Journal of Anesthesia & Clinical Research
ISSN: 2155-6148

Chenyang et al., J Anesthe Clinic Res 2013, 4:7
DOI: 10.4172/2155-6148.1000339

Research Article Open Access

How does the Serum Catecholamine Change and Post Transplant Renal Function

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Abstract

Objective: To keep different levels of blood pressure and to observe the effects on the posttransplant renal function under general anesthesia.

Methods: We selected 20 patients with the renal normal function (group N, n=20) who undergoing live donor nephrectomy under general anesthesia; the renal failure group (group F n=20) who undergoing renal transplantation. Blood pressure, ECG, SpO_2, PETCO2, BIS were monitored continuously. Levels of norepinephrine, epinephrine, aldosterone in blood plasma were measured before anesthesia, after anesthesia before skin incision, at the time point of kidney exploration and after nephrectomy 10 min,40 min,120 min or at the renal vascular anastomosis opened for 10 min, 40 min, 120 min and even for 1st, 3rd days after kidney transplant. Meanwhile, we detected the volume of urine, serum concentrations of Cr (Creatinine), BUN (Blood urea nitrogen), cystsin C (CysC) and β_2 microglobulin (β_2-MG) for group F1(using the vasoactive drug to maintain the SBP 160-140 mmHg) and group F2 (SBP was kept at 139-110 mmHg) at different time points during the donor's kidney was transplanted.

Results: 1. Aldosterone was increased significantly at kidney exploration or the renal vascular anastomosis, compared to pre-induction (P<0.05). But, there were no difference between two groups at each time points. 2. The volume of urine was increased as the time going on after kidney replacement in group F1 and F2. Meanwhile, the serum concentrations of Cr, BUN, CysC and β2-MG were decreased at the T4,T5,1st, 3rd time points, But there were no difference between F2 and F2 groups at each time points.

Conclusion: The renin angiotensin aldosterone system was activated in renal function normal or failure patients in peri-operation. And the transplanted kidney could work well under the physiologic levels of blood pressure and the higher SBP might not be essential in the renal failure patients.

Keywords: Anesthesia, general; Renal function, Renal failure; Catecholamine; Blood pressure

Introduction

We found that the blood pressure and HR increased significantly during nephrectomy, especially when kidney was explored for the patients with normal renal function under general anesthesia. Those said that the R-A-A system was activated by stretching or clamping the renal vessels. So, we thought that whether or not have the same changes for the renal failure patients during renal transplantation. What is the reasonable state for the replaced kidney in the renal failure patients?

As we know, many urologists considered that the higher blood pressure would ensure better perfusion for the transplanted kidney [1-3]. They usually asked a lot of vasoactive drugs to be used after renal artery anastomosis for these patients. However, many studies found that the concentration of catecholamine raised in peri-operation reason from stress reaction [4,5]. There was reported that the higher levels of catecholamine in the end stage of renal failure patients [6]. Hence, many renal failure patients caught hypertension. But, what's the concentration of catecholamine in the recipient during renal transplantation under general anesthesia? How high blood pressure maintained for patients after kidney transplantation is more favorable?

Actually, the transplanted kidney comes from the healthy donor and has the normal function. Can it adapt to the pathologic hypertension? Which state is better? So we investigated the concentration changes of catecholamine in different renal patients during operation under general anesthesia. We want to elucidate the effects of different levels of blood pressure on the recovery of replaced kidney in renal failure patients in order to avoid using vasoactive drugs over dosage clinically.

Material and Methods

General materials

The Ethics Committee of Qianfoshan Hospital Affiliated to Shandong University approved this study, and patients participating in the study signed the anesthesia informed consent form.

Case selection and grouping: Forty cases of patients under general anesthesia who undertaken nephrectomy (group N, n=20) and kidney transplants (group F, n=20) were selected in this study, aged from 24-54, ASA II-III without immune diseases, none of them taken sympathesis agents or anti-immune drugs before operation. The patients in group F were performed hemodiaysis continuously for 3 months and two–three times a week before operation.

