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Doppler Ultrasonographic Indexes and Its Relation to Transplanted Kidney (Allograft) Function in Sulaimani City Centre

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Doppler ultrasound, resistive index, RI, pressure index, PI, serum creatinine, kidney transplantation, allograft.

ABSTRACT
Background: The measurement of Doppler Ultrasonography(DU) indexes, including resistive index (RI) and pulsatility index (PI), could assist in evaluating a transplanted kidney. Aim of study: This work attempted at determining how Doppler sonography indexes correlated with transplanted kidney (graft) function. Methods: Our cross-sectional study conducted on 18 kidney transplanted patients (10 male and 8 female). In all cases, DU had been conducted upon transplanted kidney. We analyzed data on the pulsatility index (PI) and resistive index (RI) in the interlobular arteries. Concurrent serum creatinine explored in comparison to the DU results. Results: The pi and Ri correlate significantly , in linear manner with serum creatinine (P = .005, and P=.002 respectively).Conclusion: The PI and RI are important DU markers for determining the kidney allograft function.

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INTRODUCTION

The most common causes of chronic renal failure that necessitate renal transplantation in United States are diabetes mellitus 23% (the fastest growing); all glomerulo- nephritis/focal sclerosis 24%; hypertension-nephrosclerosis 16%; cystic kidney diseases 9%; interstitial pyelonephritis 5%; urologic disorders 4%; and unknown causes 13% [1]. Those cases with chronic renal failure (CRF) and end stage renal disease (ESRD) ultimately demand chronic dialysis or renal transplantation to support life. It affects all ages, the severity and the rapidity of development of uremia is rarely predicted. The dialysis and transplantation as treatment modality is quickly spreading over the world [2]. Blood urea nitrogen and serum creatinine are the most widely utilized renal failure indicators. The creatinine clearance is possibly utilized as a reasonable technique to assess glomerular filtration rate (GFR) [3]. The incidence of ESRD in the United states is 330 cases per million population [1].

In Sulaimani city it is estimated that we have > 100 patients on regular HD program, (according to the database registry center in chwarbax hospital). Current improved outcome of transplantation could be due to developing newer immunosuppressant drugs and advanced genetic matching. Transplantation has the advantage of reestablishing approximately normal and constant body physiology and chemistry with reduced restrictive diets. In contrast, the main drawbacks of transplantation are the bone marrow suppression, infection vulnerability, oncogenesis risks, and the psychological doubt about the future function and anatomy of the homograft [1].

The most important surgical difficulties that a surgeon could face post-transplant are either vascular and/or urologic problems. Vascular difficulties include renal artery disruption, stenosis, or mycotic aneurysm; renal vein thrombosis or disruption. In the early post-transplant those complications may prohibit the allograft kidney even from functioning, considerable transplant renal artery stenosis can result from poor surgical techniques, vessel intima damages at procurement, atherosclerosis or fibrous disease, or immune injury, but these are somehow not faced commonly [1].

Doppler ultrasonography (DU) of the intrarenal arteries was initially admitted to screen the disorders of native kidney diseases [4]. Inaddition, over the last several years, they introduced doppler indexes for evaluating kidney allograft dysfunctions [5,6]. The most common vascular complication of transplanted kidneys is renal artery stenosis (RAS) could happen because of arterial atherosclerosis in the donor, techniques of suturing, trauma to the renal or iliac artery in the donor or recipient. Diagnosing it earlier is important, as early intervention could protect graft function. Doppler ultrasonography is an excellent tool to assess patients who are suspected to suffer from RAS and can additionally assist to select the scheduled patients for further assessment by arteriography [7].

Most of physicians utilize resistive index (RI) and pulsatility index (PI) of the intrarenal arteries to obtain knowledge regarding the integrity of allograft, with regard as the most accurate parameters in

evaluation of kidney transplant recipients [8,9,10].

MATERIAL

In Sulaimani teaching hospital, between October 2013 and October 2015, our cross-sectional study on eighteen living donor renal transplant patients, ten males and eight females, received allograft from sixteen unrelated donors and two relative donors. The procedures performed by surgical teams accessing lower quadrant curvilinear (Gibson) incision, the iliac vessels are accessed by a retroperitoneal approach. The renal-to-iliac vein anastomosis is first conducted in an end-to-side technique most of the time using 5/0 polypropylene sutures. Next, The renal arteries are anastomosed, to the internal iliac arteries in an end-end fashion, in six patients and to external iliac arteries in an end-to-side fashion, in the rest twelve in all cases we use 6/0 polypropylene sutures.(figure 1)

Regarding ureteral anastomosis to the urinary bladder we prefers an extravesical ureteroneocystostomy (variation of Lich-Gregore technique) to reimplant the ureter. An internal double J ureteral stent was often placed; with a drain in the deep pelvis. We calculate the cold and hot ischemic time.

