

Comparison of the Renoprotective Effect of Dexmedetomidine and Dopamine in High-risk Renal Patients Undergoing Cardiac Surgery: A Double-blind Randomized Study

Abstract

Objective: The purpose of the current study was to compare the renoprotective effects of continuous infusion of dexmedetomidine and dopamine in high-risk renal patients undergoing cardiac surgery. **Design:** A double-blind randomized study. **Setting:** Cardiac Centers. **Patients:** One hundred and fifty patients with baseline serum creatinine level ≥ 1.4 mg/dl were scheduled for cardiac surgery with cardiopulmonary bypass. **Intervention:** The patients were classified into two groups (each = 75): Group Dex – the patients received a continuous infusion of dexmedetomidine 0.4 $\mu\text{g}/\text{kg}/\text{h}$ without loading dose during the procedure and the first 24 postoperative hours and Group Dopa – the patients received a continuous infusion of dopamine 3 $\mu\text{g}/\text{kg}/\text{min}$ during the procedure and the first 24 postoperative hours. **Measurements:** The monitors included serum creatinine, creatinine clearance, blood urea nitrogen, and urine output. **Main Results:** The creatinine levels and blood urea nitrogen decreased at days 1, 2, 3, 4, and 5 in Dex group and increased in patients of Dopa group ($P < 0.05$). The creatinine clearance increased at days 1, 2, 3, 4, and 5 in Dex group and decreased in patients of Dopa group ($P < 0.05$). The amount of urine output was too much higher in the Dex group than the Dopa group ($P < 0.05$). **Conclusions:** The continuous infusion of dexmedetomidine during cardiac surgery has a renoprotective effect and decreased the deterioration in the renal function in high-risk renal patients compared to the continuous infusion of dopamine.

Keywords: Blood urea nitrogen, creatinine clearance, dexmedetomidine, dopamine, renal dysfunction, serum creatinine, urine output

Introduction

The incidence of acute renal failure is 5%–30% of patients undergoing cardiac surgery, and the postoperative renal dysfunction is associated with a high incidence of complicated clinical course.^[1-5]

The risk factors include patients with impaired left ventricular function, diabetes mellitus, hypertension, generalized atherosclerosis, preoperative kidney dysfunction, advanced age, or prolonged cardiopulmonary bypass (CPB).^[6-8]

The pathophysiology of acute renal failure in cardiac surgery includes many factors such as hemodynamic disturbance, especially intraoperative hypoperfusion of the kidney, effects of nephrotoxic drugs, the results of the systemic inflammatory reaction induced by CPB, and the interactions of blood components and artificial membranes.^[9,10] During CPB, the release of vasoconstrictors, such as catecholamines,

vasopressin, or thromboxane, is enhanced, and the renin–angiotensin system is activated; therefore, the renal perfusion is compromised.^[11] Moreover, CPB also induces tubular damage, as suggested by the persistence of microalbuminuria up to the 6th day after cardiac surgery.^[12]

Early prevention of acute kidney injury is very important to improve the outcome of cardiac surgery with CPB. Recent studies have focused on the preventive strategies, which could be used for the high-risk patients for acute renal failure.^[13] The use of low-dose dopamine infusion has been used for renal protection in high-risk renal patients during cardiac surgery,^[14] as results of the ability to induce receptor-mediated renal artery vasodilation,^[15] increases renal perfusion, decreases renal metabolism, and results in diuresis.^[16]

Dexmedetomidine is a highly selective α_2 -adrenoceptor agonist and it has a positive effect on renal function. It

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decreases the norepinephrine level in the blood and thus it induces renal artery vasodilatation and increases renal blood flow and urine output.^[17,18] Furthermore, it decreases the secretion of vasopressin and increases the release of atrial natriuretic peptide resulting in natriuresis.^[19]

The purpose of the current study was to compare the renoprotective effects of continuous infusion of dexmedetomidine and dopamine in high-risk renal patients undergoing cardiac surgery.

Methods

Outcomes

The primary outcome was the incidence of acute renal failure diagnosed by serum creatinine level, blood urea nitrogen, creatinine clearance, and the amount of urine output.

