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CORRELATION BETWEEN DOPPLER ULTRASOUND FINDINGS AND SERUM CREATININE IN KIDNEY TRANSPLANT PATIENTS

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ABSTRACT

Doppler evaluation of transplanted kidney intraparenchymal arteries is valuable investigation for assessment of transplanted kidneys by the estimation of resistive index from these arteries by the spectral waveform Doppler analysis and the degree of parenchymal perfusion by both the color and power Doppler mapping. The aim of this study was to correlate the resistive index (RI) value and the degree of parenchymal perfusion with serum creatinine level in renal transplant patients. Cross sectional study obtained from 43 kidney transplant patients who underwent duplex Doppler scanning of their transplanted kidneys for arterial perfusion evaluation. The patients categorized into four groups according to the level of arterial tree pruning. Also spectral waveform Doppler analysis for Resistive Index (RI) measurement and the patients were categorized as elevated Resistive Index (RI) if more than or equal to 0.7 and normal if less than 0.7 readings. We find a significant correlation ($p<0.001$), by multimodalities of statistical analysis, between the Resistive Index (RI) value and the serum creatinine level reaching about (95%). In addition, there was a significant correlation between the degree of arterial pruning level and the serum creatinine level. We notice that the Resistive Index (RI) value and the severity of pruning increase with the increment of serum creatinine. There is a significant linear correlation between serum creatinine level and Resistive index (RI) value in transplanted kidney and the severity of parenchymal vascular pruning sign seen on color and power Doppler is increased with the increased Resistive index (RI) value.

1. INTRODUCTION

Chronic renal disease is a progressive loss in renal function over a period of months or years. It's identified by a blood test for creatinine. Higher levels of creatinine indicate a falling glomerular filtration rate and as a result a decreased capability of the kidneys to excrete waste products. Creatinine levels may be normal in the early stages of renal disease, and the condition is discovered if urinalysis (testing of a urine sample) shows

that the kidney is allowing the loss of protein or red blood cells into the urine. To fully investigate the underlying cause of kidney damage, various forms of medical imaging, blood tests and often renal biopsy (removing a small sample of kidney tissue) are employed to find out if there is a reversible cause for the kidney malfunction. Recent professional guidelines classify the severity of chronic renal disease in five stages, with stage 1 being the mildest and usually causing few symptoms and stage 5 being a severe illness with poor life expectancy if untreated. Stage 5 chronic renal disease is also called established chronic renal disease and is synonymous with the terms End-Stage Renal Disease (ESRD) or Chronic Renal Failure (CRF) [1]. End-stage renal disease is the name for kidney failure so advanced that it cannot be reversed and function so poorly that they can no longer keep you alive [1]. End-stage renal disease cannot be treated with conventional medical treatments such as drugs. Only 2 treatments allow you to continue living when your kidneys stop functioning: dialysis and kidney transplantation 2 Kidney transplant is the treatment of choice in end-stage renal disease patients, as it reduces morbidity and mortality rates and improves the quality of life [3]. Although, a number of factors are known to affect long-term graft survival, including recipient age, presence of diabetes, delayed graft function, number of human leukocyte antigen (HLA) mismatches, period of warm and cold ischemia, as well as acute rejection episodes and cytomegalovirus infection, none of them, alone or in combination, has been shown to have a predictive value for differentiating between patients with a good or poor chance of long-term graft survival [1]. Ultrasound is unequivocally the most valuable noninvasive imaging modality used in monitoring renal transplant [4].

