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Emrah ŞAHİN
Ender ANILIR
Adem TUNCER
Abuzer DİRİCAN
Bülent ÜNAL

Istanbul Aydin University, General Surgery and Transplantation Unit, Istanbul, Türkiye

Correspondence

Emrah ŞAHİN
Phone : +905349526940
e-mail : dr.emrahsahin@gmail.com

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ORIGINAL ARTICLE

COMPARISON OF PERIOPERATIVE OUTCOMES IN YOUNG AND GERIATRIC LIVING KIDNEY DONORS: A SINGLE-CENTER RETROSPECTIVE COHORT STUDY

Abstract

Introduction: Expanding the living kidney donor pool has increased interest in evaluating geriatric individuals (≥60 years) as potential donors. Concerns regarding age-related comorbidities and perioperative risks have historically limited the use of older donors. This study aimed to compare perioperative outcomes between geriatric and young living kidney donors.

Materials and Method: Data from donors who underwent laparoscopic living donor nephrectomy at a single tertiary center between June 2018 and December 2024 were retrospectively reviewed. Donors were divided into two groups according to age: a Geriatric Group (≥60 years, n=29) and a Young Group (≤40 years, n=100). Donors aged 41–59 years were excluded by design to maximize between-group contrast. Demographic characteristics, comorbidities, perioperative morbidity parameters, length of hospital stay, and recipient outcomes were compared. Missing BMI data (32.5%) were handled by multiple imputation using Rubin's rules.

Results: The mean age was 65.4±5.5 years in the geriatric group and 29.9±5.5 years in the young group (p<0.001). Hypertension was more prevalent among geriatric donors (31.0% vs. 1.0%; p<0.001), and surgical drains were used more frequently (58.6% vs. 23.0%; p=0.001). After multiple imputation, BMI was significantly higher in geriatric donors (28.4±5.1 vs. 25.4±5.6; p=0.029). Length of hospital stay was longer in the geriatric group (4.62±1.08 vs. 4.11±0.85 days; p=0.013). No significant differences were found in postoperative infection, bleeding, or creatinine levels. No graft loss or mortality occurred.

Conclusion: With careful selection, geriatric living kidney donors demonstrate acceptable perioperative outcomes comparable to younger donors. Chronological age alone should not be an exclusion criterion for living kidney donation.

Keywords: Kidney Transplantation; Living Donor; Aged; Nephrectomy; Perioperative Care.

INTRODUCTION

Kidney transplantation is the most effective treatment for patients with end-stage renal disease, offering a survival advantage and higher quality of life than dialysis (1, 2). However, the greatest obstacle to this "gold standard" treatment is the growing global organ shortage. Although more than 150,000 organ transplants were performed worldwide in 2022, it is far from meeting the demand (3). In Turkey, tens of thousands of patients are waiting for organ transplantation (4). This critical organ deficit extends the time spent on waiting lists, increasing the risk of morbidity and mortality for these patients (5).

One of the most important strategies for overcoming this challenge is the expansion of living donor kidney transplantation (LDKT) programs. LDKT offers significant advantages over deceased donor transplantation such as superior graft and patient survival rates, shorter cold ischemia times, and the possibility of preemptive transplantation (before starting dialysis) (6).

Historically, advanced donor age has been considered a relative contraindication for living donations because of concerns regarding age-related decline in nephron mass, increased prevalence of comorbidities, and potentially lower graft function (7). The increasing demand for organs has led to strategies to expand the donor pool to the forefront; consequently, individuals aged ≥60 years, who are among the expanded criteria donors, have emerged as a significant potential source (8). The paradigm in clinical practice is evolving from an assessment based solely on an individual's chronological age to a holistic evaluation reflecting their "biological age" and overall health status. This approach supports the idea that healthy older individuals can be safe donors (9).

Although the safety of older living kidney donors has been supported by international evidence, the majority of this evidence originates from Western transplant centers. A recent systematic review and meta-analysis by Bellini et al. (10), which analyzed 47 studies, demonstrated that while older donor age was associated with reduced graft function and higher rates of acute rejection and delayed graft function in recipients, no significant difference in 1-year recipient survival was found between recipients of donors aged <60 versus >60 years. Similarly, Yamamoto et al. (11), in a recent Japanese multicenter study of 633 living-donor kidney transplants, showed that kidneys from donors aged ≥70 years provided comparable death-censored graft survival in recipients aged ≥50 years, supporting the concept of donor–recipient age matching. However, data specifically examining perioperative outcomes in geriatric donors from Turkish transplant centers—despite Turkey's prominent role in global living-donor transplantation—remain scarce. Moreover, most comparative studies use a single age cutoff (e.g., 50 or 60 years), including the adjacent intermediate-age group, which may dilute the contrast between the youngest and oldest donors.

