ARAŞTIRMA MAKALESİ/ORIGINAL RESEARCH

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Donor Renal Artery Diameter (RAD) is Associated with Graft Function in Kidney Transplantation

Donör Renal Arter Çapı (RAD), Böbrek Naklinde Greft Fonksiyonu ile İlişkilidir

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ABSTRACT

Introduction: The aim of this study is to investigate the relationship between living donor renal artery diameter(RAD), donorrenal parenchymal volume(RPV) and post-transplant recipient graft function.
Methods: We retrospectively collected data of patients with living kidney donor-recipients. 63 living donors and recipients who met the criteria for kidney donor were included in the study. Abdomen CT protocol was performed for all living renal donors. Data of age, gender, BMI, number of rhe renal artery, renal parenchymal volume (RPV),renal cortical volume(RCV), renalartery diameter (RAD) of the donors were recorded.
Results: A statistically significant positive correlation was found between RAD and RPV (r = 0.493). It was found that the cut-off value of RAD for eGFR >60 (ml/min/1.73 m2) was 6,65 (sensitivity 68%, specificity 62%) with ROC (Receiver Operating Characteristic) curve analysis according to the Youden index. In the multivariate logistic regression analysis, RAD above 6,65 mm (OR=5,533, 95% GA = 1,193 - 25,655, p =,029) was found to be associated with 6 months eGFR.
Discussion and Conclusion: Renal artery diameter, which can be measured more easily than renal volume in CT routinely used before transplantation, may apply for the prediction of graft function.
Keywords: kidney donor, graft function, renal artery diameter, renal parenchymal volume

ÖZ

Giriş ve Amaç: Bu çalışmanın amacı, canlı donör renal arter çapının (RAD), donör renal parankim hacmi (RPV) ve nakil sonrası alıcı greft fonksiyonu ile arasındaki ilişkiyi araştırmaktır.
Yöntem ve Gereçler: Canlı böbrek vericisi olan hastaların verilerini retrospektif olarak topladık. Çalışmaya böbrek donör kriterlerini karşılayan 63 canlı donör ve alıcı dahil edildi. Tüm canlı böbrek donörlerine abdomen bilgisayarlı tomografi protokolü uygulandı. Donörlerin yaş, cinsiyet, VKİ, renal arter sayısı, renal parankim hacmi, renal kortikal hacim, renal arter çapı verileri kaydedildi.
Bulgular: Renal arter çapı ve renal parankimal hacim arasında istatistiksel olarak anlamlı bir pozitif korelasyon bulundu (r = 0.493). Youden indeksine göre ROC (Receiver Operating Characteristic) eğrisi analizi ile eGFR >60 (ml/dk/1.73 m2) için renal arter çapı cut-off değerinin 6,65 (duyarlılık %68, özgüllük %62) olduğu bulundu.. Çok değişkenli lojistik regresyon analizinde 6,65 mm'nin üzerindeki renal arter çapı (OR=5.533, %95 GA = 1.193 - 25,655, p =,029) 6 aylık eGFR ile ilişkili bulundu.
Tartışma ve Sonuç: Transplantasyon öncesi rutin olarak kullanılan bilgisayarlı tomografide renal hacimden daha kolay ölçülebilen renal arter çapı, greft fonksiyonunun öngörmede kullanılabilir.
Anahtar Kelimeler: böbrek donörü, greft fonksiyon, renal arter çapı, renal parankim hacmi,

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INTRODUCTION

Kidney transplantation is the most effective treatment method that improves the quality of life for patients suffering from end-stage renal disease compared to dialysis (1). The number of living kidney transplants is increasing in number owing to the success of the recipient graft function (2). There are several factors (i.e medical, surgical and immunological factors) between donor and recipient that affect the success of living kidney transplantation (3). Recent studies suggest that long-term graft function might also be predicted by donor kidney volume as an argument. Since, current studies are conducting to illuminate the effect of donor kidney volume on long-term graft function. Apparently, these studies revealed that kidneys with larger renal volumes, increase graft success in the long term (3, 4).

Routine abdominal computed tomography (CT) is performed to evaluate donor kidney anatomy as well as renal vascular structure before living kidney transplantation. Donor kidney volume measurement is becoming a parameter that is evaluated before renal transplantation (3-5). Additionally, renal artery diameter, which is positively correlated with ipsilateral kidney volume, is easier to measure (6).