The secondary outcome was the safety of the study medications, which was assessed by the occurrence of any adverse events.

Sample size calculation

Power analysis was performed using the Chi-square test for independent samples on the incidence of acute renal failure because it was the main outcome variable in the present study. A pilot study was done before starting this study because there are no available data in the literature for the comparison of continuous infusion of dexmedetomidine and dopamine in high-risk renal patients undergoing cardiac surgery. The results of the pilot study showed that the incidence of acute renal injury was of 15% in dexmedetomidine group and 35% in dopamine group. Taking power 0.8, alpha error 0.05, and beta 0.2, a minimum sample size of 72 patients was calculated for each group. A total of patients in each group 75 were included to compensate for possible dropouts.

Patients

After obtaining informed consent and approval of local ethics, a double-blind randomized study included 150 high-risk renal patients undergoing cardiac surgery using CPB (2010–2017) with preoperative plasma creatinine values ≥ 1.4 mg/dL and scheduled for elective coronary artery bypass graft (CABG) surgery or valvular surgery with CPB. Exclusion criteria included patients with emergent CABG, cardiac transplantation, known allergy to study medication, acute renal failure, chronic renal replacement therapy, prior renal transplantation, or aortic aneurysm surgery. The patients were randomly allocated (using simple randomization through a process of coin-tossing) into two equal groups ($n = 75$ each) and the study medication was prepared in 50 ml syringe by nursing staff and given to the anesthetist blindly:

- Group Dex (dexmedetomidine group): The patients received after induction a continuous infusion of

dexmedetomidine 0.4 $\mu\text{g}/\text{kg}/\text{h}$ without loading dose during the procedure and the first 24 postoperative hours

- Group Dopa (dopamine group): The patients received after induction a continuous infusion of dopamine 3 $\mu\text{g}/\text{kg}/\text{min}$ during the procedure and the first 24 postoperative hours.

Anesthetic technique

On arrival to the operating room, intravenous midazolam premedication (0.03–0.1 mg/kg) was administered 10 min before induction of anesthesia. A radial arterial cannula and central venous line were inserted before operation to enable continuous hemodynamic monitoring, and a pulmonary artery catheter was inserted after induction. Induction was done by fentanyl (3–5 $\mu\text{g}/\text{kg}$), etomidate (0.3 mg/kg), and rocuronium (0.6 mg/kg). After tracheal intubation, the lungs were mechanically ventilated with an oxygen–air mixture (50%–50%). The urinary bladder catheter and probes for the measurement of nasopharyngeal and bladder temperature were also inserted after induction of anesthesia. Anesthesia was maintained with sevoflurane (1%–3%), fentanyl infusion (1–3 $\mu\text{g}/\text{kg}/\text{h}$), and cisatracurium infusion (1–2 $\mu\text{g}/\text{kg}/\text{min}$). CPB used centrifugal pumps with 1–1.5 L prime of ringer lactate, in addition to antibiotics, Solu-Medrol, and mannitol. Both antegrade and retrograde blood cardioplegia were used. All patients received 4 mg/kg of heparin before bypass, aiming to provide an activated clotting time (ACT) >480 s. CPB was established with the cannulation of the right atrium and the ascending aorta. During the CPB, the anesthesia was maintained by propofol infusion (1–3 mg/kg/h). Cooling was passive to around 34°C or active to 22°C. After bypass, heparin was reversed with protamine which was titrated to achieve an ACT <140 s. After surgery, all patients were admitted to the postoperative cardiac surgical intensive care unit with full hemodynamic monitoring and managed according to the standard protocol. All patients were continuously monitored, including electrocardiography, arterial blood pressure, arterial blood gases, and pulmonary artery catheter for monitoring the hemodynamic variables. Acute renal failure was diagnosed according to RIFLE criteria.^[20]

Patients monitoring

For all patients, the following variables were closely monitored: the heart rate, mean arterial pressure, central venous pressure, mean pulmonary artery pressure, pulmonary artery wedge pressure, cardiac index, serum creatinine, creatinine clearance, blood urea nitrogen urine output, arterial oxygen saturation, and arterial blood gases. Furthermore, the amount of blood loss, transfused packed RBC, and fluids were recorded.

