Renal transplantation: Sonography and Doppler assessment of transplanted kidneys in adult Sudanese patients

Moawia Gameraddin[1,2], Awadia Gareeballah[3], Bushra A. Malik[4] Mohammed Yousef[5], Safa Siddig[3], Mowada Burai[3], and Sultan Alshoabi[1]

1. Taibah University, Department of diagnostic radiologic technology, Faculty of Applied Medical Sciences, AL Madinah, Suadi Arabia
2. Sudan University of Sciences and Technology, College of Radiological Sciences, Khartoum, Sudan
3. Alzaiem Alazhari University, Faculty of Radiological Sciences and Medical Imaging, Khartoum Sudan
4. Hail University, Faculty of Applied Medical Sciences. Department of Diagnostic Radiologic Technology, Saudi Arabia
5. Batterjee Medical College, Department of Radiological Science, Jeddah, Saudi Arabia

RESEARCH

Corresponding Author:
Moawia Bushra Gameraddin
Taibah University, Almadinah Al-munawarrah, KSA
Email: m.bushra@yahoo.com

ABSTRACT

Background
Every year, thirty-five thousand patients receive renal transplants worldwide. Kidney transplant provides better quality of life and reduced morbidity. Doppler and sonography were the best imaging modalities for evaluation.

Aims
To assess the sonographic findings of renal allograft and to determine the correlation between Doppler resistive index and size of allograft and echogenicity.

Methods
This was a cross-sectional study conducted in Khartoum State from January to August 2016. A total of 86 patients with known transplanted kidneys were scanned with ultrasound using 3MHz and 5MHz transducers. The age was categorized into four groups and so the Doppler indices. Descriptive statistics used to analyse quantitative and qualitative variables (percent and means ± SD). Spearman's rho test was used to find the correlation between RI of renal vessels and allograft size. The Qui-square test was used to find an association between RI and echogenicity of the graft.

Results
Renal transplantation was common at the age of 20 to 50 years. The mean Doppler index of the renal artery was 0.68±0.11 in renal allografts. Renal transplantation was common in professionals and homemakers (30.2 per cent and 20.93 per cent respectively). Hypertension and diabetes were the most common causes (44.1 per cent and 18.6 per cent). A significant correlation was found between RI and allograft size (p-value=0.012). There was no statistical association between RI and echogenicity of allograft (p-value=0.106).

Conclusion
The Doppler resistive index is significantly correlated with allograft size and had no association with echogenicity. Patients with enlarged allograft had raised resistive indices. The study recommended that Duplex ultrasound should be used in the initial assessment and follow-up of renal transplant.

Key Words
Renal transplantation, sonography, doppler assessment, kidneys, adult Sudanese

What this study adds:

1. What is known about this subject?

There were changes in morphology and vascularity of the transplanted kidneys. Sonographic findings of renal allograft were; hyperechoic, thin cortex, disturbed cortico-medullary ratio and increased size.

2. What new information is offered in this study?

Doppler resistive index increased significantly in enlarged transplanted kidneys. It is an indicator of the early failure of renal allograft.

3. What are the implications for research, policy, or practice?

There is an urgent needing for establishing values of Doppler indices among Sudanese adults for assessment of renal allograft. Early ultrasound examination of transplanted kidneys helps to prevent allograft failure.

Background

Renal transplant is growing in recent years, and it is considered the effective therapy for end-stage renal disease (ESRD). Kidney transplantation was associated with various complications such as vascular disorders and immunologic adverse effects.[1] These complications are remaining a challenge in kidney transplantation. In recent years, developments in transplantation technology have increased the half-life time of allograft.[3] In Sudan, kidney transplantation accounted for 28 per cent of renal replacement therapies.[2] However, there are few studies on renal transplantation in Sudan.

Gray-scale sonography is still used in evaluating transplanted kidneys. It provides essential anatomical information about the renal graft such as length, size, cortico-medullary differentiation (CMD), the thickness of the renal cortex, collecting system dilatation and echogenicity.[4] These findings were important to diagnose and manage the allograft. On the other hand, Doppler sonography assesses the vascularity of the transplanted kidneys. The Doppler resistive index (RI) was considered as a useful parameter for assessing the alterations of renal blood flow.[5] Recent and previous studies reported that RI was a promising tool to predict loss of kidney allografts and survival.[6,7]

In evaluating allograft, clinicians usually choose ultrasonography since it is accurate, sensitive and available imaging modality. The purpose of this study is to evaluate the sonographic findings of transplanted kidneys which include; kidney size, echogenicity, CMD, the thickness of renal cortex and RI in transplanted kidneys. And to assess the association of RI with morphological changes that affect the graft. These parameters determine and predict the outcome of the allograft. The complications and epidemiological data of renal transplantation were identified in this study.

