Research Article

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Perioperative management of blood pressure in living donor kidney transplantation

Canlı donörden böbrek naklinde kan basıncının perioperatif yönetimi

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Abstract

Purpose: Delayed graft function (DGF) is a poor clinical prognostic factor in kidney transplantation (KT) which frequently occurs due to acute kidney injury (AKI) within the postoperative first week. In the present study, we researched the effect of SBP (Systolic Blood Pressure) on early graft function after reperfusion in living-donor kidney transplantation.

Materials and methods: We retrospectively obtained preoperative patient clinical data from anesthesia follow-up forms. The research data included demographic data, laboratory data, medical past and kidney-related information. SBP, central venous pressure [CVP], anesthesia duration, infusion and transfusion volumes, blood loss and urine output, surgery duration, ischemia duration and onset of graft diuresis were used as intraoperative data.

Results: There was no significant difference between 4 different systolic blood pressure categories assigned after reperfusion of the kidney in terms of the related characteristics of the recipients. There were significant differences between the 4 groups categorized according to SBP after reperfusion in terms of the related in with intraoperative anesthetic and surgucal variable (p<.001).

Conclusion: Systolic blood pressure over 140 mm Hg after reperfusion may be a safe level regarding long-term graft survival and mortality. It is needed to research the long-term prognosis of living donor kidney transplantation in larger study population to confirm the outcomes of our study.

Keywords: Blood pressure, kidney transplantation, perioperative management.

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Öz

Amaç: Gecikmiş greft fonksiyonu (DGF), sıklıkla ameliyat sonrası ilk hafta içinde akut böbrek hasarına (AKI) bağlı olarak ortaya çıkan böbrek transplantasyonunda (KT) kötü bir klinik prognostik faktördür. Bu çalışmada canlı donörden böbrek naklinde SKB'nin (sistolik kan basıncı) reperfüzyon sonrası erken greft fonksiyonu üzerine etkisini araştırdık.

Gereç ve yöntem: Hastaların ameliyat öncesi klinik verilerini retrospektif olarak anestezi takip formlarından elde ettik. Araştırma verileri demografik verileri, laboratuvar verilerini, tıbbi geçmişi ve böbrekle ilgili bilgileri içeriyordu. İntraoperatif veriler olarak SKB, santral venöz basınç (CVP), anestezi süresi, infüzyon ve transfüzyon hacimleri, kan kaybı ve idrar çıkışı, ameliyat süresi, iskemi süresi ve greft diürezinin başlangıcı kullanıldı.

Bulgular: Böbrek reperfüzyonu sonrası atanan 4 farklı sistolik kan basıncı kategorisi arasında alıcıların ilgili özellikleri açısından anlamlı bir fark yoktu. Reperfüzyon sonrası SBP'ye göre kategorize edilen 4 grup arasında intraoperatif anestezive cerrahi değişkenler açısından anlamlı fark vardı (p<.001).

Sonuç: Reperfüzyon sonrası sistolik kan basıncının 140 mm Hg'nin üzerinde olması, uzun süreli greft sağkalımı ve mortalite açısından güvenli bir seviye olabilir. Çalışmamızın sonuçlarını doğrulamak için canlı vericiden böbrek naklinin uzun vadeli prognozunun daha geniş çalışma popülasyonunda araştırılması gerekmektedir.

Anahtar kelimeler: Kan basıncı, böbrek nakli, perioperatif yönetim.

