

Comparison of Dexmedetomidine and Ketamine versus Propofol and Ketamine for Procedural Sedation in Children Undergoing Minor Cardiac Procedures in Cardiac Catheterization Laboratory

Abstract

Background: The ideal anaesthetic technique for management of paediatric patients scheduled to undergo cardiac catheterisation is still not standardised. **Aim:** To compare the effects of ketamine-propofol and ketamine-dexmedetomidine combinations on hemodynamic parameters and recovery time in paediatric patients undergoing minor procedures and cardiac catheterisation under sedation for various congenital heart diseases. **Material and Methods:** 60 children of either sex undergoing cardiac catheterisation were randomly assigned into two groups Dexmedetomidine-ketamine group (DK) and Propofol-ketamine (PK) of 30 patients each. All patients were premedicated with glycopyrrolate and midazolam (0.05mg/kg) intravenously 5-10 min before anaesthetic induction. Group 'DK' received dexmedetomidine iv infusion 1 µg/kg over 10 min + ketamine 1mg/kg bolus, followed by iv infusion of dexmedetomidine 0.5µg/kg/hr and of ketamine 1 mg/kg/hr. Group 'PK' received propofol 1mg/kg and ketamine 1mg/kg/hr for induction followed by iv infusion of propofol 100 µg/kg/hr and ketamine 1 mg/kg/hr for maintenance. Haemodynamic parameters and recovery time was recorded postoperatively. **Statistical Analysis:** Independent sample t test was used to compare the statistical significance of continuous variables of both the groups. Chi square test was used for numerical data like gender. Fischer exact test was applied for non parametric data like ketamine consumption. **Results:** We observed that heart rate in dexmedetomidine (DK) group was significantly lower during the initial 25 mins after induction compared to the propofol (PK) group. Recovery was prolonged in the DK group compared to the PK group (40.88 vs. 22.28 min). Even ketamine bolus consumption was higher in DK group. **Conclusion:** Use of dexmedetomidine-ketamine combination is a safe alternative, without any hemodynamic or respiratory effects during the cardiac catheterization procedure but with some delayed recovery.

Keywords: Cardiac catheterization, children, dexmedetomidine, ketamine, propofol

Introduction

The ideal anesthetic technique for management of pediatric patients scheduled to undergo cardiac catheterization should be safe, easy to administer, provide adequate sedation, amnesia, immobility, cardiovascular stability, and fast recovery without residual complications. Management of children with congenital heart disease has been a great challenge for anesthesiologists especially during cardiac catheterization. General anesthesia with positive pressure ventilation can alter the intracardiac pressures as well as shunt fraction. Therefore, deep sedation with pain-free and spontaneously breathing patient on room air is preferred by the cardiac interventionist.

A wide variety of anesthetic agents such as propofol,^[1,2] ketamine,^[3,4] and

dexmedetomidine^[5,6] are used for this purpose. The goals of anesthesia for catheterization are analgesia, anxiolysis, amnesia for the patient, and easy separation from parents. At the same time, maintenance of airway, ventilation, acid-base balance, and temperature management are equally important. The anesthetic agent should optimize hemodynamic status before, during, and after the procedure tailored to the specific physiology of the individual patient and ensure smooth recovery.^[7]

The commonly performed cardiac catheterization laboratory procedures include diagnostic catheterization and interventional procedures such as pulmonary artery angioplasty, aortic-coarctation angioplasty, patent ductus arteriosus occlusion or stenting, ventricular

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septal defect closure, atrial septostomy, atrial septal defect closure, and aortic/pulmonary/mitral valve dilation.^[8]

This study was undertaken with an aim to compare the effects of dexmedetomidine-ketamine (DK) and propofol ketamine (PK) combinations on hemodynamic parameters and recovery time in pediatric patients undergoing minor cardiac procedures in cardiac catheterization laboratory.

Methods and Material

A prospective, randomized, controlled study was undertaken in a large tertiary teaching hospital from December 2013 to January 2015. After obtaining Institutional Ethical Committee approval, informed written consent was taken from all the patients' guardians before the procedure. The patients were randomly assigned into two groups: DK and PK with 30 children in each group by using sealed envelope method. All children between the age group of 1 month to 10 years of either sex undergoing cardiac catheterization lab procedures were included in the study. Children with chromosomal abnormalities or other multiple congenital anomalies, drug allergy, patients requiring mechanical ventilation or inotropic support, and patients with hepatic or renal dysfunction were excluded from the study.

According to hospital policy, all children were kept fasting for at least 6 h before procedure. The patients were premedicated with glycopyrrolate (10 µg/kg) and midazolam (50 µg/kg) intravenously (IV) 10 min before taking the child inside the catheterization laboratory where appropriate measures to prevent hypothermia to child were undertaken. Standard monitors including electrocardiogram and pulse-oximeter were attached. Group (DK) received: dexmedetomidine IV infusion 1 µg/kg over 10 min + ketamine 1 mg/kg IV bolus for induction and then maintenance by IV infusion of 0.5 µg/kg/h of dexmedetomidine and 1 mg/kg/h of ketamine. Group (PK) received propofol 1mg/kg and ketamine 1 mg/kg IV for induction and then maintenance by IV infusion of 100 µg/kg/min of propofol and 1 mg/kg/h of ketamine. Additional doses of ketamine 0.5 mg/kg IV bolus were administered when a child showed discomfort in both groups. Heart rate, mean blood pressure (BP), oxygen saturation (SpO₂), and respiratory rate were recorded every 5 min during the procedure. Postoperatively, heart rate and SpO₂ were recorded every 10 min. Recovery time was noted. Scores were assigned on admission to postanesthetic room where the routine vital signs were measured. Repeated scoring was performed every 10 min till the patient recovered up to score of 6 according to the Stewards Simplified Postanesthetic Recovery Score^[9] [Table 1].

