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Predictors of post-kidney transplantation complications among Egyptian recipients—1-year follow-up

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Abstract

Background Kidney transplantation is the optimal treatment modality for patients with end-stage kidney disease. We aimed to identify predictors for post-transplantation complications.

Methods A prospective cohort study with 1-year follow-up on 40 recipients (with their donors) were recruited and followed up for 1 year after transplantation. The patients were classified into two groups according to development of complications or not.

Results It was found that renal recipient had significantly lower mean age compared to donors (30.55 ± 10.24 vs. 41.28 ± 9.83 (years); $p < 0.001$). The reported complications were hypertension (42.5%), proteinuria (17.5%), surgical difficulty (17.5%), chronic rejection (12.5%), DM (7.5%), and other less common complications. Death occurred in six recipients. Significant predictors for complications were history of DM (*OR* = 3.429; 95% *CI* = 1.148–5.058; *p* = *0.044*), BUN (*OR* = 2.501; 95% *CI* = 1.094–4.007; *p* = *0.038*), creatinine (*OR* = 1.90; 95% *CI* = 1.025–2.806; *p* = *0.015*), older age (*OR* = 1.854; 95% *CI* = 1.090–3.195; *p* = *0.033*), pre-transplantation leucocytic count (*OR* = 1.775; 95% *CI* = 1.057–3.901; *p* = *0.039*), and LDL (*OR* = 1.051; 95% *CI* = 1.009–2.441; *p* = *0.047*). Elevated PTH in pre-transplantation showed significantly slight protective effect against development of complications (*OR* = 0.915; 95% *CI* = 0.624–0.957; *p* = *0.031*)**.**

Conclusion Complications are common after kidney transplant in our population and are associated with history of DM, pre-transplantation BUN, creatinine, and older age, while elevated pretransplant PTH showed slightly protective effect.

Keywords Factors, Renal transplant, Outcome, One year, Follow-up

Background

Kidney transplantation (KT) is the optimal modality of treatment for patients with end-stage kidney disease (ESKD), and if successful, it associated with improved quality of life, lower medical costs, and improved survival [1].

Better results are associated with shorter periods of time on dialysis, and the best results are achieved with preemptive transplantation [2].

Timely referral for transplantation is essential to maximize benefit and should begin when patients estimated

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glomerular filtration rate drops to less than 20 mL/min/m [3].

Multiple studies have demonstrated that patient survival is better with renal transplantation than on dialysis. The largest study based on the United States Renal Data System (USRDS) demonstrated a lower annual death rate among transplant recipients compared with patients on the waiting list with improved survival observed among diabetic and in all age groups. The reason for improved survival is unclear. It has been hypothesized that on improved clearance of uremic toxins coupled with a lower proinflammatory and/or oxidative state as seen in chronic renal failure patients, in diabetic patients, transplantation restores near normal kidney function which reduces the circulating levels of glycosylation products, thus decelerating the progression of micro vascular disease [4].

Patient survival post transplantation depends on several factors, the type of graft (living/deceased), age of patient, and the spectrum and severity of recipient's comorbidities. The leading cause of death post transplantation remains cardiovascular disease. The highest number of deaths from cardiovascular causes occur immediately post-surgery. Other causes of death include infection, related to level of immunosuppression and malignancy [5]. Thus, this study aims to identify predictors for post-transplantation complications to help in developing strategies to improve care and reduce frailty.

Methods

The present study is a prospective cohort study with 1-year follow-up and was carried out in Assiut University Kidney Transplantation Outpatient Clinic which is a tertiary care hospital with highly specialized and qualified care providers. The target population was kidney transplantation recipients visiting the transplant outpatient clinic coupled with their donners.

Inclusion criteria

All adult patients who underwent renal transplantation during the study period from October 2015 to October 2018 in Assiut University Hospital were included in the study. Excluded patients composed of patients aged less than 18 years (pediatric) or over 65; those with reduced creatinine clearance, *GFR* < 80 mL/mi, proteinuria > 250 mg, or hematuria; patients with multiple or recurrent renal calculi, infection, e.g., HIV, hepatitis B, hepatitis C, and cancer, recurrent or treated; and those with cardiovascular disease, coronary or peripheral vascular disease, and vascular heart disease.