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Introduction

Delayed graft function (DGF) is a poor clinical prognostic factor in kidney transplantation (KT) which frequently occurs due to acute kidney injury (AKI) within the postoperative first week. It has been encountered in the review of available data that meticulous perioperative hemodynamic management of the patients performed KT may reduce the incidence of DGF [1]. Although there is no consensus yet, the definition of perioperative hypotension was found associated with risk for acute kidney injury in the recent studies on non-transplantation surgeries [2]. The French instructions for perioperative hemodynamic management (2013) and AKI (2016) have recommended monitoring and optimization of systolic ejection volume, and appropriate replacement of vascular volume [3]. Besides this, the guidelines for optimization of these informations and their routine use in KT patients have not been established yet [4]. Volume perfusion in the guidance of central venous pressure (CVP) is the traditional approach followed in KT [1]. However, this procedure may lead to excessive fluid load which may impair endothelial glycocalyx and cause fluid shift to the interstitial space [4]. In addition, renal hypoperfusion may occur after fluid load. As a consequence, fluid management during KT is left at the discretion of the anesthetist during the case because there is no guideline available in clinical practice which focused on optimal blood pressure targets and hemodynamic management. Kidney transplantation is the treatment method preferred in the patients with end-stage renal failure. The kidneys obtained from the living donors have longer-term and better-quality graft survival compared with the cadaveric kidneys [4]. The most important focus point of intraoperative anesthesia management in kidney transplantation is to prevent hypotensive attacks and to preserve perfusion pressure supplied to the graft at optimal level. It is important to supply optimal renal perfusion to prevent acute tubular necrosis and renal artery thrombosis. Nevertheless, there is a very small number of studies conducted on blood pressure management during kidney transplantation. It has been reported that early graft function after kidney transplantation may affect long-term graft survival [5, 6]. In the present study, we researched the effect of SBP on early graft function after reperfusion in living-donor kidney transplantation.

Material and method

The present study was approved by Non-Interventional Clinical Research Ethics Committee of Pamukkale University Medical Faculty in August 2023 (Permission Date 05.09.2023, and number 60116787-020-415588). We retrospectively obtained preoperative clinical data of the patients from anesthesia follow-up forms. The research data included demographic data (e.g. age, gender, body mass index), laboratory data (e.g. hemoglobin, albumin), medical past (e.g. complications before kidney transplantation) and kidney-related information (reason of the end-stage kidney disease, duration and type of dialysis, HLA incompatibility). SBP, central venous pressure [CVP], anesthesia duration, infusion and transfusion volumes, blood loss and urine output, surgery duration, ischemia duration and onset of graft diuresis were used as intraoperative data. The estimated glomerular filtration rate (eGFR) and creatinine level within the postoperative first 7 days were recorded as graft function. Postoperative variables (e.g. mechanical ventilation duration, postoperative intensive care unit (ICU) admission duration and total admission duration (from surgery date to discharge date)) as well as data related with postoperative complications such as acute tubular necrosis, delayed graft function, acute transplant rejection, pulmonary edema, perirenal hematoma and death were obtained from the hospital database.

Anesthesia and operation

General anesthesia induction was achieved by using propofol, remifentanil and atracurium, and following maintained by desflurane and remifentanil infusion. Together with standard monitoring, continuous arterial pressure monitoring invasive arterial monitorization though radial artery and continuous CVP monitoring through internal jugular vein were performed. In the anesthesia for renal transplantation surgery, one of the most important main targets of monitorization is probably maintenance of renal blood flow and optimal intravascular volume state. The continuous monitorization of arterial blood pressure and evaluation of reciprocal variations of pressure waveform are important for hemodynamic management. Prior to graft perfusion, optimal arterial pressure level of 70-90 mmHg and CVP level of 8-12 mmHg were maintained by preserving

adequate intravascular volume in hemodynamic management and achieving meticulous titration of anesthetic agents. The administration of 0.9% isotonic solution from the crystalloid solutions was avoided due to concerns of hyperchloremia, metabolic acidosis and renal vasoconstriction, Ringer's lactate solution was used primarily. It was administered as a crystalloid solution at a rate of 1-3 mL/kg/hour intraoperatively. The administration of hydroxyethyl starch (HES) solutions was abstained because of increasing the risk for renal failure in the critical patients. After completion of vascular anastomoses, particularly hypotension was avoided during renal perfusion. The alpha agonist agents were abstained as far as possible because of vasoconstriction effects in the patients with hypotension despite fluid resuscitation.

In addition to standard monitoring, invasive arterial pressure and central venous pressure monitoring was performed. The arterial catheter was inserted into the radial artery while the central venous catheter was placed into the internal jugular vein. Preferably lactated ringer solution was infused during the operation taking central venous pressure into consideration to prevent acidosis. Fluid therapy was planned to maintain the CVP at 10-15 mmHg before graft reperfusion. All the patients were administered 20 mg basiliximab preoperatively and 500 mg methylprednisolone during vascular anastomosis through central venous catheter. Additionally, each patient was given 20 mg furosemide just after reperfusion to improve allograft perfusion pressure and to increase diuresis. We distributed the patients into 4 groups according to systolic blood pressure (as <130 mmHg, 130-139 mmHg, 140-149 mmHg, >150 mmHg) after reperfusion to evaluate the effect of systolic blood pressure on early graft function in living donor kidney transplantation. The eGFR and creatinine values within the postoperative first 7 days were recorded as the essentially measured parameters. Urine output after reperfusion and postoperative clinical course were recorded as the secondary results.