The aim of this study is to investigate the relationship between living donor renal artery diameter (RAD), donor renal parenchymal volume (RPV) and post-transplant recipient discharge, 3 Month and 6 Month glomerular filtration rate (eGFR) and serum creatinine (sCr) levels.

METHODS

After obtaining approval from the institutional review board (IRB number: E1-20-1201),we retrospectively collected data of patients with living kidney donor-recipients in the department of urology at Ankara City Hospital between May 2019-September 2020. Written informed consent was obtained from all patients. Data of 75 living donors and recipients were examined. Patients with no post-transplant follow-up data were excluded. Finally, 63 living donors and recipients who met the criteria for kidney donor were included in the study. Left donor nephrectomy was performed on all donors. Data of age, gender,BMI, number of the renal artery, renal paren- chymal volume (RPV), renal cortical volume (RCV), renal artery diameter (RAD) of the donors were recorded. Age, gender, BMI, HT, DM, smoking, eGFR and serum creatinine measurement datas of the recipients were recorded. In addition, per-operative surgical data (warm ischemia time (WIT) and cold is- chemia time (CIT)) data were recorded. BMI (Body Mass Index) was calculated from height and weight measurements and waist circumference was measured. Serum creatinine and Estimated Glomerular Filtration Rate (eGFR) of the recipients were recorded at the discharge, 3rd month as well as 6th month controls. eGFR> 60 (ml / min / 1.73 m2) was considered as a good graft function. The eGFR was calculated using the Modification of Diet in Renal Disease (MDRD) equation. GFR (mL/min/1.73m2) = 175× [serum creatinine (_mol/L)× 0.011312]−1.154×[age]−0.203×[1.212 if black]×[0.742 if female](7).

Pre-operative abdominal CT examinations were performed using 128 and 512-detec- tor CT devices (GE Healthcare, Milwaukee, WI, USA) by infusing 120 ml of contrast at a medium rate of 4 ml / sec. Abdomen CT protocol performed for living renal donors includes phases of non-contrast examination
(slice thickness of 2.5 mm), arterial phase (20.sec, slice thickness of 0.625 mm), nephrogram phase (60. sec, slice thickness of 0.625mm) and pyelogram phase (20. min, slice thickness of 0.625mm), respectively. The donor kidney was examined in axial, coronal and sagittal

planes, moreover cortical and parenchymal volumes were measured with a customized three-dimensional volumetric software (Advantage Workstation 4.2, GE Healthcare Technologies) at workstations. Renal cortical volume at the arterial phase, and parenchymal volume at the portal phase were measured. Renal arteries of the donor kidney were examined forquantity and its largest diameter at the workstation. Volume measurements and renal artery examination were performed by a radiologist with 10 years of experience. 12 donors had double renal arteries. The total diameters of double arteries of these patients were includedin the study.

Statistical Package for Social Sciences (SPSS), version 22.0 (SPSS Inc. Chicago, USA) computer package program was used for statistical analysis of the research data. Distribution of data was tested with the Saphiro-Wilk test. In the descriptive statistics section, categorical variables were presented as numbers, percentages. Data are presented as mean ± SD if normally distributed. Non-parametric data are reported as medians (range). The relationship between RPV, serum creatinine and eGFR wasevaluated by Pearson and Spearman correlation analysis method according to normal or non-normally distribution. Scatter-plot was used to show association between continuous variables. The ability of RAD to predict eGFR level was evaluated by ROC (Receiver Operating Characteristic) curve analysis and Area Under Curve (AUC) values of the analysis were described. Cut-off value was calculated according to Youden index. Multivariate logistic regression analyses tested the relationship between clinical variables and 6 months follow-up eGFR. The results of the regression analysis were presented with Odds Ratio (OR) and 95% Confidence interval. $p<0.05$ was considered statistically significant.

RESULTS

The demographic characteristics, clinical and laboratory values of the 63 donors (27 male and 36 female) and 63 recipients (48 male and 15 female) are shown in Table 1.

