Original Article

Predictive Value of Camera-based Donor Glomerular Filtration Rate Estimation on the Immediate Renal Allograft Outcome Following Live-related Renal Transplant: A Single-center Retrospective Study

Abstract

Purpose of the Study: The purpose of this study was to assess the association of measured glomerular filtration rate (mGFR) using camera-based method with early transplant outcomes. **Methodology:** Diethylenetriamine pentaacetate renograms of all voluntary kidney donors between January 2016 and December 2022 at Kasturba Hospital, Manipal, India, were retrieved for the study. Recipients' posttransplant biochemical parameters were collected and compared against donors with scaled mGFR >80 ml/min/1.73 m^2 (Group 1) and with mGFR between 60 and 80 ml/min/1.73 m^2 (Group 2). Donor–recipient pair age, anthropometric parameters, and their differences were also assessed against the immediate transplant outcome. Posttransplant immediate graft function was assessed by posttransplant nadir serum creatinine, day to achieve nadir serum creatinine, the incidence of slow graft or delayed graft function, and serum creatinine at 1-month posttransplantation. Recipients with serum creatinine of >2.5 mg/dl on posttransplant day 7 were taken as slow graft function. **Results:** A total of 161 donor–recipient pairs were analyzed in the study. In recipients who showed persistently high serum creatinine posttransplant, older donor age($p < 0.001$), higher difference in body mass index among the donor–recipient pair ($p = 0.03$), and mGFR <80ml/min ($p < 0.001$) were significantly associated. Slow graft function was significantly more in Group II recipients, with donors having mGFR <80ml/min as compared to Group I with mGFR >80 ml/min (37.3% vs. 10.6%) ($P < 0.001$). **Conclusions:** Camera-based mGFR using Gates' formula is a reliable tool to predict inferior graft outcomes in the immediate posttransplant period. Kidneys from donors with mGFR of 60–80 mL/min/1.73 m^2 are likely to experience slow graft function in the immediate posttransplant period.

Keywords: *Renal transplant, slow graft function, Tc-99m diethylenetriamine pentaacetate glomerular filtration rate*

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Introduction

Renal transplantation is the preferred alternative over dialysis, for end-stage kidney disease patients, improving survival outcomes and quality of life. Globally, approximately 0.1 million patients undergo renal transplantation every year and about 7500 in India.[1,2] Donor–recipient immunological assessment tools such as Human leukocyte antigen (HLA) typing, eplet matching, and HLA antibody testing, to identify, predict, and prognosticate transplant outcomes, have significantly improved allograft survival among live kidney transplant recipients over the last decade.[3] Despite these improvements, around 5% of patients suffer from delayed graft function and early graft loss.[4] The long waiting list and unavailability of well-matched donor kidneys have led toward the usage of suboptimal donor kidneys resulting in premature graft loss in a few.

Nonimmunological factors such as body mass index (BMI) disparity, donor comorbidities, gender, and predonation donor glomerular filtration rate (GFR) play an important role in transplant outcomes. The Kidney Disease Improving Global Outcomes (KDIGO 2012) recommends that a GFR of 90 mL/min per 1.73 m^2 or greater should be considered for kidney donation, while donors with predonation GFR <60 mL/min per 1.73 m^2 should not donate. KDIGO 2012 also stated that potential kidney donors with GFR 60–89 mL/min

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per 1.73 m^2 should be individualized based on health and demographic profile.[5,6] Serum creatinine-based Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation is used for screening potential donors and estimating their glomerular function, which is then subsequently confirmed by a measured GFR (mGFR) using an exogenous filtration marker, measured creatinine clearance, estimated GFR (eGFR) from the combination of serum creatinine and cystatin C, or repeat eGFR from serum creatinine.[7] Although the inulin clearance test is ideal for measuring GFR, in view of its cumbersome and invasive nature, diethylenetriamine pentaacetate (DTPA) plasma sampling method and camera-based Gates' formula methods are routinely preferred to measure the GFR of the donor kidney. Out of the two DTPA-based methods to estimate mGFR, the plasma sampling method is currently considered accurate.[8] Camera-based GFR estimation based on Gates' formula has shown a good correlation with the plasma sampling method; however, accuracy is debatable.[9] However, in view of its simplicity and reliability, camera-based GFR estimation has become universal for donor evaluation.

