Body Mass Index and Kidney Donor Profile Index as Prognostic Markers of the Outcome of Renal Transplantation

Maria Smyrli, MD, MSc[a*], Glykeria Tsouka, MD[a], Theofanis Apostolou, MD,PhD[a], and Vasileios Vougas, MD,PhD[b]

[a]Nephrology Department, Antonios. B. Billis, General Hospital of Evangelismos, Athens, Greece; and [b]Surgical Unit - Transplantation Unit, General Hospital of Evangelismos, Athens, Greece

ABSTRACT

Background. The aim of this study was to determine the effects of Kidney Donor Profile Index (KDPI) and body mass index (BMI) of the deceased donor on the kidney allograft outcome 1 year after transplantation.

Methods. We retrospectively studied 98 deceased kidney allograft donors with a mean age of 56 ± 12 years. The donors were divided into 5 groups according to their BMI: Normal BMI = 25 (n = 25); BMI 25 to 29 = Overweight (n = 33); BMI 30 to 34.9 = Obese class I (n = 19); BMI 35 to 39 = Obese class II (n = 11); and BMI >40 = Obese class III (n = 10). We examined the impact of the deceased donor's BMI and KDPI on delayed graft function (DGF) and estimated renal glomerular filtration rate (eGFR) (measured by the Chronic Kidney Disease Epidemiology Collaboration equation) 1 year after transplantation.

Results. Donor BMI significantly increased the prevalence of DGF (P = .031), and it was associated with higher cold ischemia time (P = .021). However, there was no significant association between the aforementioned BMI groups and 1-year eGFR (P = 0.57), as deceased grafts from donors with increased BMI (BMI > 40) gained sufficient renal function during the first year of transplantation. Moreover, high KDPI was associated not only with DGF (P = .015), but also with decreased values of eGFR (P = .033).

Conclusion. In this population, we identified no significant association between donor BMI and long-term clinical outcomes in deceased donor kidney transplants. KDPI, and not BMI, of the deceased donor seems to be a good prognostic factor of renal function at the end of the first year after kidney transplant, whereas high BMI and high KDPI markedly induce DGF.

In the renal transplant world, there is a disparity between the demand for renal transplants and the availability of deceased and living donors for patients with end-stage renal disease. This is also true in a large setting with the demands for renal transplants in Greece, which lies last on the list for effective renal transplants. All over the world, there are efforts to expand the donor pool, using all the opportunities for a safe renal transplant, even with "marginal donors" that were declined in previous years [1]. In this direction, marginal donors (ie, donors with extended criteria to donation under certain circumstances—eg, grafts from obese patients, grafts from donors with reduced renal function and comorbidities) are accepted for transplantation in specific recipients, allowing recipients to live without need for dialysis and with a satisfactory renal function for a period of time that approaches their life expectancy [2].

We performed a retrospective study aiming to find how obesity and the Kidney Donor Profile Index (KDPI) score, which is explained later in this article, influence future renal function and survival in patients who have undergone renal transplant and received grafts from extended criteria donors [3].

*Address correspondence to Dr Maria Smyrli, MD, MSc, General Hospital of Evangelismos, Ipsilantou 45-47, Athens 10676, Greece. Tel: +306943576787. E-mail: mariasmirli3002@hotmail.com

0041-1345/20
https://doi.org/10.1016/j.transproceed.2021.08.030

MATERIALS AND METHODS

This was a retrospective study on stable kidney transplant recipients who are under regular follow-up in the Transplantation Outpatient department of Evangelismos General Hospital of Athens, one of the largest hospitals in the Balkan Peninsula. The examined patients regularly attend our outpatient clinic at intervals ranging from 1 week to 6 months. For the purpose of this study, we collected data of all clinically stable kidney transplant recipients who had completed at least 1 year from kidney engraftment and had complete information for the main variables of interest. The study protocol was approved by the Institutional Review Board of Evangelismos General Hospital.

