Surgical outcomes of renal allograft donors with complex renal vasculature. A cross-sectional retrospective study at the National Kidney Transplantation Centre, Addis Ababa, Ethiopia

Wyniki chirurgiczne u dawców przeszczepów allogenicznych nerki ze złożonym układem naczyń nerkowych. Przekrojowe badanie retrospektywne na podstawie danych z Krajowego Ośrodka Transplantacji Nerek w Addis Abebie

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Słowa kluczowe: złożone unaczynienie nerki, nefrektomia od żywego dawcy, proste unaczynienie nerki.

Abstract

Introduction: Donors with complex renal vascular anatomy are currently selected for donation as 'extended donor criterion'. Carefully selecting these donors increases the availability of kidneys, while the donor safety should be considered.
Aim of the research: The present study is aimed at evaluating the incidence of complex renal vascular anatomy in live donor nephrectomy and its implications for the immediate surgical outcome of the nephrectomy procedure among kidney donors presenting to the National Kidney Transplantation Centre, Addis Ababa, Ethiopia.
Material and methods: An institution-based cross-sectional study was performed via a retrospective review of the charts of kidney donors who had undergone donor nephrectomy at the transplantation centre between 2015 and 2020. Statistical analysis was done using the chi-square test for categorical data and the independent t test for continuous data; $p < 0.05$ was considered as statistically significant. Results are presented in text, tables, and graphs.
Results: Donors with complex renal vasculature had a significantly longer warm ischaemia time (5.48 vs. 4.83 min) and operation time (149 vs. 128 min). No significant differences were found in estimated blood loss, complication rate, reoperations, length of postoperative hospital stay, and readmission. In the present study 28.3% of donor nephrectomies had complex renal vascular anatomy. We have found no significant difference in most of the evaluated parameters that would impact a donor's outcome.
Conclusions: According to the results of this study, living donor nephrectomy from complex renal vascular donors is a safe procedure.

Streszczenie

Wprowadzenie: Dawcy o złożonej anatomii naczyń nerkowych są obecnie kwalifikowani do dawstwa narządów na podstawie tzw. definicji dawcy o rozszerzonych kryteriach (ECD). Staranny dobór tych dawców zwiększa dostępność nerek, przy czym w procesie selekcji należy także uwzględniać aspekt bezpieczeństwa dawcy.
Cel pracy: Ocena częstości występowania złożonej anatomii naczyń nerkowych w nefrektomii od żywego dawcy oraz jej wpływu na bezpośrednie wyniki chirurgiczne zabiegu nefrektomii u dawców nerki zgłaszających się do Krajowego Ośrodka Transplantacji Nerek w Addis Abebie (Etiopia).
Materiał i metody: Przeprowadzono badanie przekrojowe obejmujące retrospektywny przegląd dokumentacji medycznej dawców nerki, którzy w latach 2015–2020 zostali poddani nefrektomii w ośrodku transplantacyjnym. Przeprowadzono analizę statystyczną przy wykorzystaniu testu χ^2 dla danych kategorycznych i niezależnego testu *t* Studenta dla danych ciągłych. Jako poziom istotności statystycznej przyjęto wartość $p < 0,05$. Wyniki analizy przedstawiono w postaci tekstu, tabel i wykresów.
Wyniki: U dawców ze złożonym układem naczyń nerkowych czas ciepłego niedokrwienia (5,48 *vs* 4,83 min) i czas trwania zabiegu były istotnie dłuższe (149 *vs* 128 min). Nie stwierdzono istotnych różnic pod względem szacowanej utraty krwi, częstości powikłań, konieczności ponownej operacji, długości pooperacyjnego pobytu w szpitalu i ponownych przyjęć. Z danych objętych analizą wynika, że 28,3% nefrektomii wykonano u dawców o złożonej anatomii naczyń nerkowych. Nie wykazano istotnych różnic pod względem większości ocenianych parametrów, które mogłyby mieć wpływ na stan dawcy po pobraniu narządu.
Wnioski: Na podstawie wyników analizy należy stwierdzić, że zabieg nefrektomii u żywego dawcy ze złożonym układem naczyń nerkowych jest bezpieczny.