This study aimed to compare the basic demographic characteristics and perioperative morbidities of geriatric (≥60 years) and young (≤40 years) living kidney donors using an extreme age-group comparison design to provide a stringent assessment of whether carefully selected geriatric donors can achieve perioperative outcomes comparable to the healthiest young donors.

MATERIALS AND METHOD

Study Design and Patient Population

This single-center, retrospective cohort study included data from consecutive living donor nephrectomies performed at the Organ Transplant Center of Istanbul Aydin University Florya Medical Park Hospital between June 2018 and December 2024. This study was conducted in accordance with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The study protocol was approved by the Non-Interventional Clinical Research Ethics Committee (Approval No: 163/2025, Date: 06 August 2025).

This study was conducted in accordance with the principles of the Declaration of Helsinki.

Inclusion criteria were as follows: (1) all consecutive living kidney donors who underwent laparoscopic donor nephrectomy at our center during the study period; (2) donor age ≤40 years or ≥60 years at the time of donation; and (3) successful completion of our center's standard multidisciplinary donor evaluation protocol, which includes comprehensive medical, surgical, urological, nephrological, psychological, and anesthesiological assessments in accordance with national guidelines.

Exclusion criteria were: (1) donors aged 41–59 years, who were excluded by the a priori study design to maximize the demographic contrast between comparison groups (extreme age-group comparison design); and (2) donors who underwent open donor nephrectomy. The rationale for excluding the intermediate age group was to create two demographically distinct cohorts representing the extremes of the donor age spectrum, thereby providing a more rigorous test of whether geriatric donors can achieve perioperative outcomes comparable to the youngest, healthiest donors. This design is analogous to approaches used in other transplant studies comparing extreme age groups (11).

The living kidney donors included in the study were divided into two main groups based on their age: Group 1 (Geriatric Donors, ≥60 years, n=29) and Group 2 (Young Donors, ≤40 years, n=100).

Data Collection and Variables

Donor variables (age, sex, body mass index [BMI], smoking history, and comorbidities), donor morbidity variables (length of hospital stay, need for a drain, laxative requirement, and complications), and outcome variables (graft and patient survival) were retrospectively collected from the hospital records. Postoperative infections were defined as culture-proven urinary tract infections, surgical site infections according to Centers for Disease Control and Prevention criteria, or infections supported by clinical and radiological findings requiring antibiotic treatment.

Surgical Technique

All donor nephrectomies were performed laparoscopically using a standard transperitoneal approach. For left nephrectomies, the surgical procedure was typically performed using three trocar ports. A fourth lateral trocar was rarely added to ensure optimal graft manipulation. In right nephrectomy cases, a fourth subxiphoid trocar was routinely placed for safe retraction of the liver. In most cases, control of the renal artery and vein was achieved by transecting both vessels together with a single vascular stapler. The graft was extracted through an approximately 5–6 cm horizontal incision, similar to a Pfannenstiel incision. A closed-system drain was sometimes placed at the discretion of the surgeon.

Statistical Analysis

All statistical analyses were performed using SPSS version 28.0 (IBM Corp., Armonk, NY). Statistical significance was set at $p<0.05$. The normality of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed continuous data were compared using Student's t-test, and non-normally distributed data were compared using the Mann–Whitney U test. Pearson's chi-square test or Fisher's exact test were used to compare categorical variables.

Missing BMI data (42/129 donors; 32.5%) were handled using multiple imputation (MI) as the primary analysis. Twenty complete datasets (m=20) were generated using a regression-based imputation model that included age, sex, and group assignment as predictor variables. Each imputed dataset was analyzed independently, and the results were combined using Rubin's rules to obtain pooled point estimates and standard errors. A complete case analysis was also performed as a sensitivity analysis for comparison. A missingness pattern analysis was conducted to evaluate whether the data were Missing Completely at Random (MCAR) or Missing at Random (MAR).

RESULTS

In total, 129 living kidney donors were included in this study. The baseline characteristics of the two groups are shown in Table 1. As per the study design, the mean age of the geriatric group was 65.4±5.5 years, while the mean age of the younger group was 29.9±5.5 years (p<0.001). The prevalence of hypertension in the geriatric group (31.0%) was significantly higher than that in the younger group (1.0%) (p<0.001). Coronary artery disease was observed in 2 geriatric donors (6.9%) and none of the young donors (p=0.049). There were no statistically significant differences between groups in terms of sex or smoking status.

