas to be the most common peritransplant collections were attributed to the surgical techniques [9]. Lymphoceles on ultrasound were usually anechoic but few cases showed septations [5]. Our study showed hematoma to be the commonest peritransplant fluid collection with the incidence rate of 44.8%.

We also found out that hematoma and urinoma usually occur much earlier (as early as postoperative day 2 to 3 weeks) compared to lymphocele (post operative day 2 to 4 weeks) similar to the findings reported from the study done by Aneetha parthipun et al in London in the year 2010 [3]. One patient had developed a huge hematoma which was compressing the graft resulting in decreased perfusion and it was detected on post transplant day ten. The patient was taken to the theatre for hematoma resection immediately which enabled to restore the normal function post-intervention.

An Additional finding from the study showed, p-value to be 0.505 depicting that there was no association between sex and development of complications. However, odds of male developing complication was found to be 58% higher than for female with 95% confidence level.

Overall our study has emphasized the utility of the ultrasound in the evaluation of the renal graft and its complications. It was also evident that early diagnosis of the complication and timely intervention was vital in graft survival.

5.1 Conclusion

Since the study is first of its kind in the country, we had no prior information regarding the complications developing among the Kenyan population who underwent renal transplantation at Kenyatta National Hospital. The outcomes were not new when compared to the information available from previous studies done overseas, However, the results obtained were coinciding with the studies done in the developed countries suggesting that the procedure and protocols followed are on par with other parts of the world.

Our study showed that the diagnostic yield of ultrasound in detecting the renal graft complications is high and the timely intervention proved to be vital in salvaging the graft.

Ultrasound not only helps in detecting the complications but also proven to be the best method utilized for guided fluid aspiration.

5.2 Recommendations

There is a need to create awareness among the clinicians and nursing staffs regarding early diagnosis of the post renal transplant complications as it was evident from our study that timely detection of a few serious complication helped the surgeons to correct them immediately resulting in salvaging the graft.

Existing protocol requires an amendment like relaxation on the time interval to perform graft scans, as some of the post transplant complications can develop immediately or on postoperative day one itself. Hence waiting for the usual protocol of 48 hours post kidney transplant scan may result in delayed detection of the complication resulting in a poor prognostic outcome.

Continuation of training all the residents to scan the renal grafts following the standard protocols developed in the department. As it is not uncommon to encounter such aforesaid emergency it's important that the residents are conversant with the imaging findings and complications of the renal graft enabling early diagnosis, thus benefiting the transplant recipient.

There is a need for a further large sample sized prospective study to assess improvement in the quality of life post renal transplant along with the longevity of the graft as well as the mortality rate.

5.3 Renal Transplant U/S protocol

Grayscale evaluation of the transplanted Kidney	<ul style="list-style-type: none">-Longitudinal and Transverse views.-Longest renal Length should be measured-Renal Collecting system should be assessed for evidence of hydronephrosis.-Perinephric space should be assessed for any fluid collections.
Doppler Evaluation of the transplanted Kidney	<ul style="list-style-type: none">-With optimum gain settings Doppler evaluation of the transplanted kidney should be performed for assessment of transplant vascularity.-Main renal artery and vein and the intrarenal arteries if the transplanted kidney including anastomoses should be examined.-Velocity measurements should be obtained at the anastomosis and distal to the anastomosis.-Doppler indices should include the PSV, RI and Pulsatility index.-Color and power Doppler images of the entire kidney should be obtained to provide a global assessment of the transplant renal perfusion and to assess for vascular abnormalities.-Upper-pole, middle-pole, and lower-pole spectral traces of the interlobar arteries should be obtained.

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APPENDICES

Appendix A: Data Collection Form

Form No ----

Participant ID: _____ Date: ___/_____/_____

Age (years): _____ Sex: Male Female

Presenting complaint _____

Post-Operative day / week / months _____

U/S Findings of Kidney Grafts:

Grey scale image findings: _____

Color Doppler findings: _____

Spectral Doppler findings: _____

- Normal findings
- Parenchymal complications
- Collecting system complications
- Vascular complications
- Perinephric fluid collections

Specific complication seen: _____

Appendix: B Informed Consent to Renal Graft Ultrasound

My name is Dr.Harish Nagaraj , a post graduate student in the department of Diagnostic Imaging and Radiation Medicine at the University of Nairobi.

I am conducting a study on the ultrasonographic findings and complication of renal grafts. This is done using ultrasound to image the structures of the transplanted kidney. It is similar to the use of ultrasound to image another body part, for example abdomen. Ultrasound is a safe imaging modality and it uses sound waves to create an image. The objective of the study is to evaluate the ultrasonographic findings and complications of renal graft. This evaluation will provide more information about the graft status to your referring physician.

I would like to recruit you in this study. The information obtained from you will be treated with confidentiality and will be handled by me. Only your hospital number will be used.