Total coverage of All eligible recipients (and their donors) during time of data collection from 2015–2018. A total of forty recipients were included in this study. Data was collected using self-designed general information questionnaire consisting of two sections: demographic characteristics and disease-related characteristics. Demographic characteristics were collected (from both recipients and donors) including age, gender, occupation, and smoking habit. Disease-related characteristics were collected including clinical history, clinical evaluation, and basic laboratory findings the day before transplantation and 1 year after transplantation. Data collection was carried out following the IRB approval from Faculty of Medicine: Assiut University was obtained. Written informed consent was obtained from all eligible patients after explanation of research objectives.

Statistical analysis

Data were verified, coded, and analyzed using IBM-SPSS 24.0 (IBM-SPSS Inc., Chicago, IL, USA)*.

Descriptive statistics

Means, standard deviations, and percentages were calculated.

Tests of significance

Chi-square test was calculated to compare the frequencies among groups.

Independent *t*-test/paired *t*-test analysis was carried out to compare the means of dichotomous data. Significant variables from the univariate analysis were entered in multivariable logistic regression model to test the independent predictors of complications in recipients using odds ratio (OR), 95% confidence interval (CI), and *p*-value. A significant *p*-value was considered when it is less than 0.05.

Results

Our study was carried out in Assiut University Kidney Transplantation Unit (a tertiary care hospital) on 40 eligible recipients and their donors 1 year following transplantation. It was found that renal recipient had significantly lower mean age in comparison to donors (30.55 ± 10.24 vs. 41.28 ± 9.83 (years); $p < 0.001$). Majority (95%) of recipients was males, while majority (70%) of donors was females ($p < 0.001$). There was a statistically significant difference in the employment status between recipients and donors where about three-quarters of recipients (72.5%) and one-third of donors (37.5%) were employed. Mean duration of dialysis before transplantation was 18.1 ± 21.88 months (Table 1).

Basic laboratory investigations were performed to all patients the day before transplantation, and the means of hemoglobin (Hg b), blood urea nitrogen (BUN), and creatinine were 10.9 ± 2.7 g/dL, 22.7 ± 20.45 mmol/L, and 1022.9 ± 2216.6 μmol/L respectively. One year

Table 1 Sociodemographic characteristics of both recipients and donors

	Sex (male) *N* (%)	Age (years) Mean ± SD	Married *N* (%)	Employed *N* (%)	Smoker *N* (%)	Dialysis duration Mean ± SD
Recipient (*n* = 40)	38 (95.0)	30.55 ± 10.24	26 (65.0)	29 (72.5)	4 (10.0)	18.1 ± 21.88
Donor (*n* = 40)	12 (30)	41.28 ± 9.83	34 (85.0)	15 (37.5)	8 (20.0)	N/A
p-value	< 0.001	< 0.001[a]	0.039	0.002	0.210	–-

N/A not applicable. Chi-square test was performed

[a] *t*-test was used

after transplantation, there was a significant increase in hemoglobin level and calcium with significant reduction in phosphorus, urea, creatinine, and PTH. Regarding the lipid profile after transplantation, there was significant reduction in serum cholesterol (170.23 ± 32.72 vs. 154.87 ± 41.53 (mg/dL); $p = 0.002$) (Table 2).

Most donors were living related, and 97.5% of them were the mother who was the most frequent donor (32.5%) followed by the sister (25%) and the brother (15%). There is only one living unrelated donor, namely the husband of his sister (Fig. 1).

Twenty-eight of the 40 recipients of kidney transplantation were of the same ABO grouping, and half of them were of blood group "O" (Fig. 2).