After multiple imputation, BMI was significantly higher in the geriatric group (28.4±5.1 kg/m²) compared with the young group (25.4±5.6 kg/m²; Rubin's pooled p=0.029). This finding was not detected in the complete case analysis (25.4±5.7 vs. 28.2±4.9; p=0.064), likely due to reduced statistical power from the 32.5% missing data rate. The missingness pattern analysis showed that the rate of missing BMI data was similar between groups (Young: 43.0% vs. Geriatric: 34.5%; p=0.544), and the mean age did not differ between donors with available and missing BMI data within either group (all p>0.05), supporting a Missing at Random (MAR) assumption.

The perioperative morbidity outcomes for the donors are summarized in Table 2. The length of hospital stay for donors in the geriatric group

Table 1. Demographic and clinical data of young and geriatric donor groups

Variable	Young Group (n=100)	Geriatric Group (n=29)	p-value
Age (years), mean±SD	29.9±5.5	65.4±5.5	<0.001[a]
Female, n (%)	59 (59.0)	18 (62.1)	0.935[b]
BMI (kg/m²), mean±SD (MI)	25.4±5.6	28.4±5.1	0.029[c]
BMI (kg/m²), mean±SD (CC)	25.4±5.7 (n=57)	28.2±4.9 (n=19)	0.064[a]
Smoking, n (%)	27 (27.0)	6 (20.7)	0.657[b]
Hypertension, n (%)	1 (1.0)	9 (31.0)	<0.001[d]
Diabetes mellitus, n (%)	0 (0.0)	1 (3.4)	0.225[d]
Coronary artery disease, n (%)	0 (0.0)	2 (6.9)	0.049[d]

SD: Standard Deviation; BMI: Body Mass Index; MI: Multiple Imputation; CC: Complete Case. a: Independent Samples t-test. b: Pearson Chi-square test. c: Rubin's pooled estimate from 20 multiply imputed datasets. d: Fisher's Exact Test. BMI complete case analysis excludes 42 donors (32.5%) with missing data.

Table 2. Perioperative outcomes and postoperative complications in donor groups

Variable	Young Group (n=100)	Geriatric Group (n=29)	p-value
Hospital stay (days), mean±SD	4.11±0.85	4.62±1.08	0.013[a]
Drain placement, n (%)	23 (23.0)	17 (58.6)	0.001[b]
Laxative requirement, n (%)	27 (27.0)	12 (41.4)	0.210[b]
Postoperative infection, n (%)	5 (5.0)	1 (3.4)	1.000[c]
Postoperative bleeding, n (%)	0 (0.0)	0 (0.0)	–
Postop max creatinine (mg/dL), mean±SD	1.26±0.31	1.28±0.23	0.522[a]
Graft loss, n (%)	0 (0.0)	0 (0.0)	–
Patient mortality, n (%)	0 (0.0)	0 (0.0)	–

SD: Standard Deviation. a: Mann–Whitney U test. b: Pearson Chi-square test. c: Fisher's Exact Test.

(4.62±1.08 d) was significantly longer than for those in the younger group (4.11±0.85 d) (Mann–Whitney U test, p=0.013). A surgical drain was placed in 58.6% of geriatric donors, whereas this rate was 23.0% in younger donors (p=0.001). No postoperative bleeding complications were observed in either group. The postoperative infection rate was low and similar between the groups (p=1.000).

During the follow-up period, no graft loss or patient death was observed in recipients from either donor group (100% graft and patient survival).

DISCUSSION

This study demonstrated that geriatric living kidney donors, despite a higher comorbidity burden, have manageable perioperative outcomes and provide excellent graft function, comparable to young donors. Our findings, consistent with the "healthy donor effect," underscore that a meticulous selection process can mitigate age-related risks, making chronological age a poor standalone criterion for exclusion.

A key strength of the present study is its extreme age-group comparison design (≥60 vs. ≤40 years), which represents a more stringent test than studies using a single age cutoff. By comparing the oldest donors directly with the youngest—rather than with donors only slightly younger than the geriatric threshold—our design amplifies any potential age-related differences. The fact that perioperative outcomes remained largely comparable despite this maximized contrast strengthens the conclusion that well-selected geriatric donors are suitable candidates. Furthermore, although the safety of older donors is supported by large-scale international evidence, including the systematic review and meta-analysis by Bellini et al. (10) encompassing 47 studies and the recent multicenter study by Yamamoto et al. (11), published data from Turkish transplant centers specifically addressing geriatric living kidney donor outcomes remain scarce, despite Turkey's prominent role in global living-donor transplantation. Our study provides real-world evidence to address this gap.