Table 1: Clinical and Demographic Characteristics of Study Population

	Donor	Recipient
Age(years)	39 (19 - 59)	32 (17 - 64)
BMI(kg/m2)	24.4 (19.5 - 43)	21.6 (17.5 - 42)
Male, n(%)	27(42.9)	48(76.2)
Female, n(%)	36(57.1)	15(25.8)
Renal Artery Diameter(mm)	6.62 ± 0.99	NA
Renal Parenchymal Volume (cm3)	150.85 (110.2 - 221.9)	NA
Renal Cortical Volume (cm3)	125.23(92.9-186.9)	NA
Warm ischemia time (min)	NA	3(1.83-5)
Cold ischemia time (min)	NA	102.1 ± 19.3
Discharge time (day)	NA	17 (7 - 46)
Hypertension, n(%)	NA	25 (39.7)
Diabetes mellitus, n(%)	NA	10 (15.9)
Smoking, n(%)	NA	1 (1.6)
Discharge sCreatinine(mg/dL)	NA	1.19 ± 0.35
3 Months sCreatinine(mg/dL)	NA	1.27 ± 0.46
6 Months sCreatinine(mg/dL)	NA	1.32 ± 0.52
Discharge eGFR (ml/min/1.73 m2)	NA	72.5 ± 25.65
3 Months eGFR (ml/min/1.73 m2)	NA	69.81 ± 18.98
6 Months eGFR (ml/min/1.73 m2)	NA	69.71 ± 21.71

BMI: body mass index, eGFR: estimated glomerular filtration rate, NA: not available.

The median age of donors, 39 (range 19-59) years; and median BMI, 24.4(range 19.5–43) kg/m2). The median age of recipients, 32 (range 17-64) years; and median BMI, 21.6 (range 17.5-42) kg/m2). Mean ± S.D. RADs, median(range) RPVs and median (-range) RCVs were 6.62 ± 0.99 mm, 150.85 (110.2- 221.9) cm^3 and 125.23(92.9-186.9) cm^3 respectively. We found the high correlation (r:0.895, p<0.001) between RPV and RCV in the scatter plot (Figure 1). Therefore, we maintained our work with RPV. In Table 2, the relationship between hospital discharge, 3 Months and 6 Months serum creatinine and eGFR levels and RPV is presented by Pearson and Spearman correlation analysis. A statistically significant negative correlation between RPV, 3rd and 6th Months serum creatinine levels (r:-0.411, r:-0.345) was found. A statistically significant positive correlation between RPV and 3rd and 6th Months eGFR levels (r:0.306, r:0.303) was found (Table 2).

Table 2: Correlation Coefficients between, Renal Parenchymal Volume and Serum Creatinine-eGFR

		Renal Parenchymal volume (cm^3)	
		r	p
Serum creatinine	Discharge	-0.337	**0.014**
	3 Months	-0.411	**0.001**
	6 Months	-0.345	**0.011**
eGFR	Discharge	0.076	0.555
	3 Months	0.306	**0.021**
	6 Months	0.303	**0.028**

r: Correlation coefficients , eGFR: estimated glomerular filtration rate

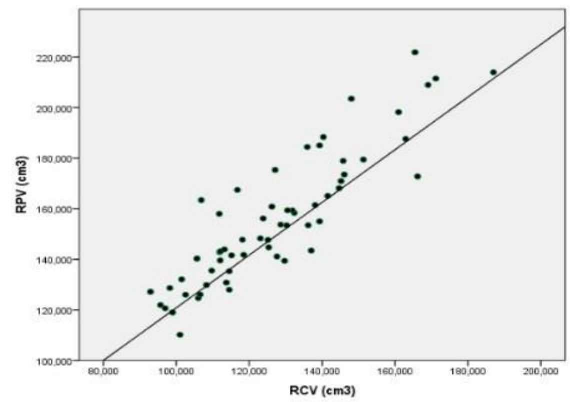
In Table 3, Pearson correlation analysis between RAD and RPV is shown. A statistically significant positive correlation was found between RAD and RPV (r = 0.493). We showed the positive correlation between RPV and in the scatter plot (Figure 1).