In the study by Torreggiani *et al*., donor eGFR was known to be associated with recipient outcome at 3, 6, and 12 months and 3 years; however, the association between donor eGFR and immediate graft function was not studied.[10] In the current study, we wished to assess the association of camera-based mGFR estimated with early transplant outcomes, which, to the best of our knowledge, has not been studied.

Methodology

Study population

We retrospectively studied the predonation DTPA renograms of all voluntary kidney donors between January 2016 and December 2022 at Kasturba Hospital, Manipal, India, after obtaining Institutional Ethics Committee clearance. Patients with biopsy-proven acute rejection and donation of the kidney with multiple renal vessels were excluded. They were excluded to reduce the bias of immunological or mechanical causes of reduced renal function, respectively, in the immediate transplant period. To estimate the impact of low predonation mGFR on posttransplant immediate graft function, donors with scaled mGFR >80 ml/min/1.73 m^2 (Group 2) were compared with patients with mGFR between 60 and 80 ml/min/1.73 m^2 (Group 1). Posttransplant immediate graft function was assessed by posttransplant nadir serum creatinine, day to achieve nadir serum creatinine, the incidence of slow graft or delayed graft function, and serum creatinine at 1-month posttransplantation. Serum creatinine post day 7 of renal transplant surgery was noted, and a number of recipients with serum creatinine >2.5 mg/dl (slow graft function) and those requiring dialysis posttransplant (delayed graft function) in Groups 1 and 2 were noted.

Donor diethylenetriamine pentaacetate renogram

Acquisition protocol

The renogram was acquired on Siemens Symbia Intevo Excel single-photon emission computed tomography (CT)/CT. Twenty percent symmetric window was placed over 140 keV photopeak energy. With the patient in the supine position, 5 mCi of Tc-99 m DTPA in bolus was injected and dynamic images (phase 1–2 s/frame ×1 min and phase 2–15 s/frame ×20 min) were acquired in 64 × 64 matrix. Full syringe and empty syringe counts were acquired for 1 min each. As per the Gates' method, the region of interest (ROI) was drawn over the whole kidney and a semilunar ROI inferolateral to the kidney for background correction [Figure 1]. If infiltration of radiopharmaceutical was observed in any case, the study was repeated after 2 days.

GFR was calculated using Gates' formula,[11] GFR = (% renal uptake of Tc-99 m DTPA) × (9.81) − (6.82).

% Renal uptake =

$$\frac{Right\ kidney\ counts - Background\ counts}{e^{-\mu\chi}} + \frac{Left\ Kidney\ counts - Background\ counts}{e^{-}\mu\chi} \times 100$$

For kidney depth estimation, camera-based automated Itoh method was adopted. Individual kidney GFR was calculated using the formula, right GFR = % right renal uptake/total GFR and similarly left GFR = % left renal uptake/total GFR. The results were summarized in a tabular form [Figure 2].

After confirming a negative final complement-dependent cytotoxicity cross-match, recipients for kidney transplant are admitted 2 days before a planned renal transplant surgery. Following the necessary surgical and medical fitness, recipients on day 2 are started on short-acting tacrolimus (0.08 mg/kg/day) and mycophenolate mofetil (1200 mg/m^2/day) as part of the standard