The statistical paragraph in material and methods

Data were statistically described in terms of mean \pm standard deviation or frequencies (number of

cases) and percentages when appropriate. Comparison of numerical variables between the study groups was done using the Student's *t*-test for independent samples. Within-group comparison of numerical variables was done using paired *t*-test. For comparing categorical data, Chi-square test was performed. Fisher's exact test was used instead when the expected frequency is <5. $P < 0.05$ was considered statistically significant. All statistical calculations were done using computer programs Statistical Package for the Social Science SPSS Inc., Chicago, IL, USA Version 15 for Microsoft Windows.

Results

Table 1 shows no significant differences regarding the demographic data, comorbidities, preoperative medications, the American Society of Anesthesiologists' physical status score, and the surgical procedures ($P > 0.05$).

Table 2 shows the changes in the urine output, serum creatinine levels, and creatinine clearance of patients. There is no significant difference in the preoperative urine output

Table 1: Preoperative data of patients

Variable	Group Dex (n=75)	Group Dopa (n=75)	P
Age (years)	53.54±10.25	52.62±9.70	0.573
Weight (kg)	84.20±11.15	85.58±10.44	0.435
Gender (male:female)	40:35	36:39	0.513
Diabetes mellitus	48	42	0.317
Hypertension	39	43	0.511
Ischemic heart diseases	58	61	0.545
Ejection fraction (%)	44.64±4.32	45.36±3.85	0.283
Angiotensin-converting enzyme inhibitors	43	38	0.412
Beta-blockers	58	54	0.452
Calcium channels-blockers	36	42	0.326
Aspirin	58	61	0.545
Statins	39	31	0.190
Stroke	4	2	0.404
Smoking			
Current smokers	29	33	0.983
Ex-smokers	34	26	0.182
ASA			
II	10	13	0.496
III	45	40	0.410
IV	20	22	0.716
Euroscore (%)	15.65±4.75	14.70±6.68	0.317
Body surface area (m ²)	1.74±0.18	1.75±0.16	0.719
CABG	41	39	0.743
Valvular surgery	17	14	0.545
CABG + valvular surgery	17	22	0.352

Data are presented as mean±SD, n (%). ASA: American Society of Anesthesiologists, CABG: Coronary artery bypasses grafting, SD: Standard deviation, Group Dex: Dexmedetomidine group, Group Dopa: Dopamine group

between the two groups ($P > 0.05$), but the urine output increased significantly after the administration of the study medications in the patients of the two groups, but the increase was more in patients of Dex group than the Dopa group ($P < 0.05$) [Figure 1a]. There was no significant difference in the preoperative serum creatinine levels and blood urea nitrogen between the two groups ($P > 0.05$), but the levels decreased after administration of the study medications in patients of Dex group and increased in the patients of Dopa group and the difference between the two groups was statistically significant ($P < 0.05$) [Figures 1b and c]. There is no significant difference in the preoperative creatinine clearance between the two

Table 2: Urine output, serum creatinine levels, blood urea nitrogen, and creatinine clearance of patients

Variable	Group Dex (n=75)	Group Dopa (n=75)	P
Urine output (mL)			
Baseline	2018.54±255.30	2070.41±280.27	0.238
Day 1	3290.68±410.40	3140.35±390.73	0.023*
Day 2	3200.35±350.74	3053.63±360.48	0.012*
Day 3	3230.75±358.16	3075.63±382.25	0.011*
Day 4	3208.68±358.16	3062.95±373.60	0.015*
Day 5	3240.23±360.45	3090.50±380.58	0.014*
Serum creatinine (mg/dL)			
Baseline	1.62±0.23	1.56±0.21	0.097
Day 1	1.55±0.78	1.88±0.89†	0.017*
Day 2	1.50±0.82†	1.96±0.94†	0.002*
Day 3	1.46±0.80†	1.80±0.85†	0.012*
Day 4	1.45±0.81†	1.83±0.89†	0.007*
Day 5	1.48±0.83†	1.82±0.89†	0.016*
Blood urea nitrogen (mg/dL)			
Baseline	48.61±7.44	46.74±6.89	0.112
Day 1	46.78±6.20	49.50±8.17	0.023*
Day 2	46.15±8.73	50.75±11.84†	0.007*
Day 3	45.97±8.57	50.13±9.45†	0.005*
Day 4	45.78±8.45	50.65±10.50†	0.002*
Day 5	45.42±9.24	51.10±12.15†	0.002*
Creatinine clearance (mL/min)			
Baseline	85.60±15.48	88.18±14.32	0.291
Day 1	89.43±15.19	83.75±18.48†	0.041*
Day 2	91.85±15.72†	85.15±17.10	0.013*
Day 3	91.54±14.86†	84.94±16.77†	0.011*
Day 4	90.94±16.33†	83.83±17.60†	0.011*
Day 5	92.18±15.40†	85.30±17.62	0.012*