We retrospectively studied 98 recipients of deceased renal transplant donors, who were transplanted in our center between January 2014 and September 2018. Donors were divided into 5 groups in relation to body mass index (BMI): Normal BMI = 25; BMI 25 to 29.9 = Overweight (n = 33); BMI 30 to 34.9 = Obese class I (n = 19); BMI 35 to 39.9 = Obese class II (n = 11); and BMI >40 = Obese class III (n = 10). We studied the influence of donor BMI and KDPI on the development of delayed graft function (DGF) and annual estimated renal glomerular filtration rate (eGFR), estimated with the Chronic Kidney Disease Epidemiology Collaboration equation [4] at the end of the first year after the kidney transplantation. In addition, the effect of cold ischemia and the age difference of donor to recipient were also evaluated and compared as for the final renal function.

Statistical Analysis

The analysis was performed using the SPSS v22 (SPSS Inc, Chicago, IL, United States) statistical package. Demographic and clinical data are expressed as counts, percentages, or mean ± standard deviation. Suitable tests of normality such as the Kolmogorov-Smirnov and the Shapiro-Wilk were applied for a parametric or a nonparametric test to be proposed for each case. The independent sample t test was applied to determine whether there was statistical evidence that the associated population means are significantly different. Paired t tests as well as the Kruskal-Wallis, χ^2 analysis, and analysis of variance procedures were used to assess the differences between groups based on the variables' type. Both Pearson (r) and Spearman (ρ) correlation measures were used to evaluate the cross-sectional association between the baseline values of these variables. Appropriate box plots were produced using the median values of the variables considered to further illustrate differences among different groups. Typically $P < .05$ was considered significant.

RESULTS

From the total cohort, 50 transplant recipients were male patients (51.02%), the mean age was 56 ± 12 years, mean eGFR 52.85 ± 19.4 mL/min/1.73 m^2, and dialysis vintage before kidney transplantation was 4.7 ± 3.1 years. Regarding transplantation-related factors, deceased donor BMI was found to be statistically significant with the development of DGF in the recipient ($P = .031$) (Fig 1), and it also affected the cold ischemia time, because higher BMI was correlated with prolonged cold time ischemia ($P = .025$). In addition, eGFR at the end of the first year after transplant was not different among the donor BMI groups, even in those with the highest BMI (>40), in whom renal function was very satisfactory (Fig 2). On the other hand, a higher KDPI score was significantly associated with increased frequency of DGF development ($P = .015$) and lower values of eGFR ($P = .033$) (Table 1). The age difference