Please note that your participation is voluntary and you can withdraw from the study any time.

Patient Number..... Signature.....

Date.....

I certify that the patient had understood and consented participation in the study.

Dr.Harish Nagaraj 0714050495

Signature.....

Date.....

Fomu ya Idhini ya ushiriki katika utafiti wa matumizi ya ultrasound katika upimaji wa figo pandikizi

Jina langu ni Dr.Harish Nagaraj , mwanafunzi katika idara ya mionzi na Tiba katika Chuo Kikuu cha Nairobi.

Ninafanya utafiti juu ya matokeo ya utafiti ultrasonographic na matatizo ya figo pandikizi .utafiti huu utafanyika kwa kutumia ultrasound na picha miundo ya figo iliyopandikizwa.

Ni sawa na matumizi ya ultrasound kwa picha nyingine katika sehemu nyingine za mwili, kwa mfano tumboni.

Ultrasound ni salama na hunatumia mawimbi ya sauti ya kujenga picha .

Lengo la utafiti ni kutathmini matokeo ultrasonographic na matatizo ya ufiadini figo pandikizi. tathmini hii itatoa taarifa zaidi kuhusu hali ya figo iliyopandikizwa kwa daktari wako .

Ninakuomba ushiriki katika utafiti huu. taarifa zitazopatikana zitatumika katika matibabu yako, na pia zitakiwa siri na jina lako halitatumika ni namba yakoya hospitali itatumika peke yake .

Tafadhali kumbuka kuwa ushiriki wako ni wa hiari na una haki ya kukataa au kujitoka katika utafiti wakati wowote. Nambari ya Mgonjwa

Sahihi

Tarehe.....

Ninathibitisha kwamba mgonjwa ameeleweka na akakubali kushiriki katika utafiti huu.

Dr.Harish Nagaraj 0714050495

Signature

Appendix C: Budget

ITEM	QUANTITY	UNIT PRICE (Ksh)	TOTAL (Ksh)
WRITING PENS	1 BOX	200	200
NOTEBOOKS	5 PIECES	60	300
FILES	8 PIECES	50	400
PRINTING PAPER	5 RIMS	400	2000
CARTRIDGE	1 PC	6000	6000
INTERNET SURFING	200 HRS	60	12000
FLASH DISCS	2 PCS	2000	4000
PRINTING DRAFTS AND FINAL PROPOSAL	10 COPIES	500	5000
PHOTOCOPIES OF QUESTIONNAIRES	50 COPIES	10	500
PHOTOCOPIES OF FINAL PROPOSAL	6 COPIES	100	600
BINDING COPIES OF PROPOSAL	6 COPIES	60	360
ETHICAL REVIEW FEE	1	3000	3000
PERSONNEL			
RESEARCH ASSISTANT	2	10000	20000
BIOSTATISTICIAN	1	20000	20000
DATA COLLECTION, DATA ANALYSIS AND THESIS DEVELOPMENT			
PRINTING OF THESIS DRAFTS	10 COPIES	1000	10000
PRINTING FINAL THESIS	6 COPIES	1000	6000
BINDING OF THESIS	6 COPIES	450	2700
DISSEMINATION COST			10000
GRAND TOTAL			103,060

Appendix D: KNH/UON-ERC Letter of Approval



UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
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KNH-UON ERC
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KENYATTA NATIONAL HOSPITAL
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Ref: KNH-ERC/A/275

26th July 2016

Dr. Harish Nagaraj
Reg. No. H58/66453/2013
Dept. of Diagnostic Imaging and Radiation Medicine
School of Medicine
College of Health Sciences
University of Nairobi

Dear Dr. Nagaraj,

REVISED RESEARCH PROPOSAL: ULTRASONOGRAPHIC FEATURES AND COMPLICATIONS OF RENAL GRAFTS AS SEEN AT KENYATTA NATIONAL HOSPITAL (P226/03/2016)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH-UoN ERC) has reviewed and **approved** your above proposal. The approval period is from 26th July 2016 – 25th July 2017.

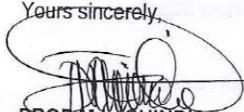
This approval is subject to compliance with the following requirements:

- a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
- b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH-UoN ERC before implementation.
- c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
- d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
- e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
- f) Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
- g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

"Protect to discover"

For more details consult the KNH- UoN ERC website <http://www.erc.uonbi.ac.ke>

Yours sincerely,



PROF. M.L. CHINDIA
SECRETARY, KNH-UoN ERC

- c.c. The Principal, College of Health Sciences, UoN
The Deputy Director, CS, KNH
The Assistant Director, Health Information, KNH
The Chair, KNH- UoN ERC
The Dean, School of Medicine, UoN
The Chair, Dept. of Diagnostic Imaging and Radiation Medicine, UoN
Supervisors: Dr. Milcah Wambugu, Dr. Wilson Ndaihera, Dr. Anthony Were

"Protect to discover"