Data are presented as mean±SD. * $P < 0.05$ significant comparison between the two groups, † $P < 0.05$ significant compared to the preoperative reading within the same group. Baseline: Preoperative values, Day 1: First postoperative day, Day 2: Second postoperative day, Day 3: Third postoperative day, Day 4: Fourth postoperative day, Day 5: Fifth postoperative day, SD: Standard deviation, Group Dex: Dexmedetomidine group, Group Dopa: Dopamine group

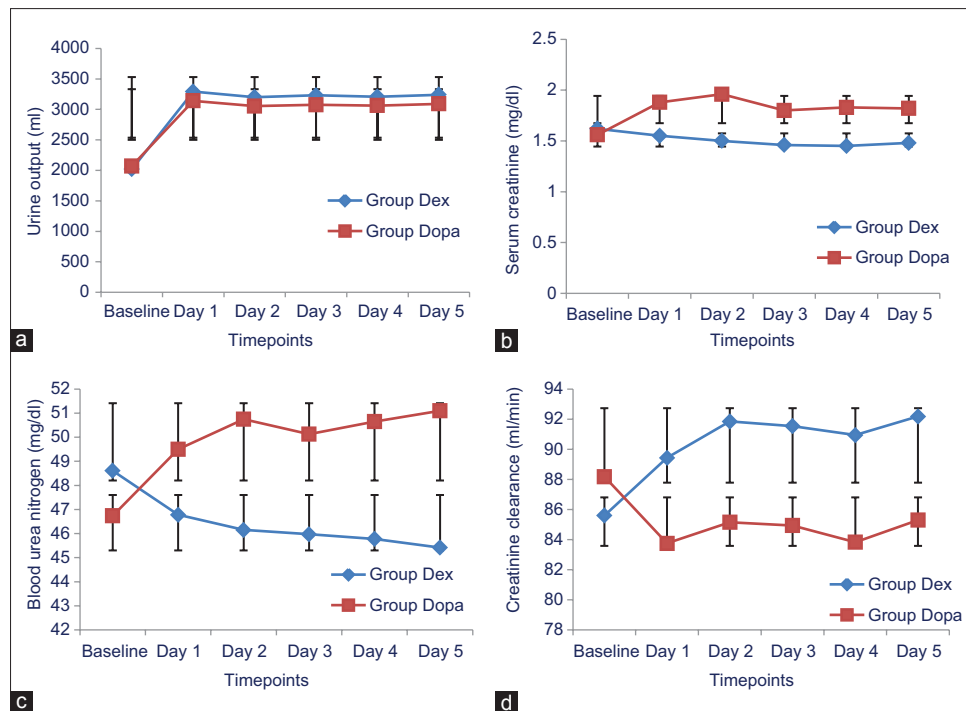


Figure 1: (a) Urine output of patients; (b) Serum creatinine of patients; (c) Blood urea nitrogen of patients; (d) Creatinine clearance of patients. Group Dex: Dexmedetomidine group, Group Dopa: Dopamine group, Baseline: Preoperative values, Day 1: First postoperative day, Day 2: Second postoperative day, Day 3: Third postoperative day, Day 4: Fourth postoperative day, Day 5: Fifth postoperative day

groups ($P > 0.05$), but the creatinine clearance increased after administration of the study medications in patients of Dex group and decreased in patients of Dopa group and the difference between the two groups was statistically significant ($P < 0.05$) [Figure 1d].