Test equipment and drugs: Anesthesia machine (Drager Julian,

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Received June 25, 2013; **Accepted** July 29, 2013; **Published** June 31, 2013

Citation: Chenyang D, Pengcai S, Binghua L, Dan F, Mengjie L, et al. (2013) How does the Serum Catecholamine Change and Post Transplant Renal Function. J Anesthe Clinic Res 4: 339. doi:10.4172/2155-6148.1000339

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Germany), Philips E2 multifunctional vital signs monitor (Philips Company, Holland), Aspect2000 Bispectral Index (BIS) monitor (Aspect Company, America), FloTrac sensor/Vigileo monitor, 7F three lumen central venous catheter, pressure sensor (Edwards Company, USA), 6% hydroxyethyl starch 130/0.4 sodium chloride injection (Voluven, 500 ml/bag, Beijing Fresenius Kabi Pharmaceutical Co., Ltd.), and compound sodium chloride injection (500 ml/bag, Qingdao Huaren Pharmaceutical Co., Ltd.). Cr (Creatinine), BUN (Blood urea nitrogen), cystsin C (CysC) and β_2 microglobulin (β_2-MG) come from the kits of B-D company, USA.

Methods

Experimental design grouping: Twenty patients (male or female) were donors for kidney, with normal renal function and named as group N.

Twenty patients (male or female) were renal failure undertaken kidney transplants, that is the recipients, group F.

Anesthesia implementation

Preparation of anesthesia: Thirty minutes before anesthesia 0.3 mg of intramuscular scopolamine and 3-5 mg of midazolam were given. Scopolamine preoperative application can reduce airway secretions, have the effect of drying the airway. Patients were continuously monitored by Electrocardiogram (ECG), Heart Rate (HR), a pulse oximetry (SpO_2), End-tidal Carbon Dioxide Partial Pressure ($PETCO_2$) Brain Bispectral Index (BIS), Systolic Blood Pressure (SBP) and Mean Arterial Pressure (MAP).

Anesthesia methods: The patients of the two groups underwent general anesthesia. Inductions of anesthesia were: intravenous injection with 3 mg of midazolam, 0.2 mg/kg of etomidate, 10 μg/kg of fentanyl, 0.6-0.8 mg/kg of rocuronium and 30 mg of lidocaine; after 3-5 min direct vision intubation under the laryngoscope was conducted (50 mg of Spray lidocaine was given in the trachea before intubation). Then intermittent positive pressure ventilation (IPPV) was performed. Respiratory indicators were: 8 ml/kg of tidal volume(VT), 12 times/min of respiratory rate (RR), positive end expiratory pressure(PEEP) with 0, 80% of inhaled oxygen concentration, 3 L/min of the oxygen flow; maintaining airway pressure <30 cm H_2O (1 cm H_2O=0.098 kPa), $PETCO_2$ at 35-45 mmHg and SpO_2>98%. Maintenance of anesthesia was: intravenous target-controlled infusion (TCI) with propofol, the target plasma concentration at 2-3 μg/ml and continuous intravenous infusion with 0.2-0.45 $\mu g/kg^{-1}/min^{-1}$ of remifentanil, following inhalation of sevoflurane and intermittent intravenous injection with atracurium. BIS values were kept at 45-55 during surgery. Arterial blood gas analysis was periodically performed during surgery.

The observed monitoring indicators: MAP, HR, SBP were determined before induction (T0), before incision(T1), explored kidney (T2) and after nephrectomy 10 (T3), 40 (T4), 120 mins (T5) in group N(or after renal artery anastomosis 10 (T3), 40 (T4), 120 mins (T5) in group F) . The average of the three measured data at each time point was taken as valid indicators. The serum concentrations of ALD, NE, E were detected at the above time points for two groups. The urine volume, the serum concentrations of Cr, BUN, CysC, β_2-MG were measured and recorded at different time points and continuing to post-operative 1st, 3rd days.

