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Renal vascular variations, split renal function and donor preferences: challenge and crossroads towards right kidney choice

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Abstract

Introduction. Renal vascular variations, split renal function (SRF) and potential donor's preferences interplay with the donation decisions in living donor kidney transplantation (LDKT). This study aimed to assess the challenges in decision for choosing an appropriate kidney for donation.

Methods. Retrospective study was performed through a review of the medical history charts and national electronic database of LDKT from 2013-2022, in one transplantation center. Those with significant missing data were excluded from the final analysis. Demographic characteristics, CT angiographic findings and Tc-99m DTPA renal scan for SRF and donor preferences were analysed. The bilateral presence and number of acessory renal arteries, their hilar or polar position in respect of the renal artery, early artery branching, variations of the vein number and left vein course were assessed. Significantly different SRF was defined as ≥10%.

Results. Out of 137 consecutive LDKT, 124 donors were included in the study. The mean age of donors was 59±11 years, 40(32%) were male and 14(11%) were unrelated. There were no variations in 88(64%) renal arteries on the right and 69(56%) on the left side. The most common variation from both sides was an accessory hilar artery (15%). An accessory inferior renal polar artery was observed in 7.6% and superior in 6.4% of kidneys. Three renal arteries or three veins on one side were observed in one donor. Variation of renal arteries on both sides was 13(5.2%). Early artery branching was found in 12.9% (8%-right and 18%-left side). Two renal veins were observed in 8(3.2%) kidneys. The Nutcracker phenomenon was found in 6 (4.8%). The donated kidneys in 60% was the left one and 10% were with vascular variation. In 33(27%) of donated kidneys we found at least one vascular variation. In 41(33%) of donors SRF was significantly different and in 8(18%) the better kidney was donated due to the donor preference.

Conclusion. Variations in renal vascular anatomy and different SRF are very often in kidney donors. Donors preferences additionally interfere with the transplanttation process. The quality of the decision process relies on good institutional policy and adequate pretransplant donor evaluation.

Keywords: vascular variations, anatomy, living donor kidney transplantation, split renal function, donor preferences

Introduction

Kidney transplantation remains the best quality of life providing and cost-effective renal replacement therapy for patients with irreversible chronic kidney failure [1]. It provides more freedom for the patients and comforttable life with less time spent in the medical centers. The preparation procedure for kidney transplantation is time consuming and a lot of medical examinations are performed before the final event happens in the urological room. The living donor kidney transplantation (LDKT) is especially important for organ procurement in countries with less developed diseased donation programs [2]. It is a big challenge for any transplant team to have a variety of examination results which helps choosing an appropriate organ for transplantation.

Living donor eligibility is an important factor for the transplant procedure. The requirements are defined by guidelines [3], with some expansions of the criteria in the field of the donor's age and comorbidities, especially in countries with predominant LDKT [4]. The relationship between the donor and the recipient is also defined by local site policies, and usually it is a family member or close relative, including spouses etc. In the literature it is known that the majority of living donors

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are related to the recipient [5]. In kidney transplantation the predominance of female-to-male donations (wife to a husband) are more likely to happen, since more than 78% of organ donors are women [6]. The relationship between female donors and recipients are most likely to happen between mother and child [6].

The variations in the renal vascular structures should be known prior to any type of renal surgery, primarily before any renal transplantat surgery. The prevalence of renal vascular variations is extremely divergent in different populations and it may be due to genetic difference across the population [7,8]. Computed tomography angiography (CTA) is the gold standard method to examine vascular structures like arterial and venous variations [9]. The most common kidney vascular variation is an accessory renal artery, from which most common is hilar artery, whereas polar arteries are less common. Early bifurcation of the renal artery has been also noticed as a common variation [10]. The presence of those variations are different in males and females. It has been concluded that renal artery anomalies of the kidney vascular pedicle are significantly correlated with the coexistence of venous system variations [11]. This is especially true for male patients, which in turn favors female kidneys for transplantation. Hence, the mothers were found as most frequent donors followed by wives [6]. In one retrospective study of 58 599 donors, 86,1% of the cases were chosen for the left kidney for transplantation. One of the main reasons for this choice, mainly of the surgeon, is that the left renal vein is longer which is advantageous for transplantation and the right one is prone to thrombosis as an shorter vessel [9].

