Original Research / Özgün Araştırma

Comparison of intraoperative hemodynamic parameters of recipients in adult living donor and deceased donor kidney transplantations

Erişkin canlı donör ve kadavra donör böbrek nakillerinde alıcıların intraoperatif hemodinamik parametrelerinin karşılaştırılması

Tumay Uludag Yanaral [1], Pelin Karaaslan [1]

1 Department of Anesthesiology and Reanimation, Faculty of Medicine, Istanbul Medipol University, Istanbul, Turkey

Submitted: *2020-12-30*

Accepted: *2021-01-23*

Correspondence

Tümay Uludağ Yanaral

Medipol Mega Hospital, Goztepe Mah. Metin Sok. No: 4 34214 Bagcilar, Istanbul, Turkey

e-mail: uludagt@yahoo.com

T: +90 505 242 21 00

F: +90 212 460 70 70

ORCID

T.U.Y. 0000-0003-3917-8183

P.K. 0000-0002-5273-1871

Özet

Amaç: Böbrek nakli anestezisi ile ilgili çok sayıda çalışma yapılmıştır ancak verici tipine göre intraoperatif parametreler açısından literatürde yeterli veri bulunmamaktadır. Bu çalışmada canlı donör ve kadavra donör böbrek nakli (BN) yapılan erişkin hastalarda intraoperatif hemodinamik parametreleri karşılaştırmayı amaçladık.

Gereç ve Yöntemler: BN yapılan hastalar verici böbrek tipine göre 2 gruba ayrıldı. Kadavra donör nakli yapılan alıcılar Grup 1 olarak çalışmaya dahil edildi. Canlı verici böbrek nakli yapılanlar arasında, Grup 1 ile benzer demografik verilere sahip aynı sayıda alıcı belirlendi ve Grup 2'ye dahil edildi. Her iki grup kaydedilen veriler ve intraoperatif hemodinamik parametreler açısından karşılaştırıldı.

Bulgular: Çalışmaya 24 hasta dahil edildi. Ortalama diyaliz süreleri Grup 1 ve Grup 2 için sırasıyla 81,6 ± 64,8 ve 16,8 ± 17,4 aydı (p = 0,001). Ortalama soğuk iskemi süresi Grup 1›de Grup 2›den anlamlı olarak daha uzundu (p = 0,001). Grup 1 ve Grup 2 için operatif ortalama idrar çıkışı sırasıyla 87.3 ± 149.6 ve 634.2 ± 534.5 idi (p = 0.002). Her iki grup ortalama arter basıncı, kalp hızı, periferik oksijen satürasyonu ve CVP değerleri açısından benzerdi.

Sonuç: Canlı donör nakline göre kadavra donör nakillerinde soğuk iskemi süresi daha uzundur ve operatif idrar hacmi daha düşüktür. İyi bir

Abstract

Objective: There are many studies on kidney transplant anesthesia, there is not enough data in the literature in terms of intraoperative parameters according to the donor type. In this study, we aimed to compare the intraoperative hemodynamic parameters in adult patients who underwent living-donor and deceased-donor kidney transplantation (KT).

Material and Methods: The patients who underwent KT were divided into 2 groups according to the donor kidney type. Recipients who underwent deceased donor transplantation were included in the study as Group 1. Among the living donor kidney transplant recipients, the same number of patients with similar demographic data as Group 1 were designated as Group 2. Both groups were compared in terms of recorded data and intraoperative hemodynamic parameters.

Results: Twenty-four patients were included in the study. The mean durations of dialysis were 81.6 ± 64.8 and 16.8 ± 17.4 months for Group 1 and Group 2, respectively (p = 0.001). The mean cold ischemia time was significantly longer in Group 1 than Group 2 (p = 0.001). The mean operative urine output for Group 1 and Group 2 were 87.3 ± 149.6 and 634.2 ± 534.5, respectively (p = 0.002). Mean arterial pressure, heart rate, peripheral oxygen saturation and CVP values were all comparable between the two groups.

The study was approved by the Ethic Committee of Istanbul Medipol University (Approval Number: 974. 24 Dec, 2020). All research was performed in accordance with relevant guidelines/regulations, and informed consent was obtained from all participants.

preoperatif hazırlık, yakın intraoperatif takip ve uygun sıvı yönetimi ile her iki tip donör alıcıda da benzer intraoperatif hemodinamik parametreler elde edilir.