The immunosuppressive drug regimen that was used in all cases constituted a composition of mycophenolate mofetil, prednisolone and cyclosporine, or tacrolimus. Creatinine serum level measurement (Jaffe method; mg/dL), is performed just before the Doppler ultrasound index measurement.

All of the allograft had undergone assessment by the Doppler Ultrasound by a single radiologist conducted-through by the same machine (Siemens sonoline Omnia) with the aid of 3.5--MHz convex probes. We examine The RI, PI, peak systolic velocity (PS), end diastolic velocity (ED) of the interlobular arteries are the indexes of Doppler ultrasound that are measured for assessment of renal artery stenosis or renal vein thrombosis .

The Doppler spectra that calculate RI and PI:

RI = (peak systolic velocity - end diastolic velocity)/peak systolic velocity

PI = (peak systolic velocity - end diastolic velocity)/mean velocity

We conducted Statistical analyses using SPSS software (version 16.0, SPSS Inc, Chicago, Ill, USA). The constant variable scores appeared as mean ± standard deviation, and descriptive statistics (crosstabs:Chi-square) were employed for data analyses. A P-value less than 0.05 was regarded as significant.

RESULTS

In our study, renal transplantation was performed for (18) patients, who were ten male (55.6%) and eight female (44.4%). The mean age of them was 33.2 ± 9.1 years (range 20-55 years) as illustrated in chart number 2. (Figure 2) The time since transplantation ranged from 1-15 months. Mean hot ischemia time was 5.4 ± 2.5 (min) while mean cold ischemia time was 93 ± 2.5 (min) as seen in chart number 3. (Figure 3). Mean Intra renal RI and PI were 0.66 ± 0.05, and 1.2 ± 0.19, respectively. Mean PS 43.6 ± 1.9 (m/s), mean ED 14 ± 6.4 (m/s), and mean serum creatinine 0.98 ± 0.25 (mg/dl). The mean values of age, RI, PI, PS, ED, serum creatinine, hot and cold ischemia time for the

patients are listed in table number 1. (Table 1).

The rate of complications of the kidney allografts in our sample were (3) patient (16.6%) and (15) patient (83%) without complications, and there was a significant correlation between all complications and intra-renal RI and PI values. There were one patient out of 18 patients (5.5%) had vascular complications of allografts in the form of renal artery stenosis (RAS), also one patient (5.5%) had hydronephrosis and another one patient (5.5%) had acute tubular necrosis(ATN) proved by renal biopsy, as seen in chart number 4. (Figure 4)

There was a significant correlation between serum creatinine, and intra-renal RI (P=0.002), as seen in chart number 5. (Figure 5) We found a significant correlation between serum creatinine and intra-renal PI (P=.0.005) as demonstrated in chart number 6. (Figure 6)

In addition, there was a significant correlation between intra-renal RI and intra-renal PI (P=0.002), as shown in chart number 7. (Figure 7)

The following charts (Figure 8 and 9) show the correlation between RI, PI and serum creatinine in non-complicated and complicated cases respectively: (Figure 8,9). We found that there was no significant correlation between patient age, and intra-renal RI and PI (P=0.2, P=.0.9, respectively), and also no significant correlation was documented between time since transplantation and intra-renal RI and PI (P=0.08, P=0.1, respectively).