Surgical complications namely, bleeding from vascular anastomosis in 4 cases and lymphocele in 2 cases due to interruption of pelvic lymphatics*)* during transplantation (17.5% each), and chronic rejection (12.5%). Less common complications included DM (mainly drug induced), infection (TB & CMV), and acute rejection. Death occurred in six patients accounting for 15% (four deaths occurred due to bleeding from vascular anastomosis immediately postoperative, while the other two died > 6 months postoperative due to either COVID-19 or myocardial infarction). Medical symptoms and conditions showed marked improvement following transplantation where all cases of uremic cardiomyopathy recovered completely, while 76.5% (13 out of 17) of hypertensive recipients recovered spontaneously, and 4 cases were controlled by single antihypertensive medication instead of 3 or 4 before transplantation (Table 3).

Mean age (years) of recipients who developed complications was significantly higher ($p = 0.008$). All females underwent transplantation developed complications compared to males with statistically significant results. Other clinical characteristics showed nonsignificant differences between those who developed and did not develop complications (Table 4).

In patients who developed complications, most of laboratory markers showed no significant change after transplantation. Only BUN and creatinine showed significant reduction, whereas serum glucose was increased significantly after transplantation (Table 5).

Based on the current study, significant predictors for post-transplantation complications were the history of DM, pre-transplantation leucocytic count, BUN and creatinine, age, and LDL. Elevated PTH in pre-transplantation showed slightly significant protective effect against development of complications (Table 6).

Discussion

End-stage kidney disease (ESRD) is a rapidly increasing global health and health care burden. The inability to care for many patients at risk for and in need of treatment for ESRD disproportionately impacts low- and middle-income countries (LMICs) [5].

The donor's demographic characteristics are currently a topic of interest to assess the potential risk of end-stage renal disease (ESRD) among living donors. Here, in the current study, we found that renal recipient had significantly lower mean age than donors (30.55 ± 10.24 vs. 41.28 ± 9.83 (years); $p < 0.001$). In line with these findings, a previous study stated that donors were younger than recipients (38.9 ± 0.07 vs. 52.7 ± 0.06 years, $p < 0.001$). But this study found that donors and recipients were primarily male (59.9% and 60.3%, respectively), but this proportion did not differ between the two groups ($p = 0.12$) [6]. The majority (72.5%) of recipients was employed, and majority (62.5%) of donors was unemployed.

In our study, the majority (95%) of recipients was males, while majority (70%) of donors was females ($p < 0.001$). Similarly, *Godara* et al. found that majority (78%) of the donors were females, whereas males contributed to 21.8% of renal donations [7]. *Kayler* et al. found that females comprised 68% of renal donors [8]. Gender disparity has been observed in living donor kidney transplant, and this appears to be unrelated to underlying medical issues in men or increased female representation in the general population. However, A single-center experience found that females comprised majority of the living donors (55%) [9]. Similarly, a study conducted in Norway showed that females compose of majority of living donors. Moreover, there are significantly more

Table 2 Laboratory findings of recipients the day before and 1 year after transplantation (mean ± SD)

	Hg b (g/dL)	Bun (m mol/L)	Creatinine (m mol/L)	Na (m eq/L)	K (m eq/L)	Mg (mg/dL)	Ca (g/dL)	Phosphorus (g/dL)	ALP (IU/L)	PTH (pg/mL)	Glucose (mmol/L)	Cholesterol (mg/dL)	HDL (mg/dL)	LDL (mg/dL)	TG (mg/dL)
Before	10.9 ± 2.7	22.7 ± 20.5	1022.9 ± 221.6	137.1 ± 15.9	4.5 ± 0.6	2.1 ± 0.5	8.6 ± 0.8	4.3 ± 1.1	144.9 ± 81.6	436.0 ± 25.7	5.1 ± 1.3	170.2 ± 32.7	39.8 ± 10.3	87.4 ± 34.4	113.6 ± 38.4
After	12.9 ± 2.2	9.6 ± 6.5	193.1 ± 218.4	139.8 ± 4.5	4.3 ± 0.6	2.1 ± 1.1	9.1 ± 1.2	3.8 ± 1.1	123.6 ± 45.9	39.5 ± 6.3	7.8 ± 16.7	154.9 ± 41.5	42.8 ± 19.6	88.9 ± 36.9	111.5 ± 45.1
p-value	< 0.001	< 0.001	< 0.001	0.25	0.05	0.122	0.001	0.024	0.10	0.01	0.62	0.002	0.82	0.62	0.68