Introduction

Live kidney donation has been shown to improve the donor pool in this period of organ shortages; nonetheless, it is critical to make careful judgments when selecting potential live donors to ensure donor safety. A donor's kidney with a complex renal vascular anatomy is generally considered a relative contraindication for donation because of the idea that it is related with greater (surgical) complication rates [1]. However, kidneys with complex vascular anatomy are prevalent in donors (between 18% and 20%), and due to the donor shortage, the acceptance of these kidneys for donation and transplantation is expected to increase over time [2, 3].

The available literature presents contradictory results about the impact of complex renal vascular anatomy in the outcome measures of donor nephrectomy [4, 5]. Consensus regarding procurement of kidneys with complex vascular anatomy and donor outcomes is not uniformly documented amongst the transplant community. In the case of live donor nephrectomy, Fuller recently proposed 2 ideas: first, 'do not harm the donor'; and second, 'make optimal use of available living donors to overcome organ shortage. It may no longer seem acceptable to exclude otherwise suitable living donors only on the grounds of technical obstacles' [6]. In view of these comments, and because single renal vascular anatomy is still chosen in most centres, we sought to investigate the impact of renal vascular anatomy complexity on the outcome of live kidney donors.

Variation of the renal vascular anatomy has gained importance with the advent of renal transplantation because it is important in selecting the appropriate kidney (left or right) for procurement. These variations are accessory renal arteries, prehilar branching (early branching), and unusual branching of the renal artery [3]. Venous variants include multiple renal veins, late confluence of renal vein, and retroaortic and circumaortic renal veins [4].

In Ethiopia, the first kidney transplantation took place in 2015 [7]. Open donor nephrectomy is the most common method of obtaining kidneys from genetically or emotionally related donors. Given the growing number of kidney transplant surgeries performed in the country, it is now more vital than ever to understand renal vascular anatomy and how it affects donor outcomes.

Aim of the research

Hence, the present study was aimed at evaluating the incidence of complex renal vascular anatomy in live donor nephrectomy and its implications in the immediate surgical outcome measures of the nephrectomy procedure at the national kidney transplantation centre of St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia.

Material and methods

The present study was conducted at the national kidney transplantation centre in St. Paul's Hospital Millennium Medical College (SPHMMC), located at Addis Ababa, Ethiopia. From September 2015 to April 2020, the data of all live kidney donors (n = 142) were collected and retrospectively reviewed. The records of 22 subjects were excluded from this study due to the lack of a significant proportion of the relevant information required for this study. In all, this study was carried out on a total of 120 kidney donors. In all our donors, renal vascular imaging was performed as part of standard preoperative screening by using computed tomography angiography (CTA).

A radiologist and a transplant surgeon both evaluated the images preoperatively and recorded their data. They discussed difficult cases if necessary. A research fellow attended all procedures to record the data, including arterial and venous anatomy, warm ischaemia time, time until kidney extraction, operation time, and intra-operative blood loss.

Results of the preoperative imaging and intraoperative findings during live donor nephrectomy were correlated to several intraoperative and postoperative (surgical) outcome measures (warm ischaemia time (WIT), estimated blood loss, operation time, complications, re-operations, length of stay, re-admission). Donor complications were classified according to the Clavien-Dindo classification [8]. To ensure the data quality, the data collection tool was prepared after intensive review of relevant literatures and similar studies.

Operational definitions

Warm ischaemic time: defined as the time from clamping until allograft perfusion with cold perfusate.

Estimated blood loss: the amount of blood lost during intraoperative stay recorded on the intraoperative note, measured in millilitres.

Operation time: operative time measured from the first incision to the last skin suture.

Simple renal vasculature: renal allografts with single, hilar renal arteries and single vein.

Complex renal vasculature: renal allografts with accessory renal artery, early branching renal artery, accessory renal veins, late confluence of renal vein, retroaortic left renal vein, and circumaortic left renal vein.