Renal transplants are routinely evaluated with sonography as either a component of screening protocol or as a work up for renal dysfunction based on rising serum creatinine level with decrease urine output [5]. Ultrasound has been advocated to diagnose renal transplant rejection but renal biopsy remains the gold slandered for final discussion to diagnose rejection [4]. If a scan is being performed in anticipation, of transplant, biopsy identifies the kidney to be edematous and swollen with loss of the central sinus fat echo and very high resistive indices, thought should be given to deferring biopsy because puncturing the capsule of a tense rejecting kidney may cause it to rupture [6]. Doppler ultrasound is the representation of movement of blood red blood cells depending on the frequency shift of the ultrasound wave between the transmitted and received wave from the moving red blood cells, by changing the frequency shift into velocity with special mathematical equations, we can obtain the velocity of the red blood cells. Some modalities of the Doppler ultrasound like the color and pulse wave Doppler also provide directional information of the red blood cells movement other modalities give quantitative information about the blood pool in the organ like the power Doppler modality. Mixing two modalities in the same real time scanning is called duplex (for two modalities) and sometimes triplex (for three modalities) used [7]. The aim of this study was to correlate the resistive index (RI) value and the degree of parenchymal perfusion with serum creatinine level in renal transplant patients.

2. Method

A cross sectional study performed in the radiology department of Al-Shaheed Ghazy Al-Hariry specialized surgical hospital in cooperation with the kidney transplantation center, in the medical city in Baghdad, the study was in the period of junuary-2020 to october-2020. The study was performed using the siemens Sonoline Elegra ultrasound system with duplex Doppler facility with proper settings for renal vascular duplex exam and using a sector probe of 3.5 MHz frequency then shifting to linear probe of 7.5 MHz frequency. By a transabdominal approach and in supine position all the patients were scanned for estimation of the resistive index of the transplanted kidney, the readings of the spectral wave form were taken from the interlobar arteries at three sites of the transplanted kidney (upper pole, mid region, and lower pole) then the average calculated and used in the study. After taking the readings the ultrasound system parameters set precisely for automatic calculation of the resistive index by the system software. A resistive index of more than or equal to 0.7 was considered elevated and considered correlated with an elevated serum creatinine level of more than or equal

to 1.5mg/dl, accordingly the patients were grouped in two groups of either correlated (elevated both, or normal both, RI and serum creatinine value assigned as =1) or (non correlated if one value is elevated and the other normal assigned as = 0). Also color Doppler and power Doppler scanning of the transplanted kidney was performed by the same machine and probes to evaluate the degree of parenchymal perfusion and categorize it into four groups with group assigned 0 being normal with excellent perfusion of the kidney with full visualization of the parenchymal vasculature up to the interlobular arteries, then group 1 that have a mild degree of arterial pruning with no visualization of the interlobular arteries, group 2 with no visualization of the arcuate arteries as moderate pruning of the arterial tree and group 3 with severe pruning with no visualization of the interlobar arteries. So four groups of arterial pruning categorized as (0 = normal, 1 = mild pruning, 2 = moderate pruning and 3 = severe pruning). We randomly selected patients according to age and sex and selectively in that all have ha renal transplantation of less than one year duration and have a recent serum creatinine level estimate at the same time of measuring the resistive index from their transplanted kidneys. The total number of patients was 45, Duplex Doppler ultrasound was performed by me under supervision on 25 of the patients whom were referred from the kidney transplantation center, two of them were omitted because they were very obese and the Doppler signal obtained was unsatisfactory for assessment. 20 patients added with their data obtained from their medical archive in the same referral center, they were examined by other expert radiologists. So the total number of patients included in the study was 43 patients.

3. Results

The resistive index range off all patients (N43) was (0.57-0.9), while the range in the elevated group (N27) was (0.71-0.9) and in non elevated group (N16) was (0.57- 0.68). The Mean resistive index off all patients (N43) was (0.7), while the mean in the elevated group (N27) was (0.78), in non elevated group (N16) was (0.62). The Median RI off all patients (N43) was (0.72), while the median in the elevated group (N27) was (0.77), and in the nonelevated group (N16) was (0.62). In this study, it's showed that the majority of elevated reading in (Serum Creatinine and Spectral Doppler RI) was at the third age group (30 – 40) years. Spectral Doppler Resistive index readings of female were less than in male. Age group had no significant effect on the correlation between the readings of the variables (serum Creatinine with Resistive Index and pruning level) (P value >0.05). The Resistive Index (RI) level is significantly correlated with serum creatinine level (high correlation coefficient 0.888 and significant correlation with P value <0.000). The Pruning level is significantly correlated with the degree of elevation of and serum creatinine (high correlation coefficient 0.839 and significant correlation with P value <0.000). Degree of correlation between the variables used in our study (Doppler resistive index and serum creatinine) approaching 95%, and between (pruning level and serum creatinine level) approaching 89%. As in table 1-3 and fig 1.