Anahtar Kelimeler: Anestezi, böbrek transplantasyonu, canlı vericiler, hemodinamik takip, kadavra

Conclusion: Cold ischemia time is longer and operative urine volume is lower in deceased donor transplants compared to living donor transplants. With good preoperative preparation, close intraoperative follow-up, and proper fluid management, similar intraoperative hemodynamic parameters are achieved in both types of donor recipients.

Keywords: Anesthesia, cadaver, hemodynamic monitoring, kidney transplantation, living donors

INTRODUCTION

Kidney transplantation (KT) is the optimal treatment option in end stage renal disease (ESRD) and is the most commonly performed organ transplantation. KT is associated with better quality of life and cost-benefit ratio and possibly longer survival compared to dialysis (1). When a kidney transplant is planned, the most important issue is to find a suitable donated kidney from a living or deceased donor.

Living donor KT is an elective surgical procedure. The recipients are evaluated in detail in an outpatient clinic before surgery, and the optimal condition of the patient is provided by a multidisciplinary team including nephrology. Unlike living donor KT, the transplant of a deceased donor kidney is a relatively urgent procedure due to the limited viability of the donated kidney. Although patients on the donor waiting list are always medically prepared for transplant, recipients from a deceased donor may have some anesthetic difficulties compared to recipients from a living donor. The relatively longer ischemia time of deceased donor kidneys than living donor kidneys may also contribute to intraoperative difficulties.

Although there are many studies on kidney transplant anesthesia, there is not enough data in the literature in terms of intraoperative parameters according to the donor type. In this study, we aimed to compare the intraoperative hemodynamic parameters in adult patients who underwent living donor and deceased donor KT.

MATERIAL AND METHODS

After obtaining approval from the local ethics committee (Approval number: 2020/974), the charts of patients who underwent KT between February 2014 and December 2020, in our hospital, were retrospectively analyzed. The patients' data were collected from the electronic medical record system and anesthesia forms. Patients' preoperative demographics, ESRD related data and anesthesia and surgery related parameters were recorded. Patients ≥18 years of age were included in the study. Patients <18 years of age and patients with incomplete data were excluded from study. The patients were divided into 2 groups according to the donor kidney type. Recipients who underwent deceased donor transplantation were included in the study as Group 1. Among the living donor kidney transplant recipients, the same number of patients with similar demographic data as Group 1 were designated as Group 2. Both groups were compared in terms of recorded data and intraoperative hemodynamic parameters.

Anesthesia Technique

All of the anesthesia procedures were performed by two anesthesiologists specialized in transplant anesthesia. General anesthesia was employed for all KT surgeries. General anesthesia was induced with IV propofol (1.5-3 mg/kg). During induction we also administered fentanyl (1-2 mcg/kg), lidocaine (1 mg/kg) and atracurium (0.5 mg/kg). We applied volume expansion with IV crystalloid solution before the administration of anesthetic induction agents to patients with hypovolemia. A central venous catheter was placed for central venous pressure (CVP) measurement, drug infusion, fluid management, and mixed venous oxygen saturation monitoring. We employed sevoflurane (2-3%) as an inhalation agent to maintain anesthesia. For the maintenance of analgesia remifentanil (0.25 mcg/kg/min) was infused. Atracurium (0.1

mg/kg) was performed as a neuromuscular blocker in order to prevent patient movement. In fluid management, the goal was to expand intraoperative volume immediately after reperfusion to increase renal blood flow and improve allograft function. We monitored CVP for fluid requirements with a CVP target of 10-15 cmH2O and applied crystalloid solutions if required. If possible, perioperative blood transfusion was avoided. Direct intraarterial blood pressure measurement was used for early detection and treatment of hypotension or hypertension. Once the vascular anastomoses were completed, we carefully maintain adequate blood pressure. During renal reperfusion hypotension was prevented, and steroid and furosemide (to promote diuresis) were administered. After the surgery, all patients were transferred to the intensive care unit (ICU) for close follow-up.

Statistical Analysis

For the analysis of quantitative data, the normal distribution suitability was examined by the Shapiro-Wilk test. Independent t-test and Mann-Whitney U test were used to compare independent groups. Chi-square and Fisher's exact tests were used to compare categorical data. Quantitative data are expressed as mean ± standard values in the tables. Categorical data was expressed as n (frequency) and percentage (%). The data were analyzed at a 95% confidence level and considered significant when the p value was less than 0.05.