Tc-99m diethylenetriaminepentaacetic acid (DTPA) renal scan is a widely used imaging technique that evaluates renal function of potential kidney donors. Split renal function (SRF) is a determination of the relative contribution of each of the two kidneys. It gives useful information in several conditions such as evaluating unilateral renal disorders, assessing individual kidney function before and after intervention, and before live donor nephrectomy [12-14]. The decision of choosing for the donation of the lower SRF kidney is ethical, but in some cases the opposite decision is made by the donor itself.

Renal vascular variations, SRF and potential donor's preferences interplay on the donation decisions in LDKT. This study aimed to assess the challenges in decisions for choosing an appropriate kidney for donation in a single transplantation center.

Material and methods

This retrospective study was performed through a review of the medical history charts and national electronic database of LDKT from 2013-2022, in one national transplantation center. Out of 137 consecutive LDKT, 124 donors were included in the study. Those with significant missing data were excluded from the final analysis. Demographic characteristics such as age, gender, relation to the recipient, CT angiographic findings, Tc-99m DTPA renal scan for split renal function (SRF) and donor preferences were analyzed. The renal vascular anatomy radiologist reports were all revised by one transplant surgeon. The bilateral presence and number of accessory renal arteries, their hilar or polar position in respect of the renal artery, early artery branching, variations of the veins number and left vein course were assessed according to the literature [15]. An early renal artery division was defined as a main renal artery branches within 1.5 cm of the ostium of the renal artery. Significantly different SRF was defined as $\geq$10% [16,17]. Statistical analysis was performed in SPSS version 21. Descriptive statistics such as frequencies and percentages were calculated. The data on the kidney vascular variations were compared with respect to patients' sex and laterality. Chi-square test was performed for categorical data, $P<0.05$ was considered as statistically significant.

Results

The mean age of 124 donors was 59±11 years, 40 (32%) were male and 14(11%) were unrelated. There were no variations in 88(64%) renal arteries on the right and 69(56%) on the left side (Figure 1), the difference was significant for overall variations considering the left kidney (Table 1). The most common variation on both sides was an accessory hilar artery in 15% of cases. An accessory inferior renal polar artery was observed in 7.6% (Figure 2a) and superior in 6.4% of patients, being significantly more frequent on the left side. Three renal arteries and three veins on one side were observed in only one patient. Variation of renal arteries (Figure 2b) on both sides was found in 13(5.2%) kidneys. Early artery branching was found in almost 13%,

Fig. 1. Kidneys without renal vascular variations

Table 1. Renal vascular variations in donor right and left kidney

	Right N=124	Left N=124	All-248	Sig.
Any arterial variation	36(36%)	55(44%)	91(37%)	P=0.045
HAA	18(15%)	19(15.3%)	37(14.9%)	P=0.630
İnferior PAA	10(8%)	9(7.2%)	19(7.6%)	P=0.243
Superior PAA	6(4.8%)	10(8%)	16(6.4%)	P=0.033
Early branching	10(8.1%)	22(17.7%)	32(12.9%)	P=0.001
Three renal arteries	0	1(0.8%)	1(0.04%)	P=0.02
Two RV	4(3.2%)	4(3.2)	8(3.2%)	P=0.450
NP	0	6(4.8%)	6(2.4%)	P= 0.044

Abbreviations: HAA - hilar accessory artery, PAA - polar accessory artery, RV - renal vein, NP - Nutcracker phenomenon