Method

This was a cross-sectional study conducted in Khartoum State from January to August 2016. A total of 86 patients of known transplanted kidneys were scanned with ultrasound (49 males and 37 female). The age was categorized into four groups: group 1 (20–35 years), group 2 (36–50 years), group 3 (51–65 years) and group 4 (66–80 years). The inclusion criteria included patients with renal allograft at least 4 months after transplantation. Exclusion criteria included signs of apparent cardiac and systematic diseases and illness. A standardized questionnaire was used to record the clinical history and demographic data. Informed consent was taken from every participant.

Color Doppler and gray-scale ultrasound examinations were performed with linear and sector array transducers (Mindray and Sonoscape US machines). B-mode frequency 3 MHz; Doppler frequency 5 MHz the kidney is scanned in its long and transverse axes. Measurements are performed with its greatest length, width, and anteroposterior (AP) dimensions. Renal volume is calculated by the standard formula (volume=length × width × AP dimension × 0.523). Cortical thickness was measured, and CMD was determined. The echogenicity of the cortex, medulla and renal sinus is carefully evaluated using the spleen and liver as acoustic windows. The perirenal areas are scanned for fluid collections. Doppler waveforms of renal and intrarenal arteries were characterized, and RI was calculated. Values of RI lesser than 0.7 were considered normal.[8] The RI values were divided into five groups; group 1(0.40–0.59), group 2(0.60–0.70), group 3(0.71–0.80), group 4 (0.81–0.90) and group 5 (0.91–0.96).

The data were analysed using software statistical program (SPSS, version 16, Chicago, USA). Quantitative data were measured in mean ± standard deviation (SD). Frequencies and percentages were measured for qualitative variables. Spearman's rho test was used to find a correlation between RI of a renal vessel and allograft size. The quiz-square test was used to find an association between RI and echogenicity of the graft.

Results

A total of 86 patients with transplanted kidney participated in the study, 56.95 percent were males, and 42.02 percent were females. The mean age (±SD) was 41.95±12.64 years. The majority of the participants (38.4 per cent and 36.0 per cent) falls in the age groups (20–35 years) and (36–50 years), while, a small percentage of participants (3.5 percent) were in group 4 (66–80 years) as shown in Table 1. Most of the patients were professional and unemployed (30.2 per cent and 25.58 per cent), while, housewives were 20.93 per cent, workers (16.28 per cent) and students were 6.98 per cent, shown in Table 2.

Most of the transplanted kidney patients have a clinical history of hypertension and diabetes (44.19 per cent and 18.60 per cent respectively), shown in Table 3. Hypertension was the leading cause of kidney transplantation. The gray-scale sonographic assessment of the graft showed 13.95 per cent enlarged 11.63 per cent loss of CMD, 8.14 per cent disturbed CMD, 5.81 per cent thick cortex, 11.63 per centthin cortex and 13.95 per cent increased echogenicity (Table 4). The complications of allograft revealed that inflammatory changes were 5.8 per cent, hydronephrosis was 4.7 per cent and perinephric fluid was 2.3 per cent (Table 5).

Qui-square results were shown in Tables 6 and 7. There was no statistically significant association between RI and rejection of allograft (p-value=0.073), the RI values in normal allografts and acute and chronic rejections were not statistically different. There was also no statistical association between RI and echogenicity (p-value=0.106). But a significant positive correlation was found between RI and allograft size (p-value=0.012). This indicated that RI indices elevated in enlarged allografts.

Discussion

Patients with renal allograft were frequently vulnerable to impaired renal function. Gray-scale sonography and Doppler were accurate imaging methods that had been used routinely for evaluating the renal allografts. In the current study, we have assessed the morphological changes and RIs of the renal allografts.

The findings of the study showed that the patients with transplanted kidneys were common in the age groups of 20–35 and 36–50 years. This age is economically important in production. This finding agrees with El Aghori who reported the prevalence was common in the age group of 20–30 and 30–40 years.[9] It was observed the prevalence was common in males more than females and most of the

participants were professional and unemployed (Table 8).