Length of hospital stay: cCounted from postoperative day one to the day of discharge.

Ethical statement

This study was carried out after obtaining ethical approval from Arba Minch University, College of Medicine, and Health Sciences Institutional Research

Ethics Review Board (Ref.no: IRB/552/12; Issue date: 26/11/2020). No personal identifiers were used in the study. All kidney donors provided informed consent in accordance with the Declaration of Istanbul. This study was conducted per the Declaration of Helsinki.

Statistical analysis

All the collected data were coded, cleaned, and entered into Epi-data version 4.4 and exported to SPSS version 25 for analysis. Descriptive statistics such as frequencies and percentages were calculated. All renal donors were categorized into 2 groups based on the renal vascular anatomy (simple vs. complex), and the data were compared with respect to patient demographics, operative characteristics, postoperative course, and complications. Statistical analysis was done using the χ^2 test for categorical data and the independent t test for continuous data; $p < 0.05$ was considered as statistically significant. Results were presented using tables, graphs, and text.

Results

Socio-demographic characteristics of kidney donors

Since the commencement of renal transplantation in Ethiopia in September 2015, 142 patients underwent donor nephrectomy, and an equal number of patients underwent renal transplantation. All donors underwent preoperative CT angiogram for assessment of renal vascular anatomy. Hand-assisted laparoscopic donor nephrectomy (HALDN) was performed for 38 (31.6%) donors, and open donor nephrectomy was performed for 82 (67.5%) donors. The donors age ranged from 20 to 62 years with a mean age of 34.88 ±11.47 years. Most of the donors were in the age range 20–30 years (50.8%) and more than half were married (59.2%). Regarding educational status and occupation, most had complete college/university education (45%) and were self-employed (55%). In total, 104 (87.5%) of the donors were blood related family members, and the remaining (12.5%) donors were spouses (Table 1).

Table 1. Socio-demographic characteristics of kidney donors and recipients at SPHMMC, Addis Ababa, 2021

Variables	Donors		
	Categories	Frequency (n = 120)	Percentage (%)
Sex	Male	61	50.8
	Female	59	49.2
Age	Mean	34.88	
	< 20	0	0
	20-30	61	50.8
	31-40	23	19.2
	41-50	19	15.8
	>51	17	14.2
Marital status	Unmarried	49	40.8
	Married	71	59.2
Educational status	No formal education	15	12.5
	Primary education	12	10
	Secondary education	39	32.5
	College and above	54	45
Occupation	Government employee	36	30
	Self employed	46	38.3
	Unemployed	18	15
	Student	20	16.6
Residence	Rural	44	36.7
	Urban	76	63.3
Relationship	Blood related	105	87.5
	Spouse	15	12.5

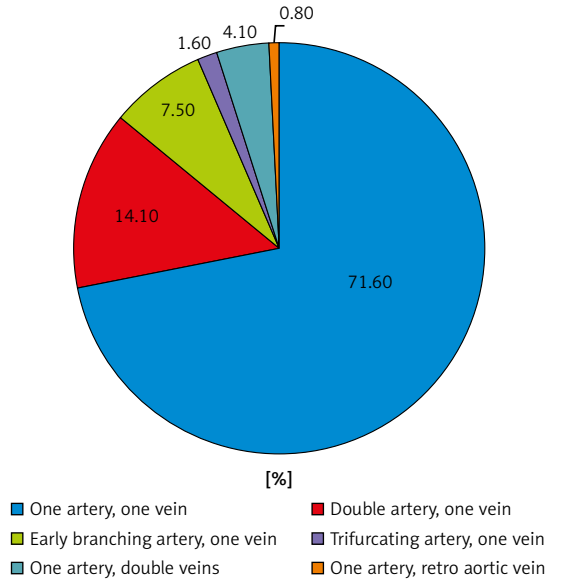

Figure 1. Renal vascular anatomy of the donated kidney (graft)

Donors' baseline characteristics

Regarding the donor baseline characteristics, in all (100%) of the donors the left kidney was chosen for donation. Of the 120 donors, 86 (71.6%) had simple vascular anatomy of the kidney (single artery and vein), and the other 34 (28.3%) had complex vascular anatomy. Among the 34 donors with complex vascular anatomy, 17 (14.1%) had multiple renal arteries with single vein, 9 (7.5%) had early branching renal artery with single vein, 2 (1.6%) had kidneys with unusually branched artery with single vein, 5 (4.1%) had kidneys with double renal veins with single artery, and 1 (0.8%) patient received a kidney with retro-aortic renal vein with single artery (Figure 1).