Table 3 shows the changes in the heart rate, mean arterial blood pressure, and central venous pressure of patients. There was no significant difference in the preoperative heart rate between the two groups ($P > 0.05$). The heart rate decreased during the surgery and 1st and 2nd days in the patients of Dex group and increased in the patients of Dopa group and the difference between the two groups was statistically significant ($P < 0.05$). There are no significant differences in the heart rate through the 3rd, 4th, and 5th days between the two groups ($P > 0.05$). There are no significant differences in the mean arterial blood pressure and central venous pressure through the study between the two groups ($P > 0.05$).

There was no significant difference in the cardiac index, mean pulmonary arterial blood pressure, and pulmonary artery wedge pressure through the study between the two groups ($P > 0.05$) [Table 4].

Table 5 shows the changes in the intraoperative data and outcome of patients. There was no significant difference in the CPB time, aortic cross-clamping, cooling temperature, requirement for intra-aortic balloon pump, pacing, nitroglycerine dose, hematocrit value, transfused-packed red blood cells, and the blood loss between the two

groups ($P > 0.05$). The required dose for epinephrine and norepinephrine was higher in the patients of Dex group than the Dopa group ($P = 0.015$ and $P = 0.017$, respectively). The required intraoperative and postoperative fluids were higher in the patients of Dex group than the Dopa group ($P < 0.05$). The incidence of acute renal impairment and acute renal failure was higher in the patients of Dopa group than the Dex group ($P = 0.034$ and $P = 0.049$, respectively). The requirement for temporary postoperative dialysis was higher in the patients of Dopa group than the Dex group ($P = 0.049$), and the incidence of the permanent dialysis was higher in the patients of Dopa group than the Dex group, but it was statistically insignificant ($P = 0.310$). The ICU and hospital length of stay prolonged in the patients of the Dopa group than Dex group ($P < 0.05$). The incidence of mortality between the two groups was statistically insignificant ($P = 0.559$).

Discussion

Many articles were reviewed for the pharmacological renal protection in high-risk renal patients who did cardiac surgery, but there was no article compared the continuous infusion of dexmedetomidine and dopamine during cardiac surgery, and therefore, the present study was done to assess the perioperative renal protection of these medications.

The present study showed that the perioperative continuous infusion of dexmedetomidine resulted in a decrease in the serum creatinine level and blood urea nitrogen, and also, there was an increase in the creatinine clearance

Table 3: Heart rate of patients, mean arterial blood pressure, and central venous pressure of patients

Variable	Group Dex (n=75)	Group Dopa (n=75)	P
Heart rate (bpm)			
T0	78.49±10.43	76.93±9.22	0.333
T1	74.46±10.55 [†]	78.57±11.22	0.022*
T2	73.50±13.29 [†]	79.42±15.87	0.014*
T3	74.21±12.67 [†]	79.18±15.38 [†]	0.032*
T4	76.21±10.46	80.18±12.80 [†]	0.039*
T5	78.15±12.70	82.30±13.62 [†]	0.055
T6	77.57±12.70	81.24±14.90 [†]	0.106
T7	78.75±13.50	83.10±15.61 [†]	0.070
Mean arterial blood pressure (mmHg)			
T0	102.15±15.41	105.10±13.50	0.214
T1	99.80±14.35	104.33±15.40	0.273
T2	97.75±11.80	99.68±12.16	0.325
T3	95.43±12.60	96.85±14.57	0.524
T4	98.90±13.46	101.37±15.70	0.302
T5	103.52±12.30	102.37±13.47	0.585
T6	105.10±9.75	105.53±11.28	0.803
T7	107.47±11.76	104.53±10.44	0.107
Central venous pressure (mmHg)			
T0	10.95±1.68	11.35±1.75	0.155
T1	12.66±1.73	12.35±1.65	0.263
T2	13.16±1.25	12.89±1.46	0.225
T3	12.65±1.80	13.00±1.32	0.176
T4	13.22±1.50	13.37±1.28	0.511
T5	13.12±1.64	13.50±1.25	0.112
T6	12.90±1.74	13.38±1.40	0.064
T7	12.57±1.80	12.70±1.55	0.636