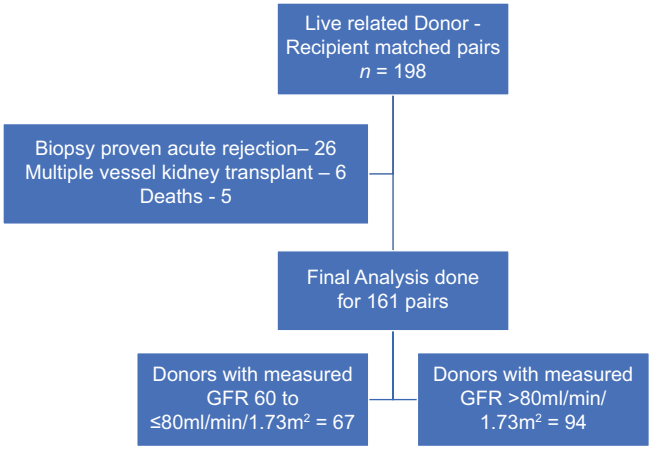

Figure 1: Flowchart indicating the number of patients included in the study

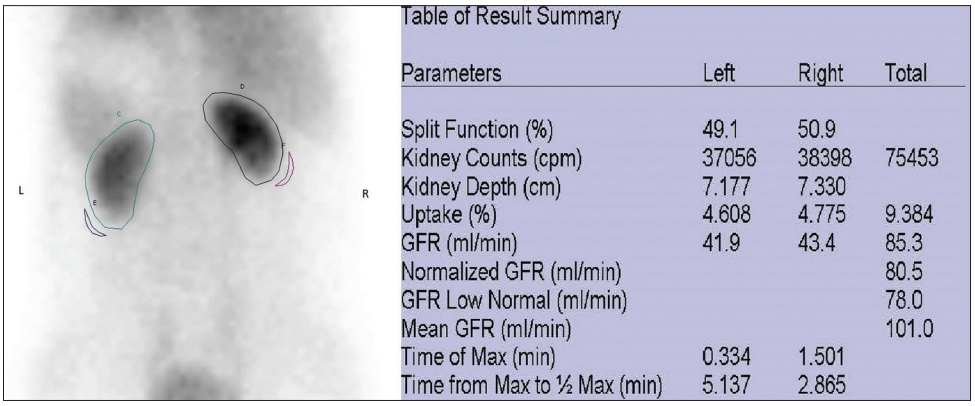

Table of Result Summary

Parameters	Left	Right	Total
Split Function (%)	49.1	50.9	
Kidney Counts (cpm)	37056	38398	75453
Kidney Depth (cm)	7.177	7.330	
Uptake (%)	4.608	4.775	9.384
GFR (ml/min)	41.9	43.4	85.3
Normalized GFR (ml/min)			80.5
GFR Low Normal (ml/min)			78.0
Mean GFR (ml/min)			101.0
Time of Max (min)	0.334	1.501	
Time from Max to ½ Max (min)	5.137	2.865	

Figure 2: DTPA renogram image showing kidney ROI placement for GFR estimation, Estimated split function and camera-based normalized GFR. DTPA: Diethylenetriamine pentaacetate, ROI: Region of interest, GFR: Glomerular filtration rate

immunosuppression protocol. At the time of renal transplant, all recipients would receive a single dose of intravenous 500 mg methylprednisolone before the arterial anastomosis. The choice of the induction agent was at the discretion of the treating transplant physician based on the immunological risk and risk of opportunistic infections in the peri- and posttransplant period. At our center, either basiliximab or rabbit antithymocyte globulin or no induction agent was used as part of peri-transplant induction regimen, as decided by the treating transplant physician. Open nephrectomy is the preferred surgical technique, with an average cold ischemic time of <1 h and a total warm ischemia time of <30 min. All recipients receive the standard triple-drug immunosuppression: oral prednisolone, short-acting tacrolimus (with trough levels maintained between 9 and 11 ng/ml), and mycophenolate mofetil (1200 mg/m^2/day) in the first postrenal transplant month. Recipients' renal function is monitored by measuring serum creatinine every 24–48 h in the first postrenal transplant month. Transplant kidney ultrasound and transplant renal artery Doppler examination are carried out on postsurgery day 3, day 7, and day 30 and when indicated. The recipient is subjected to transplant renal biopsy only on standard clinical indications, and they do not undergo protocol biopsy. Kidney donors' serum creatinine is measured on day 7 and day 30 postnephrectomy.