No significant differences in age, sex, body mass index (BMI), kidney size, and preoperative serum creatinine levels were observed between donors with simple versus complex renal vascular anatomy (Table 2).

Outcomes of donor nephrectomy

Donors with complex renal vasculature had a significantly longer warm ischaemia time ((WIT) 4.83 vs. 5.48 min, $p < 0.001$) and operation time (128 vs. 149 min, $p = 0.019$) compared with donors with a simple vascular anatomy. No significant differences were found in estimated blood loss, postoperative complication rate, reoperations, length of postoperative hospital stay, and readmission (Table 3).

Overall complications occurred as stated in Table 4 when scored according to the Clavien-Dindo classification.

Table 2. Baseline characteristics of living kidney donors

Variables	Simple vascular anatomy (n = 86)	Complex vascular anatomy (n = 34)	Total (n = 120)	P-value
Sex:				
Male	42 (48.8)	19 (55.9)	61 (50.8)	
Female	44 (51.2)	15 (44.1)	59 (49.2)	0.487
Donor age [years] (mean ± SD)	35.08 ±11.3	34.38 ±12.08	34.88 ±11.4	0.765
Donors' BMI (mean ± SD)	22.89 ±2.71	23.62 ±3.41	23.0 ±2.9	0.221
Kidney length	10.60 ±0.60	10.52 ±0.69	10.5 ±0.63	0.542
Kidney width	4.08 ±0.37	4.09 ±0.30	4.08 ±0.35	0.925
Cortical thickness	1.13 ±0.11	1.12 ±0.11	1.13 ±0.14	0.760
Preoperative Cr [mg/dl] (mean ± SD)	0.86 ±0.06	0.88 ±0.06	0.87 ±0.06	0.146

Table 3. Intra- and postoperative outcome for donors with simple and complex renal vascular anatomy at SPHMMC, Addis Ababa, 2021

Variables	Simple vascular anatomy (n = 86)	Complex vascular anatomy (n = 34)	Total (n = 120)	Total (n = 120)
Warm ischaemia time [min] (mean ± SD)	4.83 ±0.34	5.48 ±0.58	5.01 ±0.5	< 0.001*
Operative time [min] (mean ± SD)	128.37 ±23.8	149.26 ±47.4	134.3 ±33.4	0.019*
EBL [ml] (mean ± SD)	139.44 ±25.0	146.68 ±29.4	141.6 ±26.6	0.180
LOS [days] (mean ± SD)	7.20 ±1.4	7.8 ±2.1	7.5 ±2.8	0.071
Complication rate (total number of Clavien-Dindo classification)	6 (6.9)	5 (14.7)	11 (9.1)	0.186
30-Day re-admission, n (%)	3 (3.5)	2 (5.8)	5 (4.1)	0.599
Re-operation, n (%)	1 (2.3)	0	1 (1.6)	0.5223

**Statistically significant.*

Table 4. Donors' complication rates according to the Clavien-Dindo classification

Grade	Total *N* (%)	Simple vascular anatomy *n* (9%)	Complex vascular anatomy *n* (%)
No complications	109 (90.8)	80 (93)	29 (85.3)
Grade I	7 (5.8)	3 (3.5)	4 (11.7)
Grade II	3 (2.5)	2 (2.3)	1 (2.9)
Grade IIIa	1 (0.8)	1 (1.2)	0

Discussion

Kidney transplantation is the most effective method for the treatment of end-stage renal disease. The 5-year survival rate of kidney transplantation is more than twice that of dialysis, regardless of whether the donor is alive or deceased, and dialysis is three times more expensive [9]. Every day, more kidney transplants are performed around the world as a result of the increased survival and quality of life they provide. Because the quality of the graft organ determines the success of organ transplantation, preoperative radiological evaluation of living donors is critical. This requires accurate visualization of the renal anatomy, collecting system, and renovascular structures in the potential donor [9].