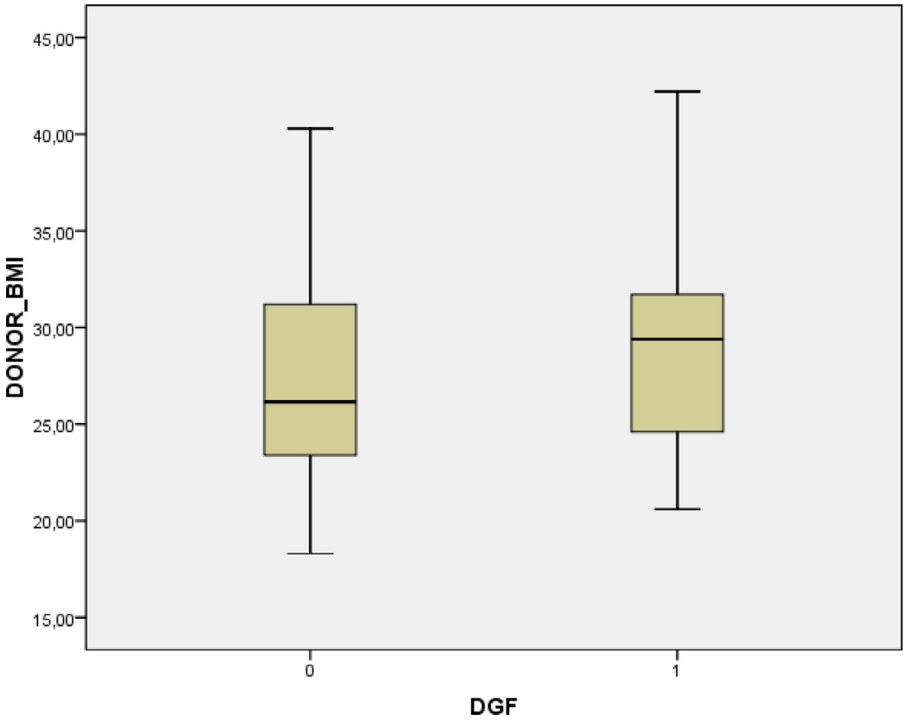

Fig 1. Impact of body mass index (BMI) on delayed graft function (DGF) of the studied population.

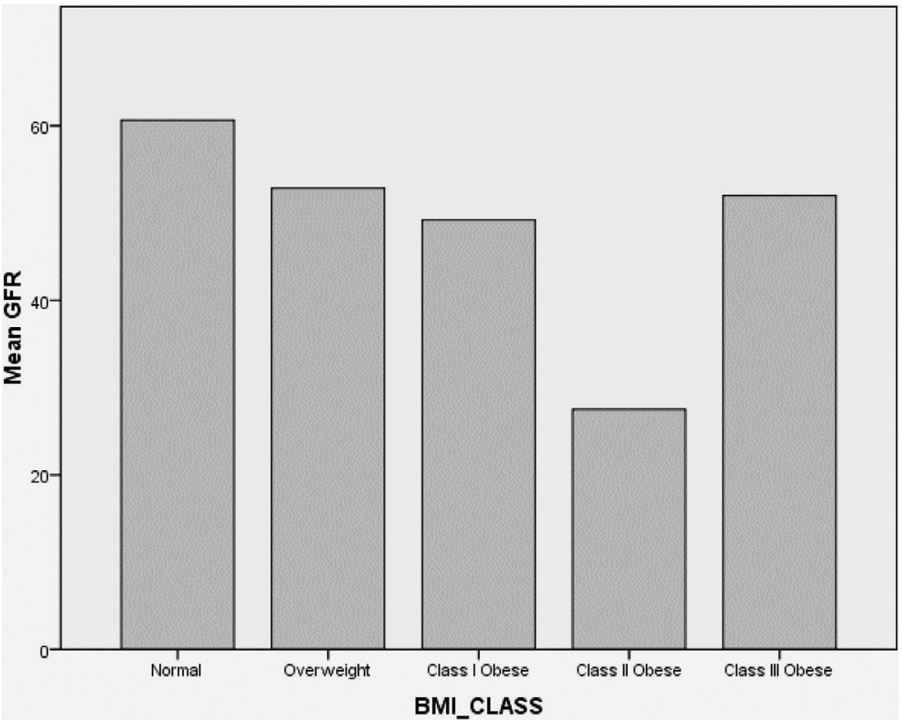

Fig 2. Impact of body mass index (BMI) on estimated renal glomerular filtration rate (eGFR) at the end of the first year after kidney transplantation.

between donor and recipient was found to have a positive relation to the presence of DGF (P = .001). Additionally, we performed multivariate analysis, including eGFR as the dependent variable and all other factors that were previously identified from univariate analyses as independent variables. As shown in Table 2, in multivariate analysis, raised KDPI seems to be an independent determinant of renal function after kidney transplantation and not BMI.