Statistical analysis

Kidney donors' and recipients' characteristics were expressed as mean ± standard deviation for continuous normally distributed variables, median (interquartile range) for continuous nonnormally distributed variables, and frequencies (percentages) for categorical variables. Comparison of demographic details of recipients as per normal nadir serum creatinine (≤1.2 mg/dl) achieved in the immediate posttransplant period and day 30 posttransplant period was performed using *t*-test for normal data and Mann–Whitney test for nonnormal data. Logistic regression was carried out to determine factors associated with achieving normal nadir serum creatinine in recipients in the immediate posttransplant period and day 30 posttransplant period. Results were expressed as odds ratios (ORs). In view of the strong collinearity between body weight and BMI, only the BMI was retained in the final model for calculating adjusted OR. Comparisons of renal transplant outcomes among recipients based on donor mGFR were performed using *t*-test and Mann–Whitney test. The incidence of delayed graft function was noted in three recipients in our study cohort, and for analysis, they were combined with the slow graft function cohort. All analysis was carried out using Statistical Package for Social Sciences 23 (SPSS 23), IBM, Chicago, Illinois, USA. A two-tailed $P < 0.05$ was considered statistically significant.

Results

A total of 198 live donor kidney transplantation were performed between 2016 and 2022. After excluding recipients with biopsy-proven acute rejections (n = 26) in the 1st month of renal transplantation, donor kidneys with multiple vessels (n = 6), and early posttransplant recipient deaths (n = 5), a total of 161 donor–recipient pairs were analyzed in the study [Figure 1].

Donor and recipient demographics

The mean age of the donors in our study was 50.02 years and that of the recipients was 35.25 years. The number of female donors was 128 constituting 79.5% of all the donors. The mean BMI of the donor group was 24.08 ± 4.87 kg/m^2 and that of the recipient was 21.93 ± 3.99 kg/m^2. However, the mean body surface area was lower among the donors, mean being 1.57 ± 0.19 m^2, whereas in recipients, it was 1.65 ± 0.23 m^2. Among the 161 donors, 41.6% (n=67) had mGFR of <80 ml/min/1.73 m^2 [Table 1].

Characteristics of donor–recipient pairs achieving normal nadir serum creatinine

Eighty-seven out of 161 recipients achieved normal nadir serum creatinine levels in the immediate posttransplant period. The mean donor age among such recipients was

47.40 years and was significantly younger compared to the mean age of 53.09 years among those who did not achieve a normal nadir serum creatinine [Table 2]. The recipients' age between the two groups was not significantly different. The median donor-to-recipient age difference was significantly different (19 [–4 and 23]) in those who achieved normal nadir serum creatinine as opposed to those who did not achieve it (21.50 [5.75 and 26.25]). The female donor-to-male recipient percentage was also matching between the two groups (71.26% vs. 67.57%, $P = 0.154$). The mean donor BMI and recipient BMI were not different between the two groups; however, donor-to-recipient BMI difference was significant between recipients achieving normal and abnormal creatinine (2.40 vs. 1.03). Similarly, the median donor-to-recipient weight difference was significantly lower among recipients achieving normal creatinine (–0.33 [–11 and 13] vs. –7.9 [–15.37 and 3.22]). The number of donors with GFR <80 ml/min/1.73 m^2 was 26.9% in recipients who achieved normal creatinine as compared to those with persistently high creatinine who had 73.1% of the donors below GFR 80 ml/min/1.73 m^2. On multivariate analysis only mGFR was a significant factor ($P < 0.05$) [Table 3].

Table 1: Baseline patient demographics and donor and recipient's details

Characteristics	Donor (*n*=161), *n* (%)	Recipient (*n*=161), *n* (%)
Gender		
Female	128 (79.5)	23 (14.3)
Male	33 (20.5)	138 (85.7)
Age (years), mean±SD	50.02±9.95	35.25±10.96
BMI (kg/m^2), mean±SD	24.08±4.87	21.93±3.99
mGFR (mL/min/1.73 m^2)		
60≤80	67 (41.6)	
>80	94 (58.4)	

mGFR: Measured glomerular filtration rate, BMI: Body mass index, SD: Standard deviation

Days to achieve normal serum nadir creatinine among Group I and II recipients

The recipients in Group II achieved lower nadir creatinine significantly early as compared to Group I, i.e., 42.6% achieved nadir creatinine in Group II as compared to 22.4% ($P < 0.001$) [Table 4].