The current study revealed that hypertension and diabetes were the most common clinical histories in the transplanted kidney recipients. In previous studies, hypertension and diabetes were the most common causes of chronic kidney disease (CKD).[10]

In the present study, the sonographic assessment of the allograft showed changes in size, CMD, cortical thickness and echogenicity of the allografts. It was observed there were increased kidney size (13.95 per cent), increased and reduced echogenicity (17.44 per cent), thin and thick cortical thickness (17.44 per cent); and disturbed and loss of CMD (19.77 per cent). These findings supported the suggestion of rejection and similar to the study of Griffin and Nicholas who reported the features of rejection included an increase in kidney size, disturbed CMD and reduced echogenicity.[11]

The study revealed inflammatory changes and hydronephrosis were the most common complications. In previous studies, urinary obstruction occurs in approximately 2 per cent of transplantations and mainly located within the distal third of the ureter.[12] The inflammatory processes are indistinguishable at routine sonography and need a biopsy to confirm the diagnosis.[13]

The current study showed that the RI is not significantly associated with the status of the allograft (p-value=0. 0.073). The RI is not significantly different in acute and chronic rejections. The mean RI was 0.68±0.11 in the study population which is approximately agreed with previous studies. Some Authors have reported the normal mean renal RI value was approximately 0.60±0.01.[14] However, most Sonographers consider the upper threshold of RI is 0.7 in adults.[15,16] Maarten et al. concluded that RI of 0.8 or higher does not reflect the healthy status of renal allograft.[17] Therefore, the use of RI in evaluating the renal allograft is controversy (Figure 1).

In the present study, a statistically significant positive correlation was found between the size of allograft and RI (P-value=0.012). This indicates that enlarged allografts had raised resistive index. However, to our knowledge, no studies demonstrate the relationship between RI and renal allograft size. A study performed by Radermacher et al. reported RI of 0.8 or higher was a strong predictor of both failure and death of allograft with a functioning graft.[18] On the other hand, we found the RI had no a statistical association with echogenicity of allograft (P-value=0.106).

However, this finding agreed with Yoo et al. who reported that parenchymal echogenicity was changed in renal allografts without clinical and statistical significance.[19] All these findings supported the importance of RI in evaluating the renal allograft.

There were limitations facing this study. There was no available reference range of RI values in Sudanese adults. Further studies with suitable sample size were recommended to confirm the initial results.

Conclusion

In Sudanese adults, renal transplantation was common in young people, and mostly affected professionals, unemployed and house wives respectively. Hypertension and diabetes were the most common causes of renal transplantation. Transplanted kidneys showed morphological changes in sonography. The RI of renal arteries had raised significantly in enlarged allografts. The echogenicity of allograft had no association with RI values of the renal artery.

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

FUNDING

ETHICS COMMITTEE APPROVAL

The study was approved by the ethics committee of the faculty of Radiological Sciences and Medical Imaging at Alzaiem Alazhari University.

Table 1: Frequency distribution of age groups

Age group (years)	Frequency	%
20-35 years	31	36
36-50 years	33	38.4
51-65 years	19	22.1
66-80 years	3	3.5
Total	86	100
The mean age was 41.95 ±12.64 years		

Table 2: Frequency distribution of patient's occupation

Occupation	Frequency	%
professionals	26	30.2
students	6	6.98
house wives	18	20.93
workers	14	16.28
Unemployed	22	25.58
Total	86	100

Table 3: Frequency distribution of patient's history

Clinical history	Frequency	%
hypertension	38	44.19
diabetes	16	18.6
other	4	4.65
no clinical history	12	13.95
DM &HT	11	12.79
hypoplastic kidney	3	3.49
Renal stones	2	2.33
Total	86	100

Table 4: Sonographic assessment of transplanted kidney

Findings	Frequency	%
Size of allograft		
normal	71	82.56
increased	12	13.95
decreased	3	3.49
Corticomedullary differentiation		
normal	69	80.23
loss	10	11.63
disturb	7	8.14
Cortical thickness		
normal	71	82.56
thin	10	11.63
thick	5	5.81
Echogenicity		

normal	71	82.56
increased	12	13.95
decreased	3	3.49

Table 5: Complications associated with renal allograft

Abnormalities	Frequency	Percent
Perinephric fluid collection	2	2.3
hydronephrosis	4	4.7
other	7	8.1
inflammatory changes	5	5.8
Total	18	20.9