Statistical analysis

The continuous variables were presented as mean (95% confidence interval [CI]) and compared using Kruskal-Wallis test. The recipient's urine output was distributed into 2 categories (as high and low) based on preoperative systolic blood pressure and their relationship with postoperative kidney function or postoperative complications was evaluated. The continuous variables were presented as mean (95% CI) in the analyses. All results were analyzed with a p value <0.05 considered significant.

Results

The patients who underwent living donor kidney transplantation (n=203) between January 2009 and May 2022 in the Pamukkale University Medical Faculty Hospital were screened. We excluded 17 patients in the pediatric group and 6 patients with a history of perioperative massive haemorrhage (>2000mL). We retrospectively analyzed 180 patients in the present study. Table 1 and 2 show the essential characteristics of the recipients. There was no significant difference between 4 different systolic blood pressure categories assigned after reperfusion of the kidney in terms of the related characteristics of the recipients.

Mean eGFR levels of the systolic blood pressure groups were between 9.6 mL/min/1.73 m^2 and 11.5 mL/min/1.73 m^2 in the preoperative last day. The eGFR levels were 13.6, 12.9, 14.1 and 13.1 mL/min/1.73 m^2 in the groups with SBP level of <130, 130-139, 140-149 and >150 mmHg in the postoperative 1st day, respectively. The creatinine levels were 4.5, 3.9, 4.2 and 3.1 mg/dl between systolic blood pressure groups in the postoperative 1st day, respectively. There was no significant difference between the 4 groups categorized according to systolic blood pressure level after reperfusion in terms of eGFR or creatinine values in any day of the postoperative first week. In addition, there was no significant difference between the 4 groups in terms of eGFR or creatinine levels according to a 1-year follow-up period.

Table 1. Preoperative demographic and clinical data of recipients

	Post-Reperfusion Systolic Blood Pressure (mmHg)				
	<130 (n=41)	**130-139 (n=34)**	**140-149 (n=45)**	**>150 (n=60)**	***p***
Age (year)	46.1 (42.1-50.3)	45.8 (43.0-48.7)	40.4 (39.3-43.3)	40.7 (37.8-44.1)	<.001
Men, n (%)	19 (46.3)	26 (76.4)	21 (46.6)	34 (56.6)	.70
Weight (kg)	69.9 (65.8-74.1)	60.6 (57.5-63.9)	71.3 (69.0-73.7)	62.9 (59.5-66.1)	.65
Comorbidities					
Diabetes mellitus	11 (26.8)	16 (47.0)	14 (31.1)	17 (28.3)	.77
Hypertension	27 (65.8)	21 (61.7)	29 (64.4)	36 (60.0)	.74
Serum albumin (g/dL)	3.8 (3.6-4.1)	4.0 (3.9-4.1)	3.7 (3.5-3.9)	4.1 (3.9-4.2)	.11
Preoperative Hb (g/dL)	10.1 (9.6-10.7)	11.0 (10.7-11.2)	11.8 (11.6-12.1)	10.9 (10.7-11.0)	.82
Preoperative BP (mmHg)					
SBP	125 (118-129)	134 (131-138)	146 (142-149)	156 (151-162)	<.001

BP: Blood Pressure, SBP: Systolic Blood Pressure, HB: Hemoglobin, A *p* value <0.05 is considered statistically significant

Table 2. Dialysis and Transplant Data (n=180)

	SBP After Reperfusion (mmHg)				
	<130 (n=41)	**130-139 (n=34)**	**140-149 (n=45)**	**>150 (n=60)**	***p***
Type of dialysis, n(%)					
Hemodialysis	34 (82.9)	30 (88.2)	42 (93.3)	55 (91.6)	
Peritoneal dialysis	7 (17.1)	4 (11.8)	3 (6.7)	5 (8.4)	
Duration of dialysis (mo)	26.4 (20.2-31.5)	26.7 (22.9-40.1)	35.9 (25.1-46.29)	30.3 (20.4-41.7)	.87
Etiology of kidney disease, n(%)					
Diabetes mellitus	16	9	12	11	
Glomerulonephritis	15	14	17	19	
Hypertension	6	10	11	22	
Polycystic kidney disease	3	1	4	5	
Urological	1	0	1	3	
HLA mismatches	2.6 (2.3-3.1)	2.9 (2.5-3.2)	3.0 (2.8-3.3)	2.7 (2.5-2.9)	.73