RESULTS

Twenty-four patients (Group 1= 12 patients and Group 2= 12 patients) were included in the study. Recipients age, donor age, gender, weight, height, body mass index, and American Society of Anesthesiologists physical status classification score were comparable between the two groups (p = 0.132, p = 0.114, p = 0.102, p = 0.349, p = 0.072, p = 0.955, and p = 1, respectively). The mean durations of dialysis were 81.6 ± 64.8 and 16.8 ± 17.4 months for Group 1 and Group 2, respectively (p = 0.001) (Table 1).

Duration of anesthesia, duration of surgery and warm ischemia time were similar between the groups (p = 0.281, p = 0.625 and p = 0.151, respectively). The mean cold ischemia time was significantly longer in Group 1 than Group 2 (700.0 ± 192.2 and 56.0 ± 10.8, respectively, p = 0.001). Groups were comparable by the means of IV fluid volume and blood loss. However, there was a significant difference in urine output between the groups. The mean urine output for Group 1 and Group 2 were 87.3 ± 149.6 and 634.2 ± 534.5, respectively (p = 0.002). Erythrocyte suspension transfusion, length of stay in ICU and hospital were also similar between groups (Table 2).

The comparison of intraoperative hemodynamic parameters is shown in Table 3. Mean arterial pressure, heart rate, peripheral oxygen saturation (SpO2) and CVP values were all comparable between the two groups. All these parameters did not differ between the groups at the induction, at the 60th minutes of anesthesia and at the extubation.

Table 1. Demographic and clinical characteristics of the patients

	Total (n = 24)	Deceased Donor Transplant (n = 12)	Living donor transplant (n = 12)	p value
Recipient age (years)*	45.0 ± 10.1	48.1 ± 7.4	41.8 ± 11.7	0.132
Donor age (years)*	47.7 ± 15.9	55.9 ± 16.6	42.6 ± 14.0	0.114
Gender (Male/Female)	12/12	4/8	8/4	0.102
Weight (kg)*	74.2 ± 17.7	70.7 ± 11.2	77.7 ± 22.4	0.349
Height (cm)*	167.4 ± 7.7	164.6 ± 6.3	170.2 ± 8.3	0.072
BMI (kg/m2)*	26.1 ± 5.1	26.2 ± 3.5	26.1 ± 6.6	0.955
ASA score	3	3	3	1.000
Duration of dialysis (months)*	49.2 ± 56.9	81.6 ± 64.8	16.8 ± 17.4	0.001

**: mean ± standart deviation. BMI, body mass index, ASA, American Society of Anesthesiologists physical status classification.*

Table 2. Comparison of anesthesia and surgery related data

	Deceased Donor Transplant (n = 12)	Living donor transplant (n = 12)	p value
Duration of anesthesia (minutes)*	188.1 ± 44.8	205.0 ± 27.6	0.281
Duration of surgery (minutes)*	149.2 ± 37.2	155.4 ± 21.6	0.625
Warm ischemia time (minutes)*	36.8 ± 16.6	28.9 ± 7.0	0.151
Cold ischemia time (minutes)*	700.0 ± 192.2	56.0 ± 10.8	0.001
Volume of IV fluid (ml)*	3290.9 ± 615.5	3925.0 ± 1065.3	0.235
Blood loss (ml)*	245.4 ± 117.1	208.3 ± 87.5	0.413
Urine output (ml)*	87.3 ± 149.6	634.2 ± 534.5	0.002
Erythrocyte suspension transfusion, n (%)	2 (16.7%)	2 (16.7%)	1.000
Erythrocyte suspension transfusion (unit)*	0.3 ± 0.6	0.2 ± 0.4	0.928
Length of stay in ICU (days)*	1.0	1.2 ± 0.6	0.755
Length of stay in hospital (days)*	8.9 ± 3.9	8.2 ± 2.3	0.618

*: mean ± standart deviation. ICU, intensive care unit.