Table 1: Mean values of age, RI, PI, PS, ED, serum creatinine, hot and cold ischemia time

Variables	Mean values	Maximum	Minimum
Age (years)	33.2+9.1	55	20
RI	0.66+0.054	0.84	0.60
PI	1.22+0.19	1.80	0.91
PS (m/s)	43+1.9	73	24
ED (m/s)	14.6+6.4	25	29
Serum creatinine (mg/dl)	0.98+0.25	1.8	0.6
Hot ischemia time (minutes)	5.4+2.5	13	3
Cold ischemia time (minutes)	93+2.5	150	60

Abbreviations: RI: resistive index, PI: pressure index, PS (m/s): peak systolic (millimeter/second), ED (m/s): end diastolic (millimeter/second)

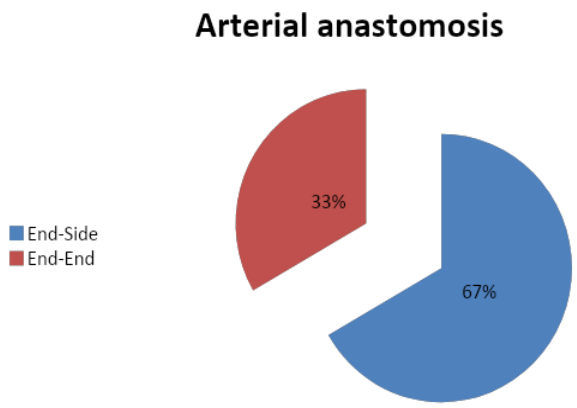

Figure 1: Arterial anastomoses

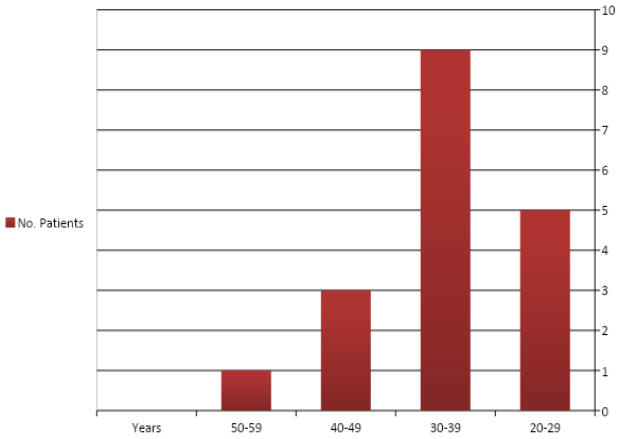

Figure 2: Age distribution

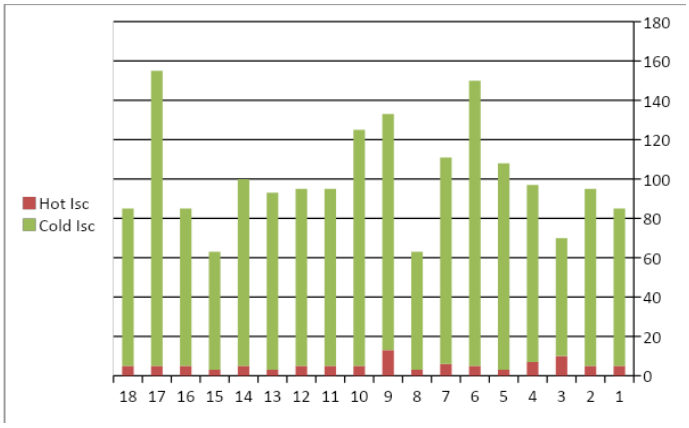

Figure 3: Hot and cold ischemia time

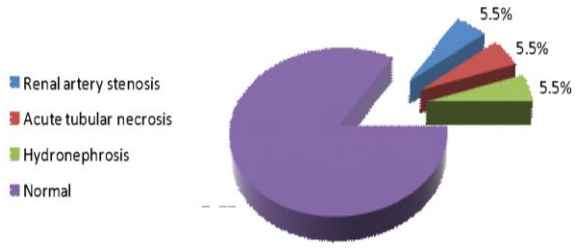

Figure 4: Rate of complications

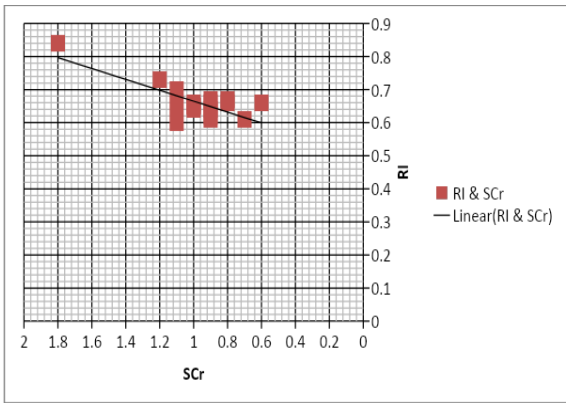

Figure 5: Correlation between RI and serum creatinine

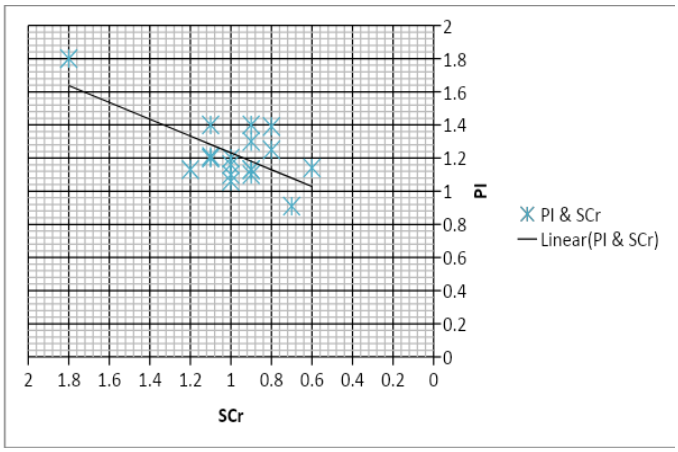

Figure 6: Correlation between PI and serum creatinine

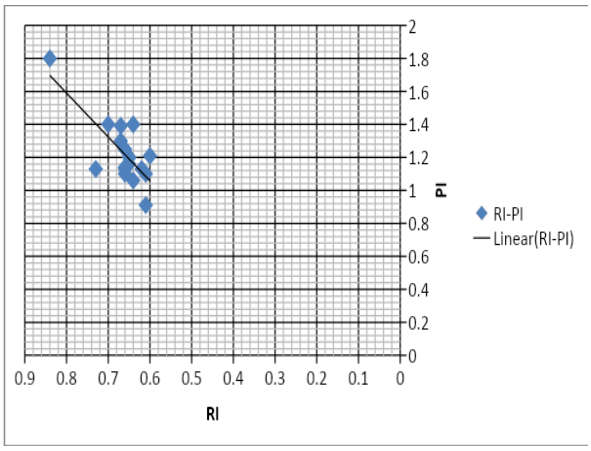

Figure 7: Correlation between RI and PI