HLA: Human Leukocyte Antigen, Mo:Month, A *p* value <0.05 is considered statistically significant

Table 3 shows the relationship of systolic blood pressure after reperfusion with intraoperative anesthetic and surgical variables. There were significant differences between the 4 groups categorized according to SBP after reperfusion (*p*<.001): The relationship between SBP after reperfusion and urine output in terms of age, gender, transfusion and haemorrhage was evaluated to be similar with the results of one-variable analysis shown in Table 3.

Table 4 shows the results of the recipients after transplantation. Our patients are routinely referred to the organ transplantation ward and monitored according to the principles of intensive care unit. We encountered acute rejection clinic in none of our patients. None of our patients became exitus within the first year. The prevalence of hematoma as a postoperative complication was also found significantly different between the 4 groups (*p*=.01). Besides, the other postoperative complications were atrial fibrillation (n=1), delirium (n=3) and dental abscess (n=1). No significant difference was found between the systolic blood pressure groups regarding these complications.

Table 3. Intraoperative anesthesia and surgical data (n=180)

	SBP After Reperfusion (mmHg)				
	<130 (n=41)	**130-139 (n=34)**	**140-149 (n=45)**	**>150 (n=60)**	***p***
Surgery time (min)	181 (169-195)	189 (170-194)	175 (171-194)	183 (174-199)	.06
Anesthesia time (min)	223 (208-237)	230 (208-247)	229 (205-248)	234 (209-241)	.11
Ischemia time (min)					
Warm	2.1 (1.5-2.8)	2.2 (1.4-2.6)	1.9 (1.3-2.5)	2.5 (1.4-2.9)	.70
Cold	44 (41-49)	47 (43-51)	45 (40-54)	49 (47-58)	.27
Intravenous fluid (mL)					
Ringer lactate	1740 (1480-2090)	2080 (1950-2250)	1930 (1810-2070)	1970 (1800-2090)	.72
Blood loss (min)	110 (80-1709	145 (110-190)	130 (105-170)	160 (145-2109	.14
Postreperfusion urine utput (mL/h)	165 (119-205)	312 (265-395)	345 (296-410)	340 (289-415)	<.001
Length of postoperative hospital stay (days)	12.7 (10.1-14.6)	13.8 (12.1-15.6)	14.8 (13.7-16.1)	12.9 (10.9-13.9)	.21
Postoperative complications, n (%)					
Acute tubular necrosis	6 (14.6)	3 (8.8)	1 (2.2)	3 (5)	<.001

Min:Minute, A *p* value <0.05 is considered statistically significant

Table 4. Post-transplant results of recipients

	SBP After Reperfusion (mmHg)				
	<130 (n=41)	**130-139 (n=34)**	**140-149 (n=45)**	**>150 (n=60)**	***p***
Length of postoperative hospital stay (days)	12.7 (10.1-14.6)	13.8 (12.1-15.6)	14.8 (13.7-16.1)	12.9 (10.9-13.9)	.21
Postoperative complications, n (%)					
Acute tubular necrosis	6 (14.6)	3 (8.8)	1 (2.2)	3 (5)	.90
Delayed graft function	1 (0.02)	3 (0.09)	2 (0.04)	1 (0.01)	.72
Pulmonary edema	1 (0.02)	0 (0.0)	4 (0.09)	2 (0.03)	.14
Hematoma	2 (0.05)	0 (0.0)	1 (0.02)	2 (0.03)	.01
Kidney function eGFR					
Preoperative	10.9 (9.6-11.5)	11.5 (10.2-12.7)	9.6 (9.1-10.7)	11.1 (10.6-11.9)	<0.001
Postoperative first day	13.6 (12.5-14.4)	12.9 (12.1-14.1)	14.1 (13.1-14.7)	13.1 (12.4-14.1)	<0.001
Postoperative seventh day	39.7 (39.1-40.6)	41.2 (39.0-42.7)	40.7 (39.5-43.8)	43.7 (42.1-45.8)	<0.001
Kidney function, creatinine (mg/dL)					
Preoperative	8.3 (6.9-9.1)	7.5 (7.1-8.2)	7.7 (7.3-8.9)	6.9 (7.0-8.2)	<0.001
Postoperative first day	4.5 (4.1-4.9)	3.9 (3.4-4.5)	4.2 (3.7-4.9)	3.1 (2.8-3.7)	<0.001
Postoperative seventh day	1.1 (0.9-1.4)	1.4 (1.2-1.6)	1.5 (1.3-1.8)	1.3 (1.2-1.7)	<0.001