Table 3. Comparison of intraoperative hemodynamic parameters

	Deceased Donor Transplant (n = 12)	Living donor transplant (n = 12)	p value
Mean arterial pressure (mmHg)*			
at the induction	107.2 ± 13.4	104.2 ± 14.9	0.610
at the 60th minutes of anesthesia	87.1 ± 12.2	87.1 ± 8.7	0.999
at the extubation	104.6 ± 10.4	101.4 ± 12.2	0.505
Heart Rate (bpm)*			
at the induction	81.8 ± 9.7	79.6 ± 3.3	0.518
at the 60th minutes of anesthesia	72.4 ± 6.0	74.5 ± 7.4	0.477
at the extubation	83.6 ± 10.0	84.8 ± 6.7	0.719
SpO2 (%)*			
at the induction	98.9 ± 1.1	98.9 ± 1.4	0.932
at the 60th minutes of anesthesia	99.7 ± 0.7	99.9 ± 0.3	0.695
at the extubation	99.7 ± 0.6	99.8 ± 0.4	0.928
CVP (cmH2O)*			
at the induction	8.4 ± 3.6	8.2 ± 3.3	0.938
at the 60th minutes of anesthesia	10.3 ± 3.2	11.2 ± 1.8	0.545
at the extubation	11.4 ± 3.4	10.6 ± 2.7	0.297

**: mean ± standart deviation. bpm, beats per minutes, SpO2, peripheral oxygen saturation, CVP, central venous pressure.*

DISCUSSION

There are big differences in donor type of KT between countries. Most kidney transplants in Western countries are from deceased donors. However, more kidneys are donated by living donors in Eastern countries. Recently, organ shortages from deceased donors have become a factor in the increasing use of living kidney donors even in Western countries (2). Therefore, pretransplant duration of dialysis also varies between countries. While some studies reported that long-term dialysis negatively affects the results of KT, others showed that there is no difference in terms of graft or patient survival with the length of dialysis treatment (3,4). Studies from the USA have shown that KT performed after a long dialysis period was associated with a higher risk of graft failure and death compared to preemptive KT (5). Conversely most of the research reported from Europe did not find any difference in graft survival between Preemptive KT and non-preemptive KT (6,7).

Due to the limited number of deceased donors, if a suitable living donor is available, most of the patients are transplanted from living donors in our institution. In this study with match analysis, patients transplant from a deceased donor had a longer preoperative dialysis duration than a living donor transplants ($p = 0.001$). The mean durations of dialysis of deceased donor transplant and living donor transplant patients were 81.6 and 16.8 months, respectively. Our durations were shorter than a study conducted in Japan. Kohei et al. reported the average dialysis time of living kidney transplant recipients as 4.41 years, and the average waiting time for a deceased donor KT as 15.4 years (3).

KT is a high-risk surgery and patients should be carefully monitored throughout the entire anesthesia period. General anesthesia is the mostly preferred technique for KT; however, many studies have shown that regional anesthesia can be used successfully and provides better analgesia after surgery (8). In the present study, the anesthesia technique was similar between deceased donor and living donor KT. Anesthesia and surgery time did not differ between the groups. There is a lack of data in the literature regarding these durations and they should be supported by further studies.

After donor nephrectomy, kidneys are stored in cold solution to preserve the viability of its cells. Prolonged ischemia time is associated with increased risk of delayed graft function and graft failure. Delayed graft function occurred in 13.5% of recipients with a total ischemic time of 14 hours or longer (9). In the literature, cold ischemia times have been reported as 8.3-10.6 hours in different studies (10). In this study, warm ischemia time was comparable between the groups, but as expected, cold ischemia time was longer in deceased donor transplant patients ($p = 0.001$). The cold ischemia time in Group 1 was 700 minutes and was consistent with the reported results. In the anesthesia management, patients with a long cold ischemia time should be carefully monitored in fluid treatment and adequate fluid replacement should be done to these patients.

There is a relationship between the length of the ischemic period and the decrease in creatinine level and the amount of urine. Immediate diuresis occurs in 90% of living donor transplants and 40-70% of deceased transplants ($p < 0.05$) (11). Early and proper diuresis should be achieved to improve graft viability (12). In our study, operative urine output of living donor transplants (634 ml) was statistically higher than those of deceased donors (87 ml) ($p = 0.002$). It should be known that intraoperative urine output will be higher in transplants from a living donor and fluid replacement should be arranged accordingly. Loop diuretics and mannitol can be used to increase diuresis. We prefer furosemide for this purpose prior to vascular clamp release.

As concluded by Ricaurte et al., intraoperative maintenance of proper hydration (infusion of 60-90 mL/kg isotonic fluids) increases flow and renal perfusion, which ensures early functionality of the graft and supports early diuresis (13). Therefore, the CVP should be between 10-15 cmH2O. If renal perfusion is delayed, graft survival has been reported to decrease by 20-40% (14). In the present study, there was no difference in CVP values between the two groups. Although the patient's surgery started with CVP values of <10 cmH2O, which were thought to be due to preoperative dialysis, the targeted mean CVP values were reached (>10 cmH2O) at the 60th minute of surgery and extubation.