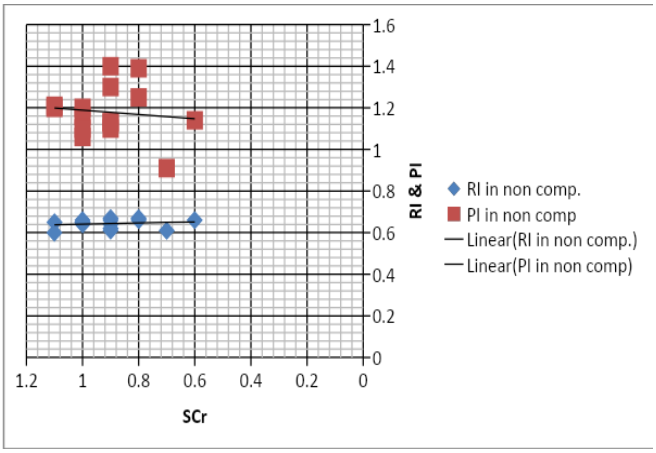

Figure 8: Correlation between RI, PI and serum creatinine in non-complicated cases

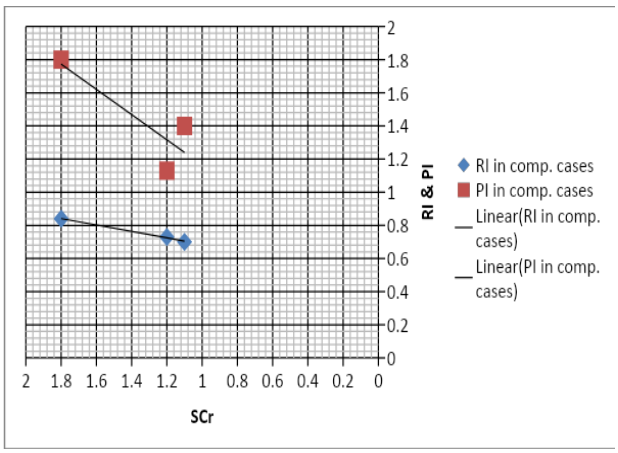

Figure 9: Correlation between RI, PI and serum creatinine in complicated cases

DISCUSSION

After transplantation of the kidney, some problems including RAS and renal vessel thrombosis could happen. For years, studies concentrated on noninvasive diagnostic techniques that can dependably estimate the transplantation outcome, and kidney allograft function, upon transplanted allograft kidney revascularization. Alot of improvement has been admitted to the doppler ultrasonography over the last years and is currently in frequent use as the first-line screen to assess kidney transplant patients [9,10,11,12]. The Doppler ultrasound is good to evaluate the kidney allograft vasculature and function, and reliable noninvasive investigation exists to identify patients who get successful kidney allograft revascularization, and for assessment the effectiveness of the transplant procedure [13,14].