Complex renovascular structures, in particular, may have consequences that directly affect surgical outcome. Complex renal vascular anatomy is a common clinical problem that poses a unique challenge in donor nephrectomy. It is critical for the kidney procurement team to consider significant vascular anatomical variations during organ harvest. Because living donor nephrectomy is performed on healthy people, the surgical technique used to obtain the kidney is critical [10].

In the present study 120 donors underwent donor nephrectomy. In 34 out of 120 donors (28.3%), complex renal vascular anatomy was present in side of nephrectomy. Left-sided donor nephrectomy was performed for all donors (100%) in the transplant centre. The practice of selecting left-sided grafts is not uncommon and has been mentioned in several studies [11–14]. A study conducted in Turkey showed that nephrectomy was performed on the left side in 90.6% (n = 1942) and on the right side in 9.4% (n = 202) of the donors. According to CTA findings, 81.1% (n = 1738) had a single renal artery, 17.2% (n = 369) had double renal arteries, 1.6% (n = 35) had triple renal arteries, and 0.1% (n = 2) had quadruple renal arteries [10]. Moreover, most meta-analyses today show that only 20–30% of laparoscopic donor nephrectomies (LDN) are right sided, and there are still high-volume centres that do not to perform right-sided laparoscopic donor nephrectomy (RLDNs) at all [11]. The preference of left-sided nephrectomies is due to the longer left renal vein, which makes vascular anastomosis technically easier and has also been shown to decrease operating time [15].

Regarding the outcome of donor nephrectomy, warm ischaemia time (WIT) and operation time were significantly longer in donors with complex renal vascular anatomy. Similar findings were reported by Lafranca *et al.* [16], Desai *et al.* [17], and Paragi *et al.* [4]. In a study that compared the impact of complex renal vasculature between open donor nephrectomy (ODN) with laparoscopic donor nephrectomy (LDN), in ODN, warm ischaemia time was significantly shorter in the single-artery group. Other parameters did not significantly differ between single artery and multiple arteries. However, in LDN multiple arteries resulted in significantly longer warm ischaemia and operation times and increased blood loss [18].

In the present study, we found no significant difference in parameters that would impact a donor's outcome, such as intraoperative estimated blood loss, postoperative complication rates, length of hospital stay, reoperation, or need for readmission based on the renal vascular anatomy. Similar to our findings, Hsu *et al.* [5] and Carter *et al.* [1] reported that renal artery anatomy did not have a significant association with intraoperative blood loss, length of hospital stay, or complication rate in the donors. Although Lafranca *et al.* reported higher postoperative overall complication rates in donors with venous multiplicity, the significance of the complication rate disappeared when Clavien-Dindo grade I complications (predominantly infections, haematoma formation at the incision site [opened at the bedside], and urinary retention not requiring insertion of a urinary catheter) were removed [16].

Conclusions

In the present study 28.3% of donor nephrectomies had complex renal vascular anatomy. Warm ischaemia time and operation time were significantly longer in donors with complex renal vascular anatomy. However, we found no significant difference in parameters that would impact a donor's outcome, such as intraoperative estimated blood loss, postoperative complication rates, length of hospital stay, reoperation, or need for readmission, among kidney donors who presented at the national kidney transplant centre, Addis Ababa, Ethiopia. Living donor nephrectomy from complex renal vascular donors is a safe procedure. For extended criteria donors (i.e. donors with complex renal vasculature), a specific informed

consent procedure should be drafted in which these donors are informed of the latest data (risks and complications) and knowledge.

Conflict of interest

The authors declare no conflict of interest.

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