Table 6: Association between status of allograft and Doppler resistive indices of renal arteries

		RI values of renal artery					Total	P-value
		0.40-0.59	0.60-.070	0.71-0.80	0.81-0.90	0.91-0.96		
Status of allograft	Acute rejection	0	1	1	0	0	2	0.073
	Chronic rejection	0	0	1	1	1	3	
	Normal graft	11	29	17	7	1	65	
Total		11	30	19	8	2	70	
The mean RI value was 0.68 ± 0.11								

Table 7: Association between RI and echogenicity of allograft

		echogenicity			Total	P-value
		normal	increased	decreased		
RI	Normal	26	2	2	30	0.106
	Abnormal	29	10	1	40	
Total		55	12	3	70	

Table 8: Correlation between allograft size and RI

|			Kidney size	RI	P-value
Spearman's rho	Kidney size	Correlation Coefficient	1	0.30*	
	RI	Correlation Coefficient	0.30*	1	0.012
*. Correlation is significant at the 0.05 level (2-tailed).					

Figure 1: Gender distribution of the study population
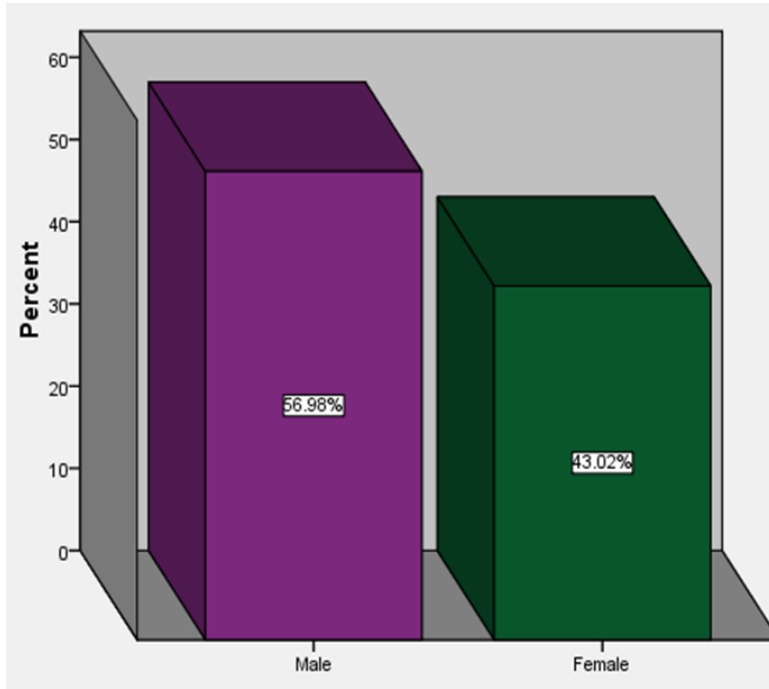
Sonogram 1: hydronephrosis of a transplanted kidney of a 35 years old male

Sonogram 2: Doppler of a 47 years old women showed elevated RI=0.95 and reduced cortical perfusion which suggest signs of chronic rejection
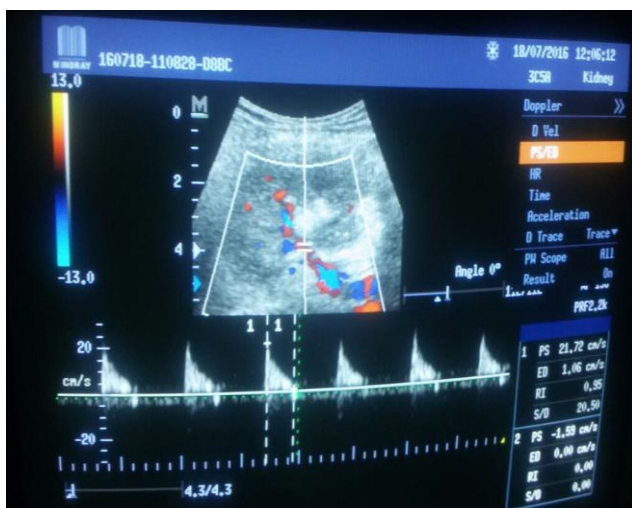
Sonogram 3: Enlarged allograft with minimal perinephric fluid collection of a 50 years old man