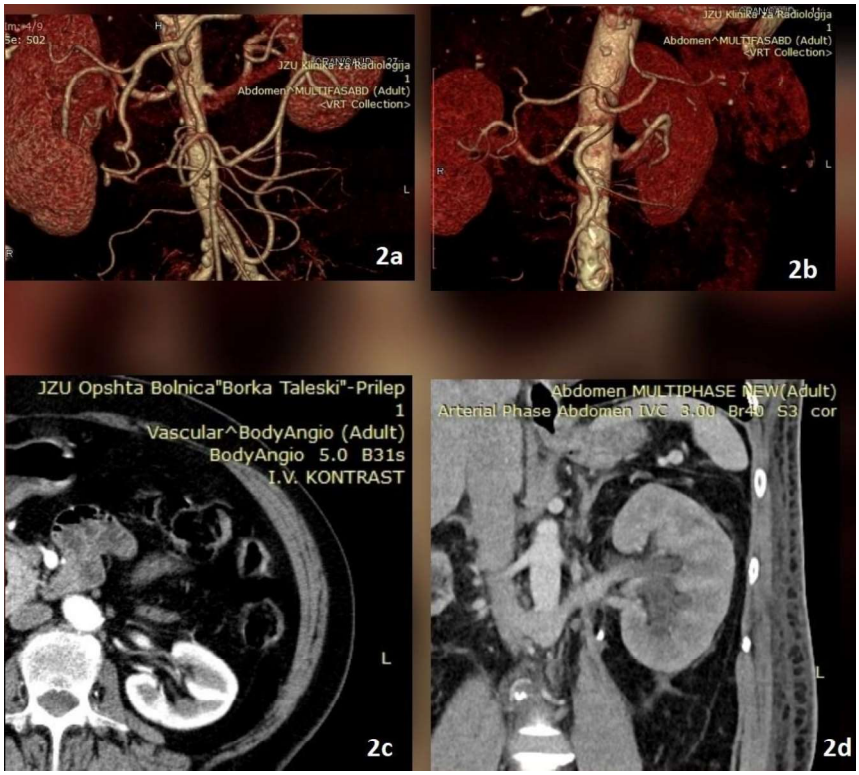

Fig. 2. Renal vascular variations: accessory polar artery, left prehilar branching - 2a; two arteries left and right - 2b; left prehilar branching - 2c; nutcracker - 2d

significantly more often on the left side (p=0.001), as shown in Figure 2c. Two renal veins were observed in 8(3%) and the Nutcracker phenomenon (Figure 2d) was found in 6(2.4%) kidneys.

There was no gender difference in vascular variations between women and men [41(49%) vs 21(52%), p= 0.234], respectively. Most of the donations were between relatives 101 (87%) and the difference between unreal ted donations between women and men was insignificant [9(11%) vs 5(12%), p=0.100], respectively. In 41(33%) of donors SRF was significantly different and 8 (18%) of those donated the better kidney because of donor's preference. The preference of the donor to donate the kidney with significantly higher SRF was more present in women than in men [7(8%) vs 1(0.02%)], p= 0.034, respectively. From the donated kidneys in 74 (60%) it was the left one and 33% of those were with vascular variations. In 33 (27%) of donor kidneys we found at least one vascular variation (Table 2).

Table 3. Vascular variations, SRF and donor preferences according to gender

N=124	Women (N=84)	Men (N=40)	Sig
any vascular variations	41(49%)	21(52%)	0.234
Unrelated donations	9(11%)	5(12%)	0.100
Preference to donate higher SRF kidney	7(8%)	1(0.02%)	0.001

Table 2. Vascular variations in donated kidney by laterality

N=124	Left N=74 (60%)	Right N= 50 (40%)
Pre-hilar branching	13 (17.5%)	4 (3.2%)
≥2 arteries	12 (16%)	8 (6.5%)

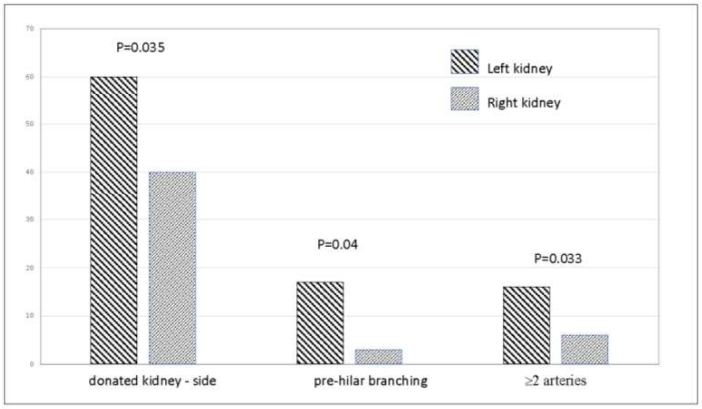

Fig. 3. Comparison of donated left or right donated kidney in respect of vascular variations

Both the perihilar branching and multiple arteries were present more often at the left side ($p<0.05$) (Figure 3).