Characteristics of donor–recipient pairs achieving normal 30-day serum creatinine

The mean donor age among recipients achieving normal creatinine was 47.23 years, significantly lower than the donors among recipients with abnormal serum creatinine, which was 53.55 ($P < 0.001$) [Table 5]. The median donor-to-recipient age difference among those who achieved normal creatinine was 19 as compared to 21 in the other group. The mean recipient weight in the normal creatinine group was 57.85 kg as compared to 62.34 kg among recipients who had persistently high serum creatinine. Similarly, the median donor-to-recipient weight difference was − 0.17 in lower among the normal nadir creatinine group, significantly lower as compared to − 7.8 among the abnormal nadir creatinine group. The donors with low GFR were 28.4% in the normal group as compared to 71.6% among the abnormal serum creatinine group. On multivariate analysis with logistic regression, only GFR >80 ml/min/1.73 m^2 was the significant predictor of good allograft function posttransplant with an OR of 8.97 (4.08–19.72) [Table 6].

Renal transplant outcomes among recipients based on the donor's measured glomerular filtration rate

The median nadir serum creatinine in Group I was 1.47 ± 0.35 as compared to 1.28 ± 0.62 in Group II ($P < 0.001$). The mean 30-day creatinine was also significantly lower in Group II as compared to Group I (1.19 ± 0.62 vs. 1.47 ± 0.41 [Table 7]. The incidence of slow graft function was also significantly lower in Group II (10.6%) as compared to 37.3% ($P \leq 0.001$) [Figure 3].

Table 2: Demographic details of recipients as per normal nadir serum creatinine (≤1.2 mg/dL) achieved in the immediate posttransplant period

Characteristics	Serum creatinine ≤1.2 mg/dL (*n*=87)	Serum creatinine >1.2 mg/dL (*n*=74)	*P*
Mean donor age±SD (years)	47.40±9.78	53.09±9.29	<0.001
Mean recipient age±SD (years)	34.67±11.49	35.93±10.34	0.727
Median donor-to-recipient age difference (IQR) (years)	19 (−4–23)	21.50 (5.75–26.25)	0.037
Female donor to male recipient (%)	71.26	67.57	0.154
Mean donor BMI±SD (kg/m^2)	24.39±4.78	23.71±4.98	0.196
Mean recipient BMI±SD (kg/m^2)	21.44±4.04	22.50±3.89	0.077
Median donor-to-recipient BMI difference (IQR) (SD) (kg/m^2)	2.40 (−0.78–6.97)	1.03 (−2.04–3.44)	0.03
Mean donor weight±SD (kg)	58.73±12.70	56.96±13.27	0.315
Mean recipient weight±SD (kg)	58.03±15.24	61.94±12.10	0.029
Median donor-to-recipient weight difference (IQR) (kg)	−0.33 (−11–13)	−7.9 (−15.37–3.22)	0.012
Donor mGFR 60≤80 mL/min/1.73 m2^2 (*n*=67)	18 (26.9)	49 (73.1)	<0.001
Donor mGFR >80 mL/min/1.73 m^2 (*n*=94)	69 (73.4)	25 (26.6)	

mGFR: Measured glomerular filtration rate, IQR: Interquartile range, SD: Standard deviation, BMI: Body mass index

Discussion

In this single-institution retrospective study, we analyzed 161 live-related donor-recipient pairs for the predictive ability of donor mGFR and immediate graft function in recipients. We excluded renal transplants from cadaveric donors and kidneys with multiple vessels from living donors, to reduce the confounding impact of prolonged ischemia time and surgical hurdles on immediate graft function.[12] We also excluded patients with biopsy-proven acute rejection in our analysis, as the primary aim of the study was to determine the nonimmunological factors associated with slow graft function and elevated nadir serum creatinine in the immediate posttransplant period and measure the impact of pretransplant donor mGFR on posttransplant kidney function.