Data are presented as mean±SD. * $P<0.05$ significant comparison between the two groups, [†] $P<0.05$ significant compared to the preoperative reading within the same group. T0: Baseline reading, T1: Reading before cardiopulmonary bypass, T2: Reading after cardiopulmonary bypass, T3: Reading first postoperative day, T4: Reading second postoperative day, T5: Reading third postoperative day, T6: Reading fourth postoperative day, T7: Reading fifth postoperative day, SD: Standard deviation, Group Dex: Dexmedetomidine group, Group Dopa: Dopamine group

and urine output in high-risk renal patients compared to the continuous infusion of dopamine. The incidence of acute renal failure decreased in the dexmedetomidine group compared to the dopamine group. The number of required patient for postoperative dialysis decreased in the dexmedetomidine group compared to the dopamine group.

These findings correlate with the study done by Niu *et al.*^[21] that showed the renal blood flow volume increased significantly during and after CPB with administration of dexmedetomidine throughout the surgery. Ji *et al.*^[22] showed in a retrospective analysis of 1133 patients that postbypass dexmedetomidine infusion is associated with a significant reduction in the incidence of acute renal injury after cardiac surgery. Cho *et al.*^[23] conducted a placebo-controlled randomized controlled trial in 200 patients undergoing valvular heart disease and found that dexmedetomidine infusion reduced the incidence and severity of acute kidney injury. Furthermore, Dai *et al.*^[24] found that small dose of dopamine (2 µg/kg/min) did not increase the renal blood flow or improve the postoperative renal function in the elderly patients undergoing cardiac

valve replacement under CPB, and another study showed the occurrence of renal vasoconstriction and impairment of renal perfusion with low-dose dopamine in patients with acute renal failure.^[25]

Furthermore, other studies showed no role of low-dose dopamine in renal protection.^[26-35] Many randomized studies showed that the dose of dopamine (3 µg/kg/min) failed to demonstrate an improvement in the creatinine clearance, urine output and incidence of renal failure during liver transplant,^[36] vascular,^[37] and obstructive jaundice surgery.^[38]

Dexmedetomidine induces diuresis through the following mechanisms: (1) It decreases the norepinephrine level in the blood, and thus, it induces renal artery vasodilatation and increases renal blood flow and urine output;^[17,18] (2) α_2 -adrenoceptors exist widely in the renal peritubular vasculatures and proximal and distal tubules,^[39] and therefore, it can improve the perfusion of the renal tissues; (3) it decreases the secretion of vasopressin and increases the release of atrial natriuretic peptide resulting

Table 4: Cardiac index, mean pulmonary arterial blood pressure, and pulmonary artery wedge pressure

Variable	Group Dex (n=75)	Group Dopa (n=75)	P
Cardiac index (L/min/m ²)			
T0	2.50±0.30	2.44±0.35	0.261
T1	2.42±0.28	2.48±0.37	0.264
T2	2.55±0.24	2.50±0.35	0.309
T3	2.62±0.26	2.55±0.29	0.121
T4	2.70±0.20	2.66±0.23	0.257
T5	2.63±0.22	2.68±0.25	0.195
T6	2.60±0.31	2.63±0.28	0.534
T7	2.64±0.26	2.58±0.29	0.184
Mean pulmonary arterial blood pressure (mmHg)			
T0	21.72±2.80	22.10±2.40	0.373
T1	20.55±2.90	21.23±2.60	0.132
T2	19.90±1.71	20.40±2.80	0.189
T3	23.16±2.42	22.65±2.21	0.178
T4	21.71±2.32	22.25±2.38	0.161
T5	22.66±3.15	21.87±2.93	0.113
T6	22.85±2.40	23.27±2.68	0.313
T7	20.78±2.18	21.36±2.45	0.127
Pulmonary artery wedge pressure (mmHg)			
T0	12.55±2.17	13.10±2.43	0.145
T1	14.60±3.42	13.75±3.80	0.152
T2	15.35±3.48	14.87±3.65	0.411
T3	15.65±3.22	15.15±3.45	0.360
T4	14.90±3.46	15.28±3.72	0.518
T5	14.72±3.20	15.00±3.51	0.610
T6	14.29±3.37	14.63±3.58	0.550
T7	13.80±3.42	14.18±3.50	0.502