eGFR: Estimated Glomerular Filtration Rate, SBP:Systolic BLood Pressure, A *p* value <0.05 is considered statistically significant

Discussion

Many studies have revealed that an optimal blood pressure management is needed to protect the graft during the anesthesia. In the previous years, for instance Tiggeler et al. [7] have reported that an effort should be exerted to maintain the SBP at >120 mmHg and emphasized that 140 mmHg is an ideal target. Also we routinely achieve a sustainable blood pressure control over this value in our operations. Nevertheless, the most appropriate blood pressure level for the kidney transplant recipients has not been exactly determined despite every treatment plan and study yet. No significant difference was discovered between the 4 groups categorized according to SBP after reperfusion in terms of early graft function or major complications. However, the group with SBP <140 mm Hg after reperfusion had a tendency to show significantly lower urine output compared with the other 3 groups after releasing the renal vascular clamp. Pascual et al. [8] have reported that lower urine output values within the post-transplant first 24 hours are associated with worse 5-year graft survival rates. Besides, they have emphasized that early-term successful graft function is an important factor for long-term survival. Moreover, in our study, considering the relationship between urine output and kidney function, we found that the recovery period was more successful in the patients detected with better urine output, and fewer postoperative complications were observed. Thus, systolic blood pressure over 140 mmHg after reperfusion may be a safe level regarding long-term graft survival and mortality. Preoperatively high systolic blood pressure can be accepted as an indicator of high blood pressure after reperfusion in our recipient patients. Besides, increasing use of vasoactive inotropic agents can be associated with reduced SBP after reperfusion. In our protocol, we do not prefer to use any routine vasoactive agent, considering its potential side effects. It has been reported that maintenance of adequate intravascular volume is needed to improve early graft function to prevent acute renal failure or kidney transplantation [9]. Intraoperative volume expansion was recommended before graft reperfusion while maintaining CVP at 10-15 mmHg to protect from acute tubular necrosis secondary to inadequate intraoperative hydration [10].

It can be considered that our study has several limitations. As the first limitation, inadequate study power can be mentioned since this is the first study in our study conducted on the relationship between arterial blood pressure after reperfusion and early graft function in living donor kidney transplantation. Secondly, we researched the effect of SBP after reperfusion on early graft function in living donor kidney transplantation retrospectively. There may be uncontrollable factors in the individual recipients, such as their capability to preserve high blood pressure and the efficacy of vasoactive inotrope agents. However, it is difficult to manage the anesthesia technically in the cases of excessively low or excessively high blood pressure during kidney transplantation. The strong side of our study is obtaining the patient data by a researcher directly from the database and analysing it by two different researchers to confirm its accuracy.

In conclusion, no significant difference was observed between the 4 groups categorized according to SBP after reperfusion in terms of early graft function or major complications. However, the group with SBP <140 mm Hg showed significantly lower urine output compared with the remaining 3 groups after releasing the renal vascular clamp. Systolic blood pressure over 140 mm Hg after reperfusion may be a safe level regarding long-term graft survival and mortality. It is needed to research the long-term prognosis of living donor kidney transplantation in a larger study population to confirm the outcomes of our study.

Conflict of interest: No conflict of interest was declared by the authors.

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Ethics committee approval: Permission was obtained from Pamukkale University Non-Interventional Clinic Research Ethics Committee for the study (permission date 05.09.2023, and number 60116787-020-415588).

Authors' contributions to the article

I.H.A. constructed the main idea and hypothesis of the study. I.H.A. and A.M.Y. developed the theory and arranged/edited the material and method section. U.O and M.C have done the evaluation of the data in the Results section. Discussion section of the article written by I.H.A., U.O., A.M.Y and M.C reviewed, corrected and approved. In addition, all authors discussed the entire study and approved the final version.