Abbreviations: Hg b hemoglobin, *BUN* blood urea nitrogen, *ALP* alkaline phosphatase, *PTH* parathyroid hormone, *HDL* high-density lipoproteins, *LDL* low-density lipoproteins, *TG* triglycerides. Paired *t*-test was used. Significant *p*-value < 0.05

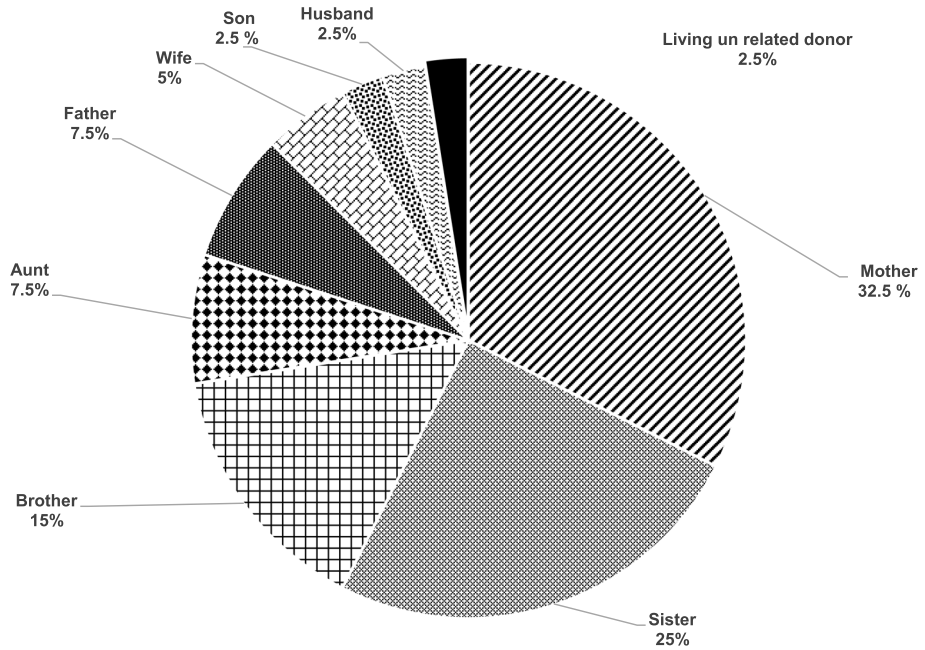

Fig. 1 Percent distribution of donors' relation to recipients

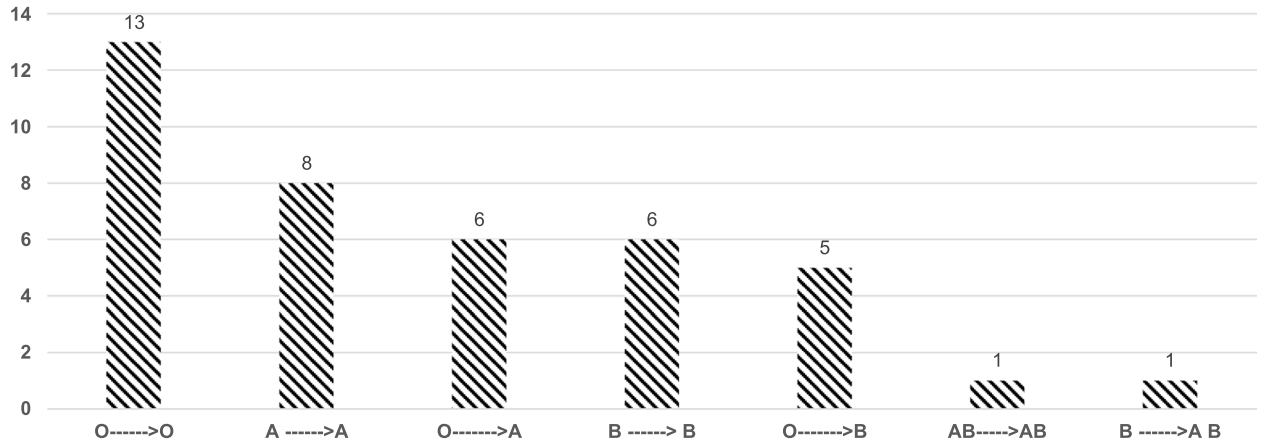

Fig. 2 Frequency distribution of donor → recipient blood groups

Table 3 Incidence and types of complication during the first year following renal transplantation

Event	Acute rejection	Chronic rejection	CMV	TB	PT DM	HTN spontaneously recovered	HTN recovered on 1 drug	UCM improved	Proteinuria	[a]Mortality	[b]Surgical difficulty
No	**2**	**5**	**1**	**1**	**3**	**13**	**4**	**40**	**7**	**6**	**6**
%	**5.0**	**12.5**	**2.5**	**2.5**	**7.5**	**76.5**	**23.5**	**100**	**17.5**	**15**	**15.0**

Abbreviations: CMV Cytomegalovirus, *TB* tuberculosis, *PT DM* post-transplantation diabetes mellitus, *HTN* hypertension, *UCM* uremic cardiomyopathy

[*] More than one complication may occur in the same patient

[a] Mortality, four deaths occurred due to bleeding from vascular anastomosis immediately postoperative, while the other two died > 6 months postoperative due to either COVID-19 or myocardial infarction

[b] Surgical difficulties included the following: bleeding from vascular anastomosis (four cases) and lymphocele (two cases) due to interruption of pelvic lymphatics

Table 4 Clinical characteristics of patients with complications

	Age/years Mean ± SD	Sex (male/female)	History of DM *N* (%)	BMI Mean ± SD	SBP Mean ± SD	DBP Mean ± SD	HLA mismatch (≥ 3/6)
Complications occurred (*n* = 19)	34.28 ± 8.2	17/2	1 (5.3%)	24.98 ± 5.8	138.42 ± 15.2	85.26 ± 11.7	13 (61.9%)
p-value	**0.008**[a]	**0.024**[b]	0.342[b]	0.823[a]	0.262[a]	0.159[a]	0.597[b]