Data are presented as mean±SD. T0: Baseline reading; T1: Reading before cardiopulmonary bypass, T2: Reading after cardiopulmonary bypass, T3: Reading first postoperative day, T4: Reading second postoperative day, T5: Reading third postoperative day, T6: Reading fourth postoperative day, T7: Reading fifth postoperative day. SD: Standard deviation, Group Dex: Dexmedetomidine group, Group Dopa: Dopamine group

in natriuresis;^[19] (4) it induces sympatholysis attenuated sodium reabsorption in tubular cells through α 2-adrenergic action;^[40] (5) it has an anti-inflammatory effect;^[41,42] and (6) it has a renoprotective effect of against the ischemic and reperfusion renal injury.^[43-46]

Contrary to the result of the present study, some studies showed no effect of dexmedetomidine on the serum creatinine and creatinine clearance, although the urinary output increased significantly during the first 24 h after cardiac surgery.^[41,47,48] Göksedef *et al.*^[49] found no effect of low-dose dexmedetomidine on urine output and renal indices such as urea, creatinine, and creatinine clearances. Davis *et al.*^[14] showed that the infusion of dopamine at small doses caused a significant improvement in renal function, improving the urinary output without deleterious effects on hemodynamics. In addition, Sumeray *et al.*^[50] showed that low-dose dopamine infusion reduces significantly the renal tubular injury following CPB surgery.

The present study did not include a control group as the dopamine was commonly used for the renoprotection during cardiac surgery, it was considered as the standard

medication during the study, and the dexmedetomidine as a new medication for renoprotection was compared to dopamine.

The present study recognizes some limitations such as a being single center study as well as the small number of patients, and there was no control group.

Conclusion

The continuous infusion of dexmedetomidine during cardiac surgery has a renoprotective effect and decreased the deterioration in the renal function in high-risk renal patients compared to the continuous infusion of dopamine.

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Nil.

Table 5: Intraoperative data and outcome of patients

Variable	Group Dex (n=75)	Group Dopa (n=75)	P
CPB time (min)	120.90±25.37	117.54±20.60	0.374
Cross clamping time (min)	97.48±12.25	94.85±11.74	0.181
Cooling temperature (°C)			
34	58	63	0.408
22	17	12	0.408
Intra-aortic balloon pump	8	5	0.384
Pacing	15	9	0.181
Epinephrine (µg/kg/min)	0.08±0.05	0.06±0.03	0.015*
Norepinephrine (µg/kg/min)	0.05±0.02	0.04±0.03	0.017*
Nitroglycerine (µg/kg/min)	0.72±0.35	0.69±0.40	0.625
Transfused P-RBC (unit)	3.75±0.62	3.58±0.72	0.123
Hematocrit (%)	38.65±3.36	37.81±3.20	0.119
Blood loss (mL)			
Intraoperative (mL)	2350.73±246.80	2320.40±225.17	0.433
Postoperative (mL/24 h)	775.38±156.69	748.85±138.00	0.272
Intraoperative fluids			
Crystalloids (mL)	3470.75±775.40	3050.42±685.50	0.001
Hesteril 6 (%)	705.50±140.43	630.85±165.30	0.003
Postoperative fluids 24 h			
Crystalloids (ml)	4300.16±915.63	4000.60±938.73	0.049
Hesteril 6 (%)	1100.35±325.70	955.42±380.80	0.013
Acute renal impairment	4	12	0.034
Acute renal failure	2	8	0.049*
Postoperative dialysis			
Temporarily	2	8	0.049*
Permanent	1	3	0.310
ICU length of stay (days)	4.38±1.35	5.03±1.89	0.016*
Hospital length of stay (days)	6.88±2.64	8.03±2.85	0.011*
Mortality	1	2	0.559

Data are presented as mean±SD, n (%). *P<0.05 significant comparison between the two groups. CPB: Cardiopulmonary bypass, P-RBC: Packed red blood cells, ICU: Intensive Care Unit, Group Dex: Dexmedetomidine group, Group Dopa: Dopamine group, SD: Standard deviation

Conflicts of interest

There are no conflicts of interest.

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