The higher use of surgical drains in our geriatric cohort likely reflects surgeon-dependent practice variation ("confounding by indication"), where surgeons proactively manage the perceived higher risk associated with age-related vascular fragility and higher rates of hypertension rather than reacting to an actual intraoperative event. This variable is inherently limited by the retrospective design, where surgeon decision-making cannot be standardized or controlled. Future prospective studies with standardized drain placement protocols would be needed to objectively assess whether geriatric donors truly require drainage more frequently.

Although the difference in length of hospital stay was statistically significant (p=0.013), the absolute difference of approximately 0.5 days (4.62 vs. 4.11 days) is unlikely to be clinically meaningful. This modest prolongation likely reflects a more conservative postoperative observation period for older patients—a rational and precautionary clinical decision—rather than an increased burden of complications. Similar findings have been reported in other studies of older donors, where slightly longer hospital stays were not associated with higher complication rates (12, 13).

The finding that geriatric donors had significantly higher BMI after multiple imputation (p=0.029) is consistent with the well-established epidemiological trend of increasing body weight with age. Notably, the meta-analysis by Bellini et al. (10) demonstrated that donor obesity increased the incidence of delayed graft function in recipients (RR=0.72, p=0.002), although it did not affect acute rejection rates. In our study, the absence of significant differences in postoperative complications between groups suggests that the moderately higher BMI in geriatric donors did not translate into adverse perioperative outcomes. The complete case analysis, which excluded 32.5% of donors, failed to detect this difference (p=0.064), underscoring the importance of appropriate handling of missing data.

Our results align with a growing body of literature supporting the safety and efficacy of using older donors (12, 13). Studies have shown that kidneys from older living donors offer a significant survival advantage over those from the deceased donor waiting list (14). Furthermore, long-term follow-up of older donors has shown stable post-nephrectomy renal function, similar to that of younger counterparts (13, 15). Direct comparison with the meta-analytic findings of Bellini et al. (10) is instructive: while their analysis found that recipients of donors aged <60 had 38% lower risk of acute rejection and 72% lower risk of delayed graft function compared to those from donors aged >60, these findings primarily reflect recipient-side graft outcomes rather than donor perioperative safety. Our study complements this evidence by demonstrating that the donor-side perioperative morbidity profile remains favorable in geriatric donors. Additionally, Yamamoto et al. (11) showed that for recipients aged ≥50 years, graft survival from donors aged ≥70 was comparable to that from younger donors (p=0.743), supporting the concept of donor–recipient age matching. This finding reinforces our conclusion that chronological age alone should not preclude donation and that age-appropriate donor–recipient pairing may optimize long-term outcomes.

The primary implication of our study is the reinforcement of a paradigm shift in donor evaluation from a rigid focus on chronological age to a holistic assessment of "physiological fitness" (16). This approach is crucial for safely expanding the donor pool to combat organ shortages.

Limitations of the Study

This study was limited by its retrospective, single-center design, which may affect the generalizability and introduce selection bias. Single-center practice patterns—particularly surgeon-dependent variables such as drain placement criteria—may not be representative of other institutions with different surgical protocols. The follow-up period was insufficient for long-term outcome analysis. The imbalance in group sizes (29 vs. 100) reflects the real-world distribution of donors and may have reduced statistical power for detecting smaller differences. The exclusion of the intermediate age group (41–59 years), while intentional for the extreme age-group comparison design, limits the generalizability of findings to the full spectrum of living kidney donor ages. The 32.5% missing BMI data represented the most significant data quality limitation. Although multiple imputation was performed as the primary analysis to address this issue, the results should still be interpreted with caution. The missingness pattern analysis supported a MAR assumption, but the possibility of data being Missing Not at Random (MNAR) cannot be entirely excluded. Furthermore, our study focused on perioperative outcomes and did not evaluate long-term recipient graft function or survival, which Bellini et al. (10) and Yamamoto et al. (11) have shown to be influenced by donor age. Future studies with longer follow-up periods are needed to address this gap.

CONCLUSIONS

When subjected to a rigorous multidisciplinary evaluation, living kidney donors aged ≥60 years are a safe and vital resource for expanding the organ pool. Chronological age should not be an absolute barrier to organ donation. Future research, ideally multicenter and prospective, should focus on refining the selection of older donor candidates and potentially integrating novel biomarkers of physiological reserve.

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