Abbreviations: SD standard deviation, *DM* diabetes mellitus, *BMI* body mass index, *SBP* systolic blood pressure, *DBP* diastolic blood pressure

[a] Independent *t*-test was used to compare the means among groups

[b] Fisher's exact analysis was used to compare the frequency among groups

females donating to spouses and children [8]. Psychosocial and cultural factors are possible explanation for the overrepresentation of females among living donors.

In our study, the mean duration of dialysis before transplantation was 18.1 ± 21.88 months that goes in the same line with a study which assessed the relation of duration of dialysis before transplantation with graft and patient survival. The rates of short-term complications such as delayed graft function, acute graft rejection, and acute patient death were significantly higher in patients with ≥ 10-year dialysis than in patients with lesser duration [2, 3, 10, 11].

As regards laboratory data in the current study, 1-year after renal transplantation, there was significant increase in hemoglobin level and calcium with significant reduction in cholesterol, phosphorus, urea, and creatinine. This was consistent with previous studies that reported significant improvement in urea, creatinine, and hemoglobin after transplantation [12, 13].

As regards postoperative complications in the current study were surgical complications namely bleeding and lymphocele and medical such as acute and chronic rejection, DM, infections (TB& CMV) and mortality. Our findings are consistent with previous study which showed that 49/200 patients (24.5%) developed surgical complications [13]. Another study reported that 64.8% of patients had acute rejections, and post-transplantation hypertension occurred in 59.5, DM in 22.9%, infections in 51.5%, hepatic complications in 22.9%, and malignancy in 13% patients. Fatal infections in 31.3% patients were the main causes of death [14].