In tow Iranian studies , the kidney transplant RI means were 0.61±0.08 and 0.57± 0.55, these results are less than the values obtained in our study 0.66±0.05 [15,16]. In the Nouri-Majelan and Nafici study, the mean RI were 0.69 ± 0.06 and mean PI were 1.30± 0.30. It is very close to the range that was obtained by our study 0.66±0.05 [16]. In our work the RI and PI are significantly correlated (P=0.002). This is correlated with the second study conducted by Ardalan et al showing the same significant correlation between the two parameters [17]. In spite of changes in altered renal parenchymal perfusion obtained by Doppler ultrasound indexes, these could possibly be affected by other factors as recipient vascular compliance [18]. Yet, on the graft vasculature, graft function, and vasoconstriction-inducing drugs, for instance, cyclosporine drugs could change the intra-renal Doppler indexes reading [19,20]. Cyclosporine, because of its vasospastic characteristics, could raise the resistance of the intra-renal vasculature [21].

Ardalan et al state that the RI or PI indexes significantly correlate with serum

creatinine level in the 2nd, 9th, 16th, and 23rd days posttransplantation and this is correlated with our results. Their study showed positive linear correlation between the PI and RI and serum creatinine [17]. Similarly according to Kahraman et al, the RI is negatively correlated with PI and the one-month and one-year creatinine clearance, in respect [13]. Tarzamni et al revealed a linear correlation between serum creatinine and the DU indexes too [22]. Yet, in contrast, in Wang and his colleagues no correlation was found between serum creatinine and neither the RI nor PI values [23].

Mosbeck and his colleagues found that the RI and PI of the intra-renal native kidney arteries rise with age in normotensive and hypertensive peoples [24]. In contrast, statistically no significant correlation exists between these indexes and recipients' age, possibly due to small sample and lower mean age in our thesis. In the same way, Nouri-Majelan and Nafici in 2007 showed that DU indexes statistically significantly correlate with recipients' age [16]. DU indexes increase in elderly individuals possibly because of reduction in prerenal aortic compression chamber function due to atherosclerosis. In-vitro experiments support this interpretation and show that the vascular compliance correlates with the variability of doppler waveform [25]. Also, age correlates with intra-renal doppler indexes of native kidneys reflecting the vascular compliance-age dependence. Other studies have revealed that the RI correlates with age of kidney transplant patients [26,27]. Yet, similar age correlation with RI and PI appear in diabetic peoples were atherosclerosis is a noticeable vascular shift with age, this stresses that RAS could happen in relation to age factors such as atherosclerosis in advanced age groups patient [28].

Also, transplanted renal artery stenosis is presented in 1% to 23% of recipients. In an Iranian study, it has been shown that the occurrence rate was 10%, and it was the same rate that found in Merkus JW et al study (10.3%) [10,15]. In Comparison to our study, the rate was as low as 5.6%. In contrast to our study, two Turkish studies have found the occurrence rate of RAS was 0.9% and 2.3% in adults and children, respectively. I think these variations in results are probably due to better wound-healing ability in children which is a known fact [29,30].

Renal vein thrombosis rate of the kidney allograft was higher (0.1% to 1%) in some studies, compared to our work results, where renal vein thrombosis was not recorded in any cases [29,30]. Thrombosis could be because of technical problems, including intimal manipulation, venues kinking, too long warm ischemic time, or other risk factors related to the patient himself like dehydration, hypotension, hypercoagulable state and unidentified intimal graft [29,30,31].

CONCLUSION

We conclude from this study that DU indexes are significantly correlated with serum creatinine level, thus, we recommend the use of the DU as an accurate investigation to predict the allograft kidney function in relation to

serum creatinine level . The drawback of DU use is the fact that it is operator dependent, in addition, the RI is strongly correlated with the PI, so each can be used in lieu of other in kidney transplantation patients who are undergoing DU study.

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