Managements of blood pressure for group F in peri-operation: In order to maintain different systolic blood pressures, we chose the different vasoactive drugs, and divided the patients in group F into two groups (group F1 and F2). We performed vasoacitive drugs of dopamine, phenylephrine infusion, and infused 3 ml/kg compound sodium chloride in group F1 in order to maintain SBP at 160-140 mmHg, which was nearly to preoperative levels. In group F2, we perfomed 6% hydroxyethyl starch 130/0.4 sodium chloride injection 5 ml/kg of intravenous infusion, or injection nitroglycerin prorenate to maintain the SBP at the 139-110 mmHg, which is the physiologic state.

Statistical methods

SPSS17.0 statistic software was adopted in the data analysis, and data were expressed as Means ± SD. Paired *t* test was used in intra-group comparison and group *t* test was used in inter-group comparison. Differences in values of p<0.05 were considered to be significant.

Results

Changes in hemodynamic indicators

Compared with T_0, MAP and HR were decreased after induction of two groups (P<0.05). MAP and HR in group F were higher than those in group N at time points of T_0, T_3, T_4, T_5 (P<0.05). The hemodynamic indicators of the N group with no statistical significance in intra-group comparison at other time points (P>0.05) (Table 1).

The changes of serum ALD, NE, E in two groups

Serum concentrations of ALD were increased significantly in two groups at time points of T_2, T_3, T_4, T_5, comparied with T_0 and T_1 (P<0.05). However, no statistical significance of ALD, NE, E were found in inter-group comparison (P>0.05) (Table 2).

The effects of blood pressure on the renal function in group F

Serum concentrations of Cr, BUN, CysC, β_2-MG were decreased after kidney transplantation between group F1 and F2 at T_4, T_5, 1st, 3rd days(P<0.05). While, with the extension of time, the urine volume increased obviously. There was no significant difference about the above indicates between F1 and F2 groups(P>0.05) (Table 3).

Discussions

The renal failure patients were suffered from the hypertension, hyperkalemia, edema, renal anemia, uremic pericarditis, coagulation disorders, disorder of Acid-base imbalance and heart failure or

	group	T0	T1	T2	T3	T4
MAP	N	101 ± 15	82 ± 15*	79 ± 11	72 ± 8	77 ± 9
	F	119 ± 13#	102 ± 12#*	101 ± 10#*	95 ± 11#*	95 ± 12#*
HR	N	74 ± 12	69 ± 10*	73 ± 11	78 ± 9	65 ± 8
	F	98 ± 10#	78 ± 10	79 ± 8	86 ± 14	90 ± 11#

T0 vs T0: *P<0.05 in intra-group comparison, #P<0.05

Table 1: Comparison of hemodynamic indicators at various points in time between the two groups (± s, n=20).

	group	T0	T1	T2	T3	T4
NE (pg/ml)	N	772 ± 154	742 ± 96	725 ± 79	640 ± 82	638 ± 77
	F	742 ± 117	781 ± 102	698 ± 82	702 ± 75	674 ± 84
E (pg/ml)	N	89 ± 66	72 ± 25	69 ± 36	64 ± 15	63 ± 12
	F	91 ± 52	69 ± 34	58 ± 13	67 ± 17	68 ± 14
ALD (pg/ml)	N	276 ± 9.3	304 ± 11	575 ± 16*§	583 ± 19*§	639 ± 17*§
	F	299 ± 12	301 ± 14	539 ± 12*§	568 ± 11*§	642 ± 23*§

T0 Vs T0: *P<0.05; To Vs T1 §P<0.05: in intra-group comparison, #P<0.05

Table 2: Comparison of serum concentration of NE, E, ALD at various points in time between the two groups ($\bar{x}$ ± s, n=20).