In our study, the donor gender disparity existed, with females constituting the majority as donors (79.5%) and males being the recipients (85.2%), a trend which was also observed from studies across Asia and the USA.[13-15] + age (P < 0.001, Tables 2 and 5), donor-to-recipient age difference (P = 0.037, and P = 0.027, respectively, Tables 2 and 5), were significantly lower among recipients who achieved normal nadir and 30-day serum creatinine. Previous studies have noted, recipients who receive kidney from donors older than 55–60 years, had poor transplant outcomes. These findings were in accordance with our study results, where we observed kidney recipients who received an allograft from older donors had higher nadir and 30-day serum creatinine.[16,17] Even though the donors in our cohort were younger, with a mean age of 50 years, we could still observe the inferior outcomes of old donor kidneys on nadir serum creatinine in younger recipients. The percentage of female-to-male donors was assessed in our study. It is known that male-to-male or male-donor-to-female recipient pairs had lower graft failure and only female donor-to-male recipients had a negative effect on the transplant outcome.[18] In our study, the percentage of female donors to male recipients was similar between the two groups and did not confound other factors such as age, BMI, and donor mGFR on immediate transplant outcomes [Tables 3 and 5].

The mean BMI of donors was higher than the recipients in our study, 24.08 ± 4.87 versus 21.93 ± 3.99, respectively. This disparity was seen because the majority of the donors were healthy females who have higher BMI and

Table 3: Multivariate analysis using logistic regression to determine factors associated with achieving normal nadir serum creatinine in recipients in the immediate posttransplant period

Characteristics	OR (95% CI)	*P*
Donor–recipient age difference	0.99 (0.96–1.02)	0.462
Donor–recipient BMI difference	1.09 (0.95–1.26)	0.217
Donor mGFR >80 mL/min/1.73 m^2	9.55 (4.26–21.41)	<0.001

mGFR: Measured glomerular filtration rate, BMI: Body mass index, OR: Odds ratio, CI: Confidence interval

Table 4: Days to achieve nadir serum creatinine among Group 1 and Group 2 renal allograft recipients

Days to achieve nadir serum creatinine	Group 1 (60–≤80) (*n*=67; 100%), *n* (%)	Group 2 (>80) (*n*=94; 100%), *n* (%)	*P*
Day 1–Day 5	15 (22.4)	40 (42.6)	<0.001
6–10	7 (10.4)	24 (25.5)	
11–20	20 (29.9)	13 (13.8)	
>20	25 (37.3)	17 (18.1)	
Median (IQR) (days)	17.00 (6.00–27.00)	8.00 (3.00–18.50)	0.003

IQR: Interquartile range

Table 5: Demographic details of recipients who achieved normal serum creatinine (≤1.2 mg/dL) by day 30 posttransplant period

Characteristics	Serum creatinine ≤1.2mg/dL (*n*=90)	Serum creatinine >1.2mg/dL (*n*=71)	*P*
Mean donor age±SD (years)	47.23±9.75	53.55±9.09	<0.001
Mean recipient age±SD (years)	34.60±11.35	35.93±10.47	0.633
Median donor-to-recipient age difference (IQR) (years)	19 (−2.5–23)	21 (8–27)	0.027
Female donor-to-male recipient (%)	71.11	68.05	0.175
Mean donor BMI±SD (kg/m^2)	24.1±4.8	24.05±5	0.665
Mean recipient BMI±SD (kg/m^2)	21.37±3.96	22.63±3.95	0.037
Median donor-to-recipient BMI difference (IQR) (SD) (kg/m^2)	1.91 (−1.01–6.90)	1.09 (−1.97–3.66)	0.114
Mean donor weight±SD (kg)	58.05±12.82	57.75±13.2	0.634
Mean recipient weight±SD (kg)	57.85±15.07	62.34±12.10	0.013
Median donor-to-recipient weight difference (IQR) (kg)	−0.17 (−12.03–2.25)	−7.8 (−15.3–3.5)	0.03
Donor mGFR 60≤80 mL/min/1.73 m^2 (*n*=67), *n* (%)	19 (28.4)	48 (71.6)	<0.001
Donor mGFR >80 mL/min/1.73 m^2 (*n*=94), *n* (%)	71 (75.5)	23 (24.5)	