Infection was reported in two-patient post-transplantation, and *Cytomegalovirus* (CMV)) infection accounted for 50% of infections. Similar results were reported from a study which determined the patterns of infectious complications in the renal transplant Tunisian recipients where CMV was the most frequently reported pathogen followed by urinary tract infection, which occurred within 3 months after surgery [15]. This could be explained by intensive antirejection treatment.

Post-transplantation DM developed in 7.5% of our recipients which agrees with Lempinen et al. (2015) and Jain et al. (2019) [1, 14, 16]. Possible factors associated with new onset of DM following transplantation may be multiple and variable such as immunosuppressive medication regimen (namely corticosteroids and tacrolimus). Other possible factors include improved appetite and weight gain. However, there were no reported cases of newly developed hypertension post transplantation which may be due to short period of follow-up. Most of studies focus on hypertension prior to transplantation as a risk factor for 1-year graft loss [12].

Again, Lempinen et al. *reported* that there were 282 complications occurring in 259 (15.5%) renal transplantations. Ureteral obstruction occurred in 53 (3.1%), lymphoceles in 39 (1.5%), postoperative hemorrhage in 36 (2.1%), and renal vein thrombosis in 22 (1.3%) patients, respectively. Out of the 17 lung emboli, 4 were fatal [16]. Proteinuria developed in 17.5% of our patients, which is in agreement with another study, concluded that persistent post-transplantation proteinuria was detected in 28.8% patients. Possible etiology of post-transplantation proteinuria includes chronic allograft dysfunction, acute rejection, transplant glomerulopathy, and glomerular disease. Proteinuria may result in significantly lower graft survival rates [17].

Significant predictors for post-transplantation complications in this study were history of DM and pre-transplantation elevated laboratory markers, namely: leucocytes, BUN and creatinine, older age, and LDL.

Strangely, elevated PTH in pre-transplantation showed significantly slight protective effect against development of complications which is opposite to Elin Isaksson et al. (2018) who concluded that low levels of parathyroid hormone before transplantation were associated with increased risk of posttransplant vascular events both in patients with and without pretransplant parathyroidectomy [18]. This may be due to the small number of studied cases, and the level of hyperparathyroidism in the studied patients was not so high to necessitate parathyroidectomy, so this point needs further study on wide scale and designed proposal to avoid biased results. In accordance with our results, *Tang et al.* concluded recipient sex, race, height, weight, diabetes, history of

Table 5 Laboratory profile of patients with complications before and after transplantation

	BUN (mmol/L)	Creatinine (µmol/L)	Sodium (mEq/L)	Potassium (mmol/L)	Mg (mg/dL)	Calcium (mmol/L)	Phosphorous (mg/dL)	ALP (IU/L)	Glucose (mmol/L)	PTH
Pre T	25.2 ± 6.6	1219.4 ± 665.1	140.4 ± 4.2	4.2 ± 0.6	2.2 ± 1.2	9.2 ± 1.1	3.8 ± 1.2	124.8 ± 8.9	5.0 ± 1.1	36.9 ± 4.5
Post T	11.3 ± 1.7	238.4 ± 56.2	139.4 ± 4.7	4.4 ± 0.6	1.9 ± 0.7	9.0 ± 1.3	3.7 ± 1.1	122.7 ± 11.4	10.1 ± 2.9	41.8 ± 3.8
p-value	**0.024**	**0.044**	0.527	0.231	0.449	0.699	0.927	0.921	**0.002**	0.094

Abbreviations: Pre T pre transplantation, *Post T* post transplantation, *BUN* blood urea nitrogen, *ALP* alkaline phosphatase, *PTH* parathyroid hormone. Paired sample *t*-test was used to compare the means among groups

Table 6 Independent predictors of complications among renal transplantation recipients: multivariable logistic regression model