Index	Catagory	T3	T4	T5	T1d	T3d
Urine	F1	65 ± 0.14	378 ± 11.51**	735 ± 14.9**	5864 ± 1375**	531 ± 1059**
	F2	45 ± 2.35	297 ± 13.8**	764 ± 12.3**	5262 ± 1995**	501 ± 1261**
Cr (mmol/L)	F1	480 ± 102	305 ± 109*	121 ± 44*	107 ± 37*	98 ± 12*
	F2	453 ± 93	340 ± 101*	128 ± 94*	108 ± 13*	102 ± 13*
BUN (μmol/L)	F1	19.1 ± 2.2	16.1 ± 2.2	13.3 ± 3.7	8.0 ± 3.0*	7.0 ± 2.8*
	F2	17.8 ± 2.6	14.8 ± 2.6	14.0 ± 4.9	8.5 ± 3.0*	8.0 ± 2.6*
CysC (mg/l)	F1	3.2 ± 1.3	2.9 ± 1.2	2.7 ± 0.6	1.8 ± 1.2*	1.2 ± 0.5*
	F2	3.5 ± 1.0	2.5 ± 1.2	2.9 ± 0.8*	1.5 ± 1.4*	1.3 ± 0.3*
β2-MG (mg/l)	F1	7.0 ± 1.45	4.98 ± 2.76*	3.85 ± 1.82*	3.60 ± 1.16*	3.33 ± 2.50*
	F2	6.8 ± 1.93	5.37 ± 2.40*	4.15 ± 1.24*	3.48 ± 1.92*	2.60 ± 1.30*

To vs T3: *P<0.05

Table 3: Comparison of the renal function after transplantation for F group patients with different level blood pressure ($\bar{x}$ ± s, n1=9, n2=8).

disfunction of lungs, liver and other diseases. With the severity of this desease, the patients must be dependent on the hemodialysis frequently, usually performed at two or three times a week. And at this moment, the kidney transplantation should be the sole method to survival.

As we know, there are more reasons to influence to the recovery of the transplanted kidney, such as, the quality of the donor kidney, the warm or cold ischemia time, ABO blood type, HLA match, and so on [7-9]. For all of them, many people think that the level of blood pressure which means the perfusion for the kidney is the key factor and the managements of anesthesia with anesthetic agents was important too [10-12]. But, how can we do for the new kidney in the recipient? It need higher blood pressure just like the former to keep its perfusion? Or is it the physiologic blood pressure more fitting? What's the changes of the catecholamine during this operation under general anesthesia? What kind of blood pressure level is more suitable for the new kidney? Up to now, we can't find the real answers. Therefore, we did this study and hope to explored which state is the better for the replaced kidney recovery.

The data reveals that the serum concentrations of ALD, NE, and E of the renal failure patients were not lower than the normal renal function patients. That means it was not need vasoactive agents to keep the higher blood pressure. The valid fluid therapy might be the better selection to maintain some degree blood pressure and higher or normal SBP could have the same effect to the transplanted kidney. The serum concentrations of Cr, BUN, CysC, β_2-MG are recognized the characteristic markers for renal function [13]. The two groups didnot have significantly different renal transplantation, which indicated that the higher blood pressure or the normal blood pressure have the same effect to maintain the transplanted kidney function after operationt. The new kidney coming from the healthy donor can work well in the physiological enviroment state, it doesnot need much higher blood pressure to maintain perfusion. Therefore whether it is from a new kidney blood catecholamine concentration or the new kidney itself needs, it didn't need using vasoactive drugs raise blood pressure. Physiological levels of blood pressure can meet the needs of the new kidney, amount of vasoactive agents might be harmful to the patients undertaken kidney transplantation. As yet, the preceding opinion might be unclear. What is the best level of the blood pressure for this kidney or what's the mechanism for the new kidney in the renal failure body to work well? So, many studies should be taken to elucidate the reasons deeply in the future.

Conclusion

The renin angiotensin aldosterone system was activated in function normal or failure patients in peri-operation. And the transplanted kidney could work well under the normal blood pressure state for the renal failure patients. It doesnot need much higher blood pressure to maintain perfusion.

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