Strict vital signs monitoring is the critical point in transplant anesthesia. Following unclamping the vessels and reperfusion of the graft hypotension may occur. This may result in delay and failure in renal function. Intraoperative mean arterial pressure should ideally be 60-70 mmHg, and hypotension should be managed with IV fluids and preferably short-acting medications (13). Furthermore, oxygen saturation should be kept above 90%. In our cohort, no difference was observed between the groups in intraoperative mean arterial pressure, heart rate and SpO2 values. We found that donor kidney type has no effect on these values. In our opinion, the recipient should be well hydrated and oxygenated to be hemodynamically stable and to ensure adequate renal perfusion.

The retrospective nature of the study with a relatively small patient volume and not evaluating the complications can be considered as the limitations of the study.

CONCLUSION

Deceased donor transplantations are often scheduled as emergency surgery. However, there is often enough time to prepare the recipient and perform dialysis if necessary. Preoperative dialysis improves the electrolyte imbalances and maintains the optimum fluid volume levels. Thus, similar intraoperative hemodynamic data to living donors can be obtained from deceased donor recipients. In conclusion, cold ischemia time is longer and operative urine volume is lower in deceased donor transplants compared to living donor transplants. With good preoperative preparation, close intraoperative follow-up, and proper fluid management, similar intraoperative hemodynamic parameters are achieved in both types of donor recipients.

Conflict of Interest

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Ethical Approval

This study was approved by the ethics committee of the Istanbul Medipol University (Approval Number: 974. 24 Dec, 2020), and written informed consent was obtained from the patients.

REFERENCES

1. Aulakh NK, Garg K, Bose A, et al. Influence of hemodynamics and intra-operative hydration on biochemical outcome of renal transplant recipients. J Anaesthesiol Clin Pharmacol 2015; 31:174-179.
2. Kim SJ, Lee HH, Lee DS, et al. Prognostic factors affecting graft and patient survival in cadaveric and living kidney transplantation. Transplant Proc 2004; 36:2038-2039.
3. Kohei N, Sawada Y, Hirai T, et al. Influence of dialysis duration on the outcome of living kidney transplantation. Ther Apher Dial 2014; 18:481-488.
4. Kimura T, Ishikawa N, Fujiwara T, et al. Kidney transplantation in patients with long-term (more than 15 years) prior dialysis therapy. Transplant Proc 2012; 44:75-76.
5. Prezelin-Reydit M, Combe C, Harambat J, et al. Prolonged dialysis duration is associated with graft failure and mortality after kidney transplantation: results from the French transplant database. Nephrol Dial Transplant 2019; 34:538-545.
6. Kessler M, Ladriere M, Giral M, et al. Does pre-emptive kidney transplantation with a deceased donor improve outcomes? Results from a French transplant network. Transpl Int 2011; 24:266-275.
7. Pérez-Flores I, Sánchez-Fructuoso A, Calvo N, et al. Preemptive kidney transplant from deceased donors: an advantage in relation to reduced waiting list. Transplant Proc 2007; 39:2123-2124.
8. Hirata ES, Baghin MF, Pereira RI, Alves Filho G, Udelsmann A. Influence of the anesthetic technique on the hemodynamic changes in renal transplantation: a retrospective study. Rev Bras Anestesiol 2009; 59:166-176.
9. Serrano OK, Vock DM, Chinnakotla S, et al. The Relationships Between Cold Ischemia Time, Kidney Transplant Length of Stay, and Transplant-related Costs. Transplantation 2019; 103:401-411.
10. Gallego Valcarce E, Ortega Cerrato A, Llamas Fuentes F, et al. Short cold ischaemia time optimises transplant results for kidneys from expanded criteria donors. Nefrologia 2009; 29:456-463.
11. Baxi V, Jain A, Dasgupta D. Anaesthesia for renal transplantation: an update. Indian J Anaesth 2009; 53:139-147.
12. Dawidson I, Ar'Rajab A, Dickerman R, et al. Perioperative albumin and verapamil improve early outcome after cadaver renal transplantation. Transplant Proc 1994; 26:3100-3101.
13. Ricaurte L, Vargas J, Lozano E, Díaz L. Anesthesia and kidney transplantation. Transplant Proc 2013; 45:1386-1391.
14. Sprung J, Kapural L, Bourke DL, O'Hara JF Jr. Anesthesia for kidney transplant surgery. Anesthesiol Clin North Am 2000; 18:919-951.