Predictor	Odds ratio (OR)	95% confidence interval (CI)	*p*-value
History of DM	3.429	1.148–5.058	**0.044**
Elevated BUN pre-transplantation	2.501	1.094–4.007	**0.038**
Elevated creatinine pre-transplantation	1.901	1.025–2.806	**0.015**
Older age (years)	1.854	1.090–3.195	**0.033**
Increased WBCs pre-transplantation	1.775	1.057–3.901	**0.039**
Pre-transplantation LDL	1.051	1.009–2.441	**0.047**
Pre-transplantation PTH	0.915	0.624–0.957	**0.031**
Sex (male)	1.241	0.845–2.656	0.215

hypertension, and cold ischemic time within their model to predict postoperative complications and graft loss at 1-year post-transplantation [19]. Another metanalysis stated that recipient age, donor age, standard versus extended criteria donor, living versus deceased donor, HLA mismatch, and delayed graft function all predicted 1-year posttransplant complications [19].

Hypercholesterolemia is present in 50–60% of kidney transplant recipients. Lipid-lowering therapy decreases the risk of cardiovascular events in both primary and secondary preventions studies in a wide range of population groups. The potential benefit of lipid reduction in renal transplant recipients was demonstrated in the ALERT study (*A*ssessment of *LE*scol in *R*enal *T*ransplantation) that included 2102 renal transplant recipients. The authors stated that lipid-lowering agents could improve survival in such patients with dyslipidemia [20–22].

The main limitations of the current study included relatively small sample size, being conducted in single center with short-term duration of follow-up. A longer period of follow-up is required for both recipients and donors to allow for reporting of long-term complications. But the main points of strength in the current study was that being the first study that discussed 1-year follow-up among renal recipients in our locality and such a prognostic study can guide clinicians and patients to understand factors associated with development of complications in the first-year post-transplantation.

Conclusion

Recipients were mostly males with lower mean age, while donors were living-related females. A significant improvement in hemoglobin and electrolytes levels was reached after transplantation. Reported complications were HTN, proteinuria, surgical difficulty during transplantation, chronic rejection, and death. Predictors for post-transplantation complications were history of diabetes mellitus, pre-transplantation leucocytes, blood urea nitrogen and creatinine, older age, and elevated low-density lipoproteins.

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Authors' contributions
AA and OH suggested the research idea, AT wrote the research protocol and collected the data from participants, EA and YA supervised the data collection, EA performed the lab. investigations, and MD carried out statistical analyses, interpretation of results, wrote up first draft of manuscript, and revised and submitted the manuscript. All authors revised and agreed upon the final version of the manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Approval of the research was obtained from Ethical Review Board (IRB) of Faculty of Medicine, Assiut University. Written informed consent was obtained from all eligible patients after explanation of research objectives.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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References

1. Jain D, Haddad DB, NG, (2019) Choice of dialysis modality prior to kidney transplantation: does it matter? World J Nephrol 8(1):1–10. https://doi.org/10.5527/wjn.v8.i1.1
2. Fielding-Singh V, Vanneman MW, Grogan T et al (2022) (2022) Association between preoperative hemodialysis timing and postoperative mortality in patients with end-stage kidney disease. JAMA 328(18):1837–1848. https://doi.org/10.1001/jama.2022.19626
3. Lim LM, Lin MY, Hwang SJ, Chen HC (2021) Chiu YW (2021) Association of glomerular filtration rate slope with timely creation of vascular access