DISCUSSION

Obesity is a frequent major public health matter and in many developed countries will obviously continue to be a public health issue. Parallel to this, there is a continuously increasing number of renal donors with obesity for recipients who also are obese and, in some cases, have certain accompanying comorbidities [1,5]. To this end, the inclusion and acceptance of extended criteria renal donors for transplantation was introduced. This strategy led to an effort to determine and classify the quality of renal grafts that will be given to specific recipients. This was made possible by combining a variety of donor factors, apart from BMI, into a single number (percentage) that summarizes the likelihood of graft failure after deceased donor kidney transplant [3,6]. This is the KDPI, which expresses the probable longevity of a deceased donor kidney in terms of expected function in the future, relative to all of the kidneys recovered for transplantation. Lower KDPI scores are associated with a longer estimated function, whereas higher KDPI scores are associated with shorter functions. The score is a percentage that encompasses 10 factors related to the deceased donor: age, height, weight, race, presence of hypertension, diabetes, cause of death, serum creatinine, hepatitis C virus status, and donation after circulatory death (former nonheart-beating donors). The majority (65%) of deceased donor kidneys have a KDPI between 21 and 85, as also can be observed in our data (Table 1), and are expected to function for about 9 years. Kidneys with a KDPI exceeding 85% are expected to function for >5.5 years. Because living donor kidneys have tended to be

Table 1. Relation Between Different Scores of KDPI with DGF, BMI, and eGFR of the Examined Renal Recipients

	Kidney Donor Profile Index				
Parameters	<25%	25%-50%	50%-80%	>80%	*P* Value
No. of patients	13	13	49	23	–
Mean BMI	24.28	26.6	28.72	29.7	.001
DGF	24%	25%	31.25%	60%	**.015**
Mean eGFR (mL/min/1.73 m^2) CKD-EPI	78.25	62.25	49.5	41.1	**.033**

Probability values of $P < .05$ were considered statistically significant in all comparisons, are in bold.

BMI, body mass index; CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; DGF, delayed graft function; eGFR, estimated renal glomerular filtration rate; KDPI, Kidney Donor Profile Index.

Table 2. Univariate and Multivariate Analysis of Factors Possibly Associated with eGFR After Kidney Transplantation

	Univariate Analysis				Multivariate Analysis			
Parameter	Coefficients	Lower 95%	Upper 95%	*P* Value	Coefficients	Lower 95%	Upper 95%	*P* Value
Age (y)	−0.689	−1.110	−0.267	.001	1.387	0.323	2.451	**.012**
Sex	−3.266	−16.081	9.549	.612	−0678	−16.462	15.106	.932
BMI (kg/m^2)	−1.177	−2.295	−0.059	**.039**	1.085	−0.170	2.339	1.085
KDPI (%)	−42.51	−65.613	−19.423	**.000**	−107.494	−169.725	−45.264	**.001**
Donor creatinine (mg/dL)	−8.525	−27.256	10.204	.366	20.266	0.021	40.432	**.050**
Cold time ischemia (h)	−0.525	−1.185	0.134	.116	−0.383	−1.197	0.432	.351

Probability values of $P < .05$ were considered statistically significant in all comparisons, are in bold.
BMI, body mass index; eGFR, estimated renal glomerular filtration rate; KDPI, Kidney Donor Profile Index.

transplanted into lower-risk patients (eg, younger, nondiabetic) and kidneys with KDPI >85% have tended to go to higher-risk patients, the actual differences in half-lives for a given patient may not be great [7,8]. And of course, the actual graft survival for any given patient also depends on many other patient-specific factors such as age, diagnosis, HLA mismatching, compliance with treatment protocols, and other factors. KDPI provides more granularity in how each kidney is expected to function relative to other available kidneys. Use of the KDPI is an element in kidney evaluation, which considers other donor characteristics. The candidate for such a graft has to consent to receive kidneys with a KDPI over 85%. The decision to accept these kidneys depends on a variety of factors, including the transplant center's expected waiting times, the patient's clinical characteristics, whether living donation is a possibility, and quality of life considerations [3].