mGFR: Measured glomerular filtration rate, IQR: Interquartile range, SD: Standard deviation, BMI: Body mass index

the recipients, due to the chronic nature of the disease and poor nutritional status, tend to have lower weight and hence lower BMI.[19] Lower recipient BMI and low in-between donor–recipient BMI difference was significantly associated with achieving normal nadir serum creatinine on univariate analysis; however, they failed to show significance on multivariate analysis. It has been shown that although BMI has been a known risk factor associated with transplant outcomes, a large study, consisting of 296,807 adult transplant cases, done by Schold *et al.* showed that multivariable models including age, race, gender, and ethnicity exist in determining the effect of BMI on transplant outcome and concluded that BMI cutoffs in isolation should not be a contraindication for renal transplant.[20]

With respect to donor kidney function *per se*, donor mGFR estimation is crucial and multiple methods are utilized to estimate it. Although DTPA plasma sampling method is the gold standard for GFR estimation, we used the camera-based Gates' formula to estimate GFR as it was noted that the camera-based GFR assessment is reliable, less time-consuming, simpler, and easily reproducible.[21] There are some concerns regarding GFR overestimation in people with high BMI. Since the mean BMI mong donors was below 25kg/m2 in our study, the above concern may not significantly impact our results. Studies done in the Indian population have showed that the camera based GFR values correlated well with the formula based eGFR calculated values and creatinine clearance.[22,23] Internationally, it has been accepted that a total GFR <60 mL/min per 1.73 m^2 is a contraindication for renal donors and a GFR of >90 mL/min per 1.73 m^2 is considered safe for donation. Values between 60 and 90 mL/min per 1.73 m^2 are considered the gray area where the decision for kidney donation is based on the center and patient factors and approved for donation on a case-to-case basis. Gaillard *et al.* divided the donors into three groups based on the GFR values, 60–80, 80–90, and >90 mL/min per 1.73 m^2, and concluded that although >90 mL/min per 1.73 m^2 GFR is recommended, values lower than 90 mL/min per 1.73 m^2 are reasonable for older donors and suggested that age-calibrated mGFR might improve the efficiency of the selection process.[24] In the consensus guidelines by the International Forum on the Care of the Live Kidney Donor, the authors concluded that donors with GFR <80 mL/min per 1.73 m^2 are not ideally suited for donation.[25] In our study, we divided the donors into two groups, mGFR of 60–80 mL/min per 1.73 m^2 as Group I and mGFR >80 mL/min per 1.73 m^2 as Group II. We found that Group I had significantly poorer outcome posttransplantation as 49 out of 67 recipients (73.9%) had serum creatinine of >1.2 mg/dl as compared to 25 out of 94 recipients (26.6%) in Group II [Table 2]. On multivariate analysis, only donor mGFR was an independent factor in predicting better transplant outcomes in the form of achieving normal nadir and day 30 creatinine [$P < 0.001$, Tables 3 and 6]. This trend has also been seen in a study by Torreggiani *et al*., in which 90 donor–recipient pairs were studied to look for the association of donor characteristics with transplant outcomes. In this study, the authors found that only donor GFR and donor age were strong predictors of transplant outcome.[10] Furthermore, we found that in recipients whose creatinine values became normal, Group 1 recipients with lower donor mGFR took longer duration to attain nadir creatinine values than recipients who received kidneys from Group II donors [Table 4]. The percentage of slow graft function among recipients from Group I donors were significantly higher than in recipients receiving a kidney from Group II donors (37.31% vs. 10.64%,