Discussion

As result of the organ shortage, the number of LDKTs from marginal donors with age (>65 years) and comorbidities, is rising [2,18] the European Renal Registry data shows that over the last decade the mean age of donors has changed from 45 to 55 years [19]. Our analysis also found that the mean age of donors was above 55 where 43(35%) of donors were above 65 years. Female donors were predominant (68%) and that was in line with worldwide published results [20,21]. We found a lower percentage of unrelated donors (11%) compared to the previous report from ERA EDTA Registry (35%) [22]. The explanation of this discrepancy would probably be found in the traditional family bonds in our non-western families, where a broader and less rocky palette of choice (of relatives) is available for donation. Females were not only the more frequent donors but also the vast majority of those who donated the kidney with significantly higher SRF were women. We did not find such data in published studies, and it might be to a certain extend explained by the high altruistic stands of females in our milieu. Thus, female related donors donate their kidneys without concern for their own health being not aware they are committing a heroic deed. Wives donate as a form of empowerment and as a personal benefit: they donate in order to avoid taking on a carer role for their husband and as a way of protecting their children [23]. Our study did not confirm the gender discrepancy in unrelated donations which were more female as in Bal's study and in the registry data [22], so further studies are needed to explain the motives.
The relevance of the renal vascular variations might have an impact on the total surgery, cold and warm ischemia time and on graft function by many studies [24-26]. Our analysis also confirmed the presence of such anatomical variations with prevalence of any vascular variation on both sides at 37% which was similar to many published studies [27-29]. Also, the accessory hilar and polar renal arteries were found in 72 kidneys (29%) and early branching in 13% of kidneys as reported by others [28-30]. In respect of gender and side, women and left kidney were more affectted by variations in our results. The previous published reports are divergent especially depending on the population specimen (cadaveric, radiological or transplant). Still all of them emphasize the need for pretransplant evaluation of the vessel's anatomy.
As far as we know this is the first study in our transplantation center about the donor characteristics, regarding demographics, renal vascular variations and donor preference. The limitation of our study was certainly the retrospective design, involving partly missing data which might interfere with the results. Considering that female gender is generally more prone to kidney donation and left kidney is preferable for transplantation, with this analysis we strongly underline the importance of vascular donor evaluation in our transplant population.

Consclusion

Variations in renal vascular anatomy and different SRF are very often in kidney donors. Donors preferences additionally interfere with the transplantation process. The quality of the decision process relies on a reasonable institutional policy and adequate pretransplant donor evaluation.

Conflict of interest statement. None declared.

References

1. Abecassis M, Bartlett ST, Collins AJ, *et al*. Kidney Transplantation as Primary Therapy for End-Stage Renal Disease: A National Kidney Foundation/Kidney Disease Outcomes Quality Initiative (NKF/KDOQI™) Conference. *Clin J Am Soc Nephrol* 2008; 3(2): 471-480.