Table 3: Correlation Coefficients between Renal Artey Diameter and Renal Parenchymal Volume

	Renal Parenchymal Volume(cm^3)	
	r	p
Renal Artery Diameter (mm)	0.493	<0.001

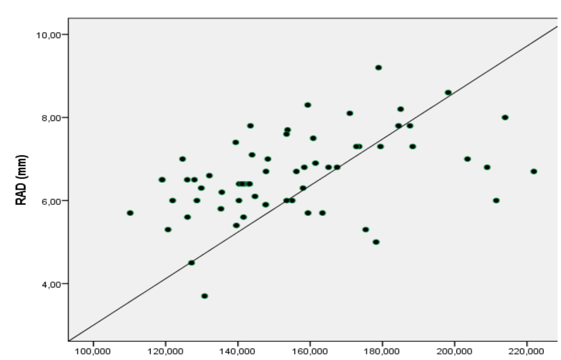
r: Correlation coefficients

The threshold value of the eGFR level for the normal renal function was determined as >60 (ml/min/1.73 m2). It was found that the cut-off value of RAD for eGFR >60 (ml/min/1.73 m2) was 6.65 (sensitivity 68%, specificity 62%) with ROC (Receiver Operating Characteristic) curve analysis according to the Youden index. In the multivariate logistic regression analysis, RAD above 6.65 mm (OR = 5.533, 95% GA= 1.193 - 25.655, p = 0.029) was found to be associated with 6 months eGFR (Table 4).



RCV: Renal cortical volume, RPV: Renal parenchymal volüme

Figure 1: Correlation between RCV and RPV



RAD: Renal artery diameter, RPV: Renal parenchymal volume

Figure 2: Correlation between RAD and RPV

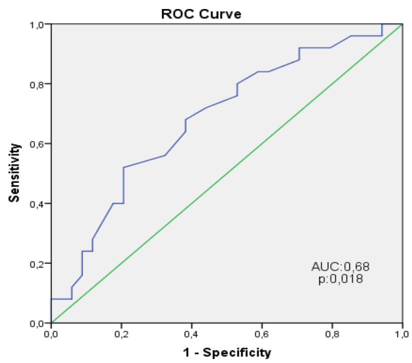


Figure 3: Receiver operating characteristic (ROC) curve for renal artery diameter (mm) to predict eGFR<60 (ml/min/1.73 m2).

Table 4: Multivariate Logistic Regression Analysis of Recipient Age, Recipient BMI, WIT, CIT and RAD

	MVA		
	OR	**95% CI**	**p**
Recipient age (years)	.981	(0.934 - 1.03)	.433
Recipient BMI (kg/m2)	.898	(0.8 - 1.009)	.070
Warm ischemia time (min)	1.005	(0.99 - 1.021)	.510
Cold ischemia time (min)	1.012	(0.979 - 1.046)	.481
Renal artery diameter (mm)	**5.533**	**(1.193 - 25.655)**	**.029**

BMI: body mass index OR: Odds ratio CI: Confidence Interval MVA: multivariate analysis

DISCUSSION

In kidney transplantation, there are numerous donor and recipient dependent factors that affect long-term graft functions. Donor charateristics; such as age, gender, as well as donor comorbidities such as hypertension, affecting donor quality, determine graft function (8)

In addition, there are studies that indicates association between; age, body weight, BMI, body surface area, renal volume and renal cortical volume of donor and long-term positive graft results of recipient. Current studies have found positive correlation between recipient graft function and donor renal parenchymal volume and renal cortical volume (4,5,7-9). In our study, a high correlation was found betwe en RPV and RCV (r: 0.895). Therefore, we maintained our work with RPV.

Renal volume; which can be measured by CT (computer tomography), MRI (magneticresonance imaging), and ultrasound, as an indicator of kidney mass, can be used as a predictive entity in post-transplantation recipient's renal functions (5). Before transplantation, CT is performed to evaluate donor renal and vascular structure in most centers. Studies in- vestigating interaction between renal volume measurements and graft function reveal that the higher the renal volume, the better the results (5, 7, 8, 10). Saxena et. al (11) showed that higher renal volume, measured by MRI, is associated with better 1 year eGFR. Coruh et.al (5) found moderate positive correlation between renal volume and 6th month graft function in their study. In both studies, a hi- gher correlation was noticed when the renal volumes were adjusted according to the weight of the recipient. In our study, we observed that as the renal parenchymal volume increases, the function of graft has better outcomes.