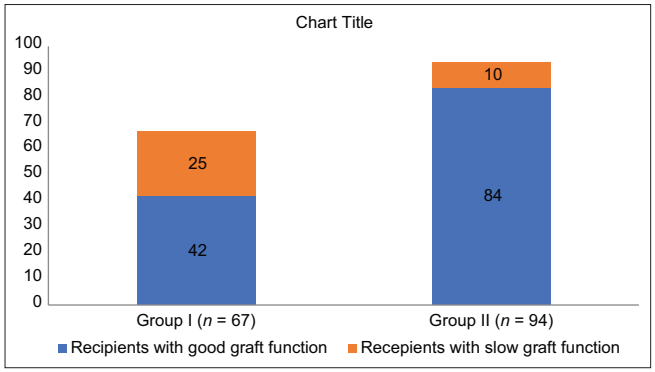

Figure 3: Bar histogram showing the incidence of slow graft function among recipients based on donor GFR. GFR: Glomerular filtration rate

Table 6: Multivariate analysis using logistic regression to determine factors associated with achieving normal serum creatinine in recipients by day 30 posttransplant period

Characteristics	OR (95% CI)	*P*
Donor–recipient age difference	0.99 (0.96–1.01)	0.362
Donor–recipient weight difference	1.018 (0.973–1.066)	0.441
Donor mGFR >80 mL/min/1.73 m^2	8.97 (4.08–19.72)	<0.001

mGFR: Measured glomerular filtration rate, OR: Odds ratio, CI: Confidence interval

Table 7: Renal transplant outcomes among recipients based on the donor's measured glomerular filtration rate

	Group I (*n*=67)	Group II (*n*=94)	*P*
Mean nadir serum creatinine, mean±SD	1.47±0.35	1.28±0.62	<0.001
Days required to achieve nadir serum creatinine, median (IQR)	17.00 (6.00–27.00)	8.00 (3.00–18.50)	0.003
Mean 30 days serum creatinine	1.47±0.41	1.19±0.62	<0.001
Incidence of slow graft function, *n* (%)	25 (37.3)	10 (10.6)	<0.001

SD: Standard deviation, IQR: Interquartile range

$P < 0.001$) [Table 7 and Figure 3]. Studies aimed to identify factors for slow graft function among living kidney donor transplants are lacking. Data from living donor kidney transplants from the Australian and New Zealand Registry identified delayed graft function in 2.3% of 3358 transplants, indicating the low incidence for it in living donor transplants.[26] Risk factors for delayed graft function included right-sided kidney, donor BMI, increasing time on dialysis, and total ischemic time. Only eGFR of the donor, calculated using the CKD-EPI creatinine equation, was recorded and was used for analysis in the above study and was not found to be significant.[26]

The main strength of our study is the use of measured donor GFR using Gates' formula to predict the graft function and occurrence of slow graft function in the immediate posttransplant period among living kidney donor recipients. This would provide a guide for transplant physicians when choosing a prospective donor with an mGFR <80 mL/min per 1.73 m^2 for kidney donation. Long-term follow-up data of donors with mGFR <80 mL/min per 1.73 m^2 and the incidence of CKD and new-onset hypertension in them would further contribute to the decision process of selecting donors for kidney transplant. The drawbacks of the study were as follows: it was a single-center study and requires validation from large multicenter data. Also being retrospective in nature, the inherent bias and concerns of retrospective studies cannot be ruled out.

Conclusions

In living kidney donor transplants, camera-based mGFR using Gates' formula is a reliable tool to predict inferior graft outcomes in the immediate posttransplant period. Kidneys from donors with mGFR of 60–80 mL/min per 1.73 m^2 are likely to experience slow graft function, higher nadir serum creatinine in the immediate posttransplant period, and a higher 30-day serum creatinine among recipients. Following kidney donation from donors with mGFR <80 mL/min per 1.73 m^2, the long-term recipient and donor outcomes need to be evaluated.

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Conflicts of interest

There are no conflicts of interest.

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