2. Okumi M, Unagami K, Kakuta Y, *et al*. Elderly living donor kidney transplantation allows worthwhile outcomes: the Japan Academic Consortium of Kidney Transplantation study. *Int J Urol* 2017; 24: 833-840.
3. Chadban, Steven J, Curie MD, *et al*. KDIGO Clinical Practice Guideline on the Evaluation and Management of Candidates for Kidney Transplantation. *Transplantation* 2020; 11-103.
4. Segall L, Nistor I, Pascual J, *et al*. Criteria for and Appropriateness of Renal Transplantation in Elderly Patients with End-Stage Renal Disease: A Literature Review and Position Statement on Behalf of the European Renal Association-European Dialysis and Transplant Association Descartes Working Group and European Renal Best Practice. *Transplantation* 2016; 100(10): 55-65.
5. D'Alessandro AM, Sollinger HW, Knechtle SJ, *et al*. Living related and unrelated donors for kidney transplantation. A 28-year experience. *Ann Surg* 1995; 222(3): 353-362.
6. Godara S, Jeswani J. Women donate, men receive: gender disparity among renal donors. *Saudi J Kidney Dis Transpl* 2019; 30(6):1439-1441.
7. Çınar C, Türkvatan A. Prevalence of renal vascular variations: Evaluation with MDCT angiography. *Diagn Interv Imaging* 2016; 97(9): 891-897.
8. V. Ankolekar, R. Sengupta Renal artery variations: A cadaveric study with clinical relevance. *Int J Cur Res Rev* 2013; 05: 154-161.
9. Phelan PJ, Shields W, O'Kelly P, *et al*. Left versus right deceased donor renal allograft outcome. *Transpl Int*. 2009; 22(12): 1159-1163.
10. Regmi PR, Amatya I, Kayastha P, *et al*. Normal Anatomy and Variants of Renal Vasculature with Multidetector Computed Tomography in a Tertiary Care Hospital: A Descriptive Cross-sectional Study. *JNMA J Nepal Med Assoc*. 2020; 58(231): 911-914.
11. Sosnik H, Sosnik K. Renal vascularisation anomalies in the Polish population. Coexistence of arterial and venous anomalies in the vascular pedicle of the kidney. *Folia Morphol (Warsz)* 2019; 78(2): 290-296.
12. Wang Y, Li M, Dai S, Li Y. The Role of Tc-99m DTPA Renal Dynamic Scintigraphy in Retroperitoneal Liposarcoma. *BioMed Re Intl* 2020:9765162.
13. Smith HW. Diseases of the kidney and urinary tract. In: Smith HW ed. The Kidney: Structure and Function in Health and Disease. Oxford*: Oxford University Press* 1951; 836-887.
14. Taylor AT. Radionuclides in nephrourology, Part 2: pitfalls and diagnostic applications. *J Nucl Med* 2014; 55(5): 786-798.
15. Cases C, Garcia-Zoghby L, Manzorro P, *et al*. Anatomical variations of the renal arteries: Cadaveric and radiologic study, review of the literature, and proposal of a new classification of clinical interest. *Ann Anat* 2017; 211: 61-68.
16. Miyazaki C, Harada H, Shuke N, *et al*. ^{99m}Tc-DTPA dynamic SPECT and CT volumetry for measuring split renal function in live kidney donors. *Ann Nucl Med.* 2010; 24: 189-195.
17. Lentine KL, Kasiske BL, Levey AS, *et al*. KDIGO Clinical Practice Guideline on the Evaluation and Care of Living Kidney Donors. *Transplantation* 2017; 101: 1-109.
18. Reese PP, Feldman HI, McBride MA, *et al*. Substantial variation in the acceptance of medically complex live kidney donors across US renal transplant centers. *Am J Transplant* 2008; 2062-2070.
19. Echterdiek F, Schwenger V, Döhler B, *et al*. Kidneys from Elderly Deceased Donors-Is 70 the New 60? *Front Immunol* 2019; 10: 2701.
20. Brar A, Markell M. Impact of gender and gender disparities in patients with kidney disease. *Curr Opin Nephrol Hypertens* 2019; 28(2): 178-182.
21. Piccoli GB, Alrukhaimi M, Liu ZH, *et al*. What we do and do not know about women and kidney diseases; questions unanswered and answers unquestioned: reflection on World Kidney Day and International Woman's Day. *BMC Nephrol* 2018; 19(1): 66.
22. ElHafeez Abd, Noordzij S, Kramer M, *et al*. The association of living donor source with patient and graft survival among kidney transplant recipients in the ERA-EDTA Registry - a retrospective study. *Transpl Int* 2021; 34: 76-86.
23. Rota-Musoll L, Brigidi S, Molina-Robles E, *et al.* An intersectional gender analysis in kidney transplantation: women who donate a kidney. *BMC Nephrol* 2021; 22: 59.
24. Benedetti E, Troppmann C, Gillingham K, *et al*. Short- and long-term outcomes of kidney transplants with multiple renal arteries. *Annals of Surgery* 1995; 221(4): 406-414.
25. Gupta V, Kotgiwar S, Trivedi S, *et al*. Bilateral variation in renal vasculature. *International Journal of Anatomical variations* 2010; 3: 53-55.
26. Areumu A, Igbokwe M, Olatise O, *et al*. Anatomical variations of the renal artery: a computerized tomographic angiogram study in living kidney donors at a Nigerian Kidney Transplant Center. *Afr Health Sci* 2021; 21(3): 1155-1162.
27. Gebremickael A, Afework M, Wondmagegn H, Bekele M. Renal vascular variations among kidney donors presented at the national kidney transplantation center, Addis Ababa, Ethiopia. *Trans Res in Anatomy* 2021; 25.
28. Gulas E, Wysiadecki G, Cecot T, *et al.* Accessory (multiple) renal arteries-Differences in frequency according to population, visualizing techniques and stage of morphological development. *Vascular* 2016; 24(5): 531-537.
29. Johnson PB, Cawich SO, Shah SD, *et al.* Accessory renal arteries in a Caribbean population: a computed tomography-based study. *SpringerPlus* 2013; 2(1): 1-5.
30. Natsis K, Paraskevas G, Panagouli E, *et al.* A morphometric study of multiple renal arteries in Greek population and a systematic review. *Rom J Morphol Embryol* 2014; 55(3): 1111-1122.