in incident hemodialysis. Sci Rep 11(1):1–12. https://doi.org/10.1038/s41598-021-92359-w
4. Rose C, Gill J (2017) Gill JS (2017) Association of kidney transplantation with survival in patients with long dialysis exposure. Clin J Am Soc Nephrol 12(12):2024–2031. https://doi.org/10.2215/CJN.06100617
5. Mayrdorfer M, Liefeldt L, Wu K et al (2021) (2021) Exploring the complexity of death-censored kidney allograft failure. J Am Soc Nephrol 32(6):1513–1526. https://doi.org/10.1681/ASN.2020081215
6. Thurlow JS, Joshi M, Yan G et al (2021) (2021) Global epidemiology of end-stage kidney disease and disparities in kidney replacement therapy. Am J Nephrol 52(2):98–107. https://doi.org/10.1159/000514550
7. Adler JT, Hyder JA, Elias N et al (2015) (2015) Socioeconomic status and ethnicity of deceased donor kidney recipients compared to their donors. Am J Transplant 15(4):1061–1067. https://doi.org/10.1111/ajt.13097
8. Godara S, Jeswani J (2019) Women donate, men receive: gender disparity among renal donors. *Saudi J Kidney Dis Transpl*. 2019;30(6):1439–1441. http://www.sjkdt.org
9. Øien CM, Reisæter AV, Leivestad T, Pfeffer P, Fauchald P (2005) Os I (2005) Gender imbalance among donors in living kidney transplantation: the Norwegian experience. Nephrol Dial Transplant 20(4):783–789. https://doi.org/10.1093/ndt/gfh696
10. Sanfey H (2005) (2005) Gender-specific issues in liver and kidney failure and transplantation: a review. J Womens Health 14(7):617–626. https://doi.org/10.1089/jwh.2005.14.617
11. Bonner K, Joshi G, Seibert R (2019) Kayler LK (2019) Association of dialysis duration with outcomes after kidney transplantation in the setting of long cold ischemia time. Transplant Direct 5(1):1–6. https://doi.org/10.1097/TXD.0000000000000855
12. Foroutan F, Friesen EL, Clark KE et al (2019) (2019) Risk factors for 1-year graft loss after kidney transplantation systematic review and meta-analysis. Clin J Am Soc Nephrol 14(11):1642–1650. https://doi.org/10.2215/CJN.05560519
13. Pillot P, Bardonnaud N, Lillaz J et al (2012) (2012) Risk factors for surgical complications after renal transplantation and impact on patient and graft survival. Transpl Proc 44(9):2803–2808. https://doi.org/10.1016/j.transproceed.2012.09.030
14. Abugharbia M, Salah A, Elhendy YA (2021) Refaie AF (2021) Prevalence and risk factors for death with graft function among Egyptian kidney transplant recipients in Mansoura. Zagazig Univ Med J. https://doi.org/10.21608/zumj.2021.55359.2074
15. Charfeddine K, Kharrat M, Yaich S, Jarraya F, Mkawar K (2002) Hachicha J (2002) Infection in kidney transplant recipients in Tunisia. Saudi J Kidney Dis Transpl 13(2):195–198
16. Lempinen M, Stenman J, Kyllönen L (2015) Salmela K (2015) Surgical complications following 1670 consecutive adult renal transplantations: a single center study. Scand J Surg 104(4):254–259. https://doi.org/10.1177/1457496914565419
17. Khedr E, El Sharkawy M, El Shahawy Y (2015) Dawlat Sany HS (2015) Proteinuria in Egyptian renal transplant recipients. Saudi J Kidney Dis Transplant 26(1):161–167
18. Isaksson E, Almquist M, Seeberger A, Sterner G (2018) Is low pre-transplant parathyroid hormone a risk marker for cardiovascular disease in long-term follow-up of renal transplant recipients? Clin Exp Nephrol 22(5):1188–1197
19. Tang H, Hurdle JF, Poynton M et al (2011) (2011) Validating prediction models of kidney transplant outcome using single center data. ASAIO J 57(3):206–212. https://doi.org/10.1097/MAT.0b013e3182121bc5
20. Holdaas H, Fellström B, Jardine AG et al (2003) ALERT trial. The Lancet 2003(361):2024–2031
21. Holdaas H, Fellström B, Cole E et al (2005) (2005) Long-term cardiac outcomes in renal transplant recipients receiving fluvastatin: the ALERT extension study. Am J Transplant 5(12):2929–2936. https://doi.org/10.1111/j.1600-6143.2005
22. Aufhauser DD, Peng AW, Murken DR et al (2018) (2015) Impact of prolonged dialysis prior to renal transplantation. Clin Transplant 32(6):e13260. https://doi.org/10.1111/ctr.1326

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