Renal volumetry calculations are performed by the radiologist with manual segmentation measurements. This requires time, manpower and experience. Instead, we evaluated the predictive value of donor renal artery diameter for graft function, which is easier to measure. In a previous study evaluating the correlation of donor renal artery diameter and ipsilateral renal parenchyma volume, a positive correlati- on was found. Additionally, a weak correlation between RAD and eGFR also drawn attention (6). In our study, we also showed that donor renal diameter was positively correlated with ipsilateral parenchymal volume. In the multivariate logistic regression analysis we revealedthat the diameter of the renal artery was related to the recipient 6th month eGFR level above 60 ml / min / 1.73 m^2.

These parameters, that offer better graft outcomes, may be utilized for the recipient's favor who have more than one donor candidate. Renal artery diameter, which can be measured more easily than renal volume in CT routinely used before transplantation, may be applied for the prediction of graft function.

Limitations of the Study

The limitations of this study are its single center, retrospective, low sample size and short follow-up time.

Conclusion

There are no studies in the literature that have been conducted to predict graft function via calculating donor renal artery diameter. Therefore, we could not compare long-term graft function with any other studies. We believe that our study can be sustained by a larger sample with longer follow-up periods.

Authors' Contributions: All stages of this studywere performed by a single author.

Conflict of Interest: None
Fundings: None
Informed Consent: Written informed consent was obtained from all patients

REFERENCES

1. Abecassis M, Bartlett ST, Collins AJ, Davis CL, Delmonico FL, Friedewald JJ, et al. Kidney transplantation as primary therapy for end-stage renal disease: a National Kidney Foundation/Kidney Disease Outcomes Quality Initiative (NKF/ KDOQI™) conference. Clin J Am Soc Nephrol. 2008;3(2):471-80.

2. Baid-Agrawal S, Frei UA. Living donor renal transplantation: recent developments and perspectives. Nat Rev Nephrol. 2007;3(1):31-41.

3. Al-Adra DP, Lambadaris M, Barbas A, Li Y, Selzner M, Singh SK, et al. Donor kidney vol-ume measured by computed tomography is a strong predictor of recipient eGFR in living donor kidney transplantation. World J Urol. 2019;37(9):1965-72.

4. Hugen CM, Polcari AJ, Farooq AV, Fitzgerald MP, Holt DR, Milner JE. Size does matter: do-nor renal volume predicts recipient function following live donor renal transplantation. J Urol.2011;185(2):605-9.

5. Coruh AG, Uzun C, Akkaya Z, Gulpinar B, Elhan A, Tuzuner A, editors. Is There a Correlation with Pre-donation Kidney Volume and Renal Function in the Renal Transplant Recipient?: A Volumetric Computed Tomography Study. Transplant Proc; 2019: Elsevier.

6. Kesavan A, Tai BC, Goh B, Raman L, Ananthara-man V, Tiong HY. Renal artery diameter is a sur- rogate marker for kidney volume in living kidney donors. J Urol. 2017;197(4S):e1001-e2.

7. Muto NS, Kamishima T, Harris AA, Kato F, Onodera Y, Terae S, et al. Renal cortical volumemeasured using automatic contouring software for computed tomography and its relationship with BMI, age and renal function. Eur J Radiol.2011;78(1):151-6.

8. Sikora MB, Shaaban A, Beddhu S, Bourija H, WeiG, Baird B, et al. Effect of donor kidney volume on recipient outcome: Does the "dose" matter? Transplantation. 2012;94(11):1124-30.

9. Poggio E, Hila S, Stephany B, Fatica R, Krish-namurthi V, Del Bosque C, et al. Donor kidney volume and outcomes following live donor kidney transplantation. Am J Transplant. 2006;6(3):616- 24.

10. Yano M, Lin MF, Hoffman KA, Vijayan A, Pil-gram TK, Narra VR. Renal measurements on CT angiograms: correlation with graft function at living donor renal transplantation. Radiology. 2012;265(1):151-7.

11. Saxena AB, Busque S, Arjane P, Myers BD, Tan JC. Preoperative renal volumes as a predictor of graft function in living donor transplantation. AmJ Kidney Dis.2004;44(5):877-8