4. Discussion

This study is an attempt to estimate renal graft state on the basis of the measuring the Resistive Index (RI) and level of arterial pruning and correlating it with the level of serum creatinine in the same patient at the same time of the Doppler assessment. We find that by using simple Linear correlation analysis between Serum Creatinine and Spectral Doppler Resistive Index, there was a Linear correlation ship between the two factors, the slop value indicating that with increasing one unit of scale in the (Serum Creatinine), a positive increment should be occurred in the unit of the function (Spectral Doppler Resistive Index). The same relationship was found between the serum creatinine and pruning level. Study using the Kaplan–Meier analysis confirmed that there was a significant difference in the incidence of graft function deterioration according to Resistive Index values, higher or lower than 0.635 [8]. In a series published by, for example, the sensitivity of Doppler sonography for the diagnosis of rejection were 43%, when a threshold Resistive Index of 0.90 was applied [9]. Had shown in their study, in comparison to our study, that there is no significant correlation between the

parenchymal perfusion grade and the Resistive Index or serum creatinine measuresn [10]. Showed that Resistive Index, assessed within one week of the transplant, could forecast 1-month and 1-year graft function in 45 renal transplant recipients [11]. Reported that severe elevation in vascular impendence in the transplanted kidneys with Resistive Index more than 0.9 was specific for acute vascular rejection [12], [13]. Retrospectively investigated the utility of the resistive index (RI) in evaluating the major causes of renal allograft dysfunction with ureteral obstruction (mean RI, 0.72 +/- 0.026) was the only cause of allograft dysfunction other than rejection with a mean RI greater than 0.70 [14]. Showed that in patients, in whom Doppler signals were absent, were subsequently shown at nephrectomy to have absence of perfusion resulting from severe acute vascular rejection [12], this goes with our finding of severe pruning level as an indicator of the severity of renal dysfunction. Measured Resistive Index in a very large cohort study of renal-transplanted patient has and showed that Resistive Index was a good predictor of both allograft failure and patient's death despite a functioning graft. Specifically, the authors reported a better long-term graft survival in patients with Resistive Index <0.80. Also various risk factors, including age of the donor and recipient, reduced renal function at 1 year, proteinuria, arterial hypertension, number of HLA mismatches, have been proposed as predictors of long-term renal function in transplanted patients.

However, none of these, alone or in combination, has been demonstrated to be a more reliable predictor of survival of the transplanted kidney than an increase in Resistive Index [15]. Demonstrated that, in comparison to our study, in kidney transplant patients there is a strong correlation between intrarenal Resistive Index and age of the recipient, and concluded that the main factor influencing Resistive Index is the vascular compliance of the recipient, which is, in turn, affected by age-dependent atherosclerosis phenomena [16]. Such correlation could not be estimated in our study because it needs a prolonged follow up of the patients and estimate those who will develop rejection earlier according to age prospectively. Suggest that It seems fairly certain, however, that a grade 0 appearance, which corresponds to the typical appearance of a normal native kidney, is unlikely to be useful in differentiating "normal" transplants from ones undergoing rejection. In reverse to our study, his study cannot determine the utility of abnormal vascular grades in detecting the presence of significant rejection. An abnormal vascular grade, such as grade 2, may still prove useful if it correctly differentiates kidneys undergoing significant rejection from those that are not [10]. Many other studies agreed with our study in that Doppler ultrasonography of the intrarenal arteries is a fast, repeatable method and is therefore one of the first-choice investigations in the management of the kidney transplant patient [11], [15], [17].