In our study, patients with obesity with BMI >30 represented 42% of all patients. In many other studies, this percentage was <25%. This led to an increase of the presence of DGF and even cold ischemia time in most of our patients. This can be explained by the fact that there are increased technical challenges in using such grafts (damage to tubules, ischemia kidney preservation, or delay in anastomotic procedures), but in the end, this was not accompanied with a worse final eGFR 1 year after the transplant [2]. This led to the conclusion that the deleterious effects of DGF may not apply to donors with obesity, and this supports the use of such kidneys in patients with end-stage renal disease for transplant [7,9]. In addition to this, even grafts from donors with malignant obesity (BMI >40) developed a satisfactory renal function at the end of the study. How could this be explained, knowing that surgery in donors with a high BMI represents a challenge for the surgeon? In many similar studies, despite the risk for DGF presence in such patients, the same result was noticed, leading to the conclusion that in donors with obesity a greater nephron mass possibly accompanies such grafts, which leads to a satisfactory renal function [7,10].

As for KDPI score, it has been demonstrated as an accurate prediction of donor contributions to transplant outcomes. Age of the donor has the highest negative impact in transplant outcomes, especially if donors are >50 and <18 years old. Additionally, a greater positive impact is weight (<80 kg) and a short stature of the donor. In our patients, KDPI was related to the final eGFR, a finding similar to many other studies, where KDPI score and age related to a poor graft function.

In conclusion, in our sample of patients, KDPI, and not donor BMI, was related to a lower renal function at the end of the first year after transplant. In accordance with medical literature, higher KDPI, high donor BMI, and greater age difference between donor and recipient are related to increased frequency of DGF, but only the KDPI score was related to a poor graft function. With these findings, one can adopt a specific strategy for the use of extended criteria donor's graft, aiming to give the right kidney to the right recipient. While trying to minimize the complications, patients who have waited a long period of time for a graft can be given a satisfactory renal function, avoiding the deleterious effects of the extended stay on the transplant list, especially in countries like ours where the likelihood of a transplant is low and one can wait more than 10 years on the list.

REFERENCES

[1] Friedman AN, Miskulin DC, Rosenberg IH, Levey AS. Demographics and trends in overweight and obesity in patients at time of kidney transplantation. Am J Kidney Dis 2003;41:480–7.

[2] Marinaki S, Kriki P, Kolovou K, Boletis JN. Obesity in kidney transplant donors and recipients: does the benefit outweigh the risk? Integr Obesity Diabetes 2016;2:213–8.

[3] Lee APK, Abramowicz D. Is the Kidney Donor Risk Index a step forward in the assessment of deceased donor kidney quality? Nephrol Dial Transplant 2015;30:1285–90.

[4] Levey AS, Stevens LA, Schmid CH, Zhang YL, Castro 3rd AF, Feldman HI, et al. A new equation to estimate glomerular filtration rate. Ann Intern Med 2009;150:604–12.

[5] Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2014;384:766–81.

[6] Bae S, Massie AB, Luo X, Anjum S, Desai NM, Segev DL. Changes in discard rate after the introduction of the Kidney Donor Profile Index (KDPI). Am J Transplant 2016;16:2202–7.

[7] Zens TJ, Danobeitia JS, Leverson G, Chlebeck PJ, Zitur LJ, Redfield RR, et al. The impact of kidney donor profile index on delayed graft function and transplant outcomes: a single-center analysis. Clin Transplant 2018;32:e13190.

[8] Cannon RM, Jones CM, Hughes MG, Eng M, Marvin MR. The impact of recipient obesity on outcomes after renal transplantation. Ann Surg 2013;257:978–84.

[9] Weissenbacher A, Jara M, Ulmer H, Biebl M, Bösmüller C, Schneeberger S, et al. Recipient and donor body mass index as important risk factors for delayed kidney graft function. Transplantation 2012;93:524–9.

[10] Gupta A, Chen G, Kaplan B. KDPI and donor selection: Editorial. Am J Transplant 2014;14:2444–5.