5. Conclusion

There is a significant linear correlation between serum creatinine level and Resistive index (RI) value in transplanted kidney and the severity of parenchymal vascular pruning sign seen on color and power Doppler is increased with the increased Resistive index (RI) value.

6. References

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Table (1): Age, gender, Resistive index, Pruning category and Correlation category distribution in the sample,

Age group	Number (n43)	Percentage
10-20 years	3	0.069
20-30 years	8	0.186
30-40 years	17	0.395
40-50 years	10	0.232
50-60 years	5	0.116
Sex	**Number (n43)**	**Percentage**
Males	30	0.7
Females	13	0.3
Resistive index	**Number (n43)**	**Percentage**
Increased (RI $\geq$ 0.7)	27	0.627
Normal (RI < 0.7)	16	0.372
Pruning category	**Number (n43)**	**Percentage**
Non = 0	22	0.51
Mild = 1	9	0.21
Moderate = 2	9	0.21
Severe = 3	3	0.7
Correlation category	**Number (n43)**	**Percentage**
Correlated = 1	41	0.95
Non correlated = 0	2	0.05

Table (2): Distribution of Pruning levels by age group.

Age Groups	Frequency & percents	Pruning				Total
		Non	Mild	Moderate	Sever	
10 - 20	Frequency	2	0	1	0	3
	% of Total					7.0%
20 - 30	Frequency	4	1	3	0	8
	% of Total					18.6%
30 - 40	Frequency	8	5	2	2	17
	% of Total					39.5%
40 - 50	Frequency	5	2	2	1	10
	% of Total					23.3%
50 - 60	Frequency	3	1	1	0	5
	% of Total					11.6%
Total	Frequency	22	9	9	3	43
	% of Total	51.2%	20.9%	20.9%	7.0%	100.0%

Table (3): Correlation of the study variables.

Pruning	Serum Cr Mean level	Resistive index	Serum creatinine and Resistive Index	Serum creatinine and pruning

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		Mean level	correlation		correlation	
			Correlation Coefficient	P value	Correlation Coefficient	P value
Non (N22)	1.436	0.654	0.888	<0.000	0.839	<0.000
Mild (N9)	2.211	0.74				
Moderate (N9)	3.444	0.81	High	Significant	High	Significant

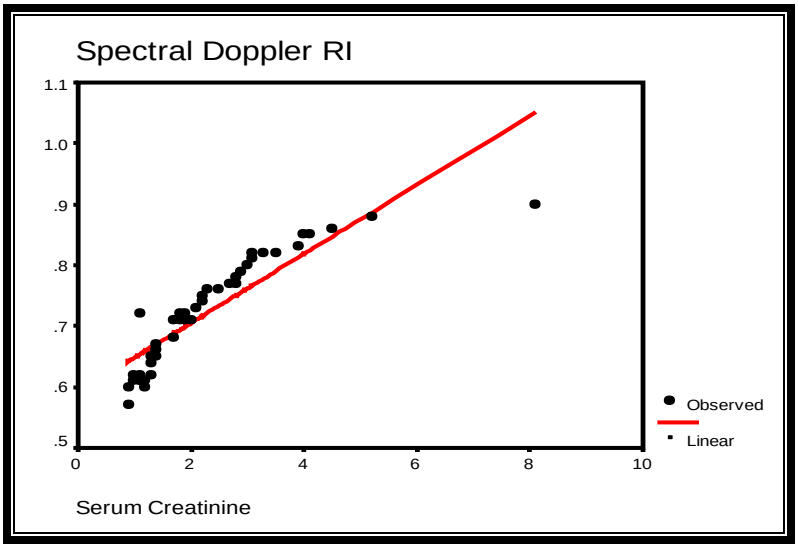

Figure (1): Linear correlation between the Serum Creatinine and Spectral Doppler Resistive Index (RI).