For statistical analysis, a sample size of 30 in each group was calculated with an alpha error of 5% (confidence interval 95%) and power of study of 80% and data analysis was done using statistical software version 17.0. This mean

Table 1: Stewards scoring system for post-op recovery

	Score
Consciousness	
Awake	2
Responding to stimuli	1
Not responding	0
Airway	
Coughing on command or crying	2
Maintaining good airway	1
Airway requires maintenance	0
Movement	
Moving limbs purposefully	2
Non-purposeful movements	1
Not moving	0

Table 2: Comparison of mean age (years) in group DK and PK

Group	No	Age (years)		P
		Mean	SD	
Group DK	30	4.84	2.61	0.627
Group PK	30	5.08	2.22	

Table 3: Comparison of weight (kgs) in group DK and PK

Group	Number of patients	Weight (kg)		P
		Mean	SD	
Group DK	30	15.52	6.26	0.541
Group PK	30	16.56	5.35	

and standard deviation were used for continuous data such as age, weight, duration of surgery, heart rate, BP, respiratory rate, and recovery time. Independent sample *t*-test was used to compare the statistical significance of continuous variables of both the groups. Chi-square test was used for numerical data like gender. Fischer exact test was applied for nonparametric data like ketamine consumption.

Results

A total of 60 children were recruited in this study. There was no significant difference between the two groups with respect to patient characteristics, type and mean duration of surgery.

The patient's age and weight were comparable in two groups [Tables 2 and 3]. The mean age in DK group was 4.84 (±2.61) years and in PK group was 5.08 (±2.22) years with *P* = 0.627. The mean weight in DK group was 15.52 (±6.26) kg and in PK group was 16.56 (±5.35) kg with *P* = 0.541. By using two independent sample *t*-test, *P* > 0.05, therefore there was no significant difference between mean age and weight between the two groups. Mean duration of surgery/procedure in group DK and

group PK was 44.04 ± 10.81 min and 39.20 ± 11.70 , and there was no significant difference in duration of surgery ($P \geq 0.05$). The two groups were comparable with respect to type of surgery/procedure [Table 4]. Heart rate was significantly lower in DK group at 5, 10, 15, 20, 25 min postinduction in comparison to PK group. Later on, the heart rate continued to be lower in both the groups but it was not statistically significant [Figure 1].

There was no statistically significant difference between the two groups in mean BP [Figure 2].

There was no significant difference between mean SpO₂ in group DK and group PK from baseline to 60th min [Figure 3]. There was no significant difference between the respiratory rate in group DK and group PK from baseline to 60th min [Figure 4]. Recovery was significantly delayed in DK group (40.88 ± 8.19) versus 22.28 ± 3.63 min in PK group ($P \leq 0.05$) [Table 5]. Actual ketamine consumption was (2.02 mg/kg/h) in DK group, whereas in PK group, it was (1.25 mg/kg/h). Ketamine boluses consumption was significantly higher in DK group (09 patients in DK vs. 02 patients in PK) ($P \leq 0.05$) [Table 6].

Discussion

Pediatric cardiac catheterization procedures are different from adults in several ways including different types of disease pattern in the patient, different requirements for the procedure, mandatory sedation or general anesthesia so as to prevent movement in almost all patients and a need of complete evaluation of structurally abnormal heart. Commonly performed procedures are angioplasty, valvuloplasty, coil embolization, atrial septostomy, device closure, diagnostic cath studies, and electrophysiological studies.

In this study, we compared the DK versus propofol ketamine combinations on hemodynamic stability and recovery time in 60 spontaneously breathing children undergoing cardiac catheterization. We observed decrease in the heart rate after induction in both the groups, but the decrease was statistically significant in the dexmedetomidine-ketamine

group in the first 25 min after induction. Later on, the decrease in heart rate was persistent in both the groups till the end of procedure but it was not statistically significant. In a similar study by Tosun *et al.*, the effects of DK and PK combinations on hemodynamics, sedation level, and the recovery period in pediatric patients undergoing cardiac catheterization were studied.^[10] The heart rate in Group 1 was significantly lower (average 10–20 beats/min) than Group 2 after induction and throughout the procedure. We found a similar decrease in the heart rate in the dexmedetomidine-ketamine group. Systolic, diastolic, and mean BP were reduced after induction in both the groups, but there was no statistically significant difference in the

Table 4: Comparison of type of procedure in group DK and PK

S.no	Type of procedure	Group DK	Group PK	Total
1.	ASD for device closure	9	8	17
2.	VSD for device closure	6	6	12
3.	PDA for device closure	8	8	16
4.	Cath study	6	7	13
5.	Bicuspid aortic valve with severe AS	1	1	2
Total		30	30	60

Table 5: Comparison of mean recovery time (mins) in group DK and PK

Group	Number of patients	Recovery time (min)		P
		Mean	SD	
Group DK	30	40.88	8.19	<0.001
Group PK	30	22.28	3.63	

Table 6: Comparison of ketamine boluses consumption (n) in group DK and PK

Ketamine used	Group		Total	P
	Group DK	Group PK		
Yes	21	28	49	0.037
No	9	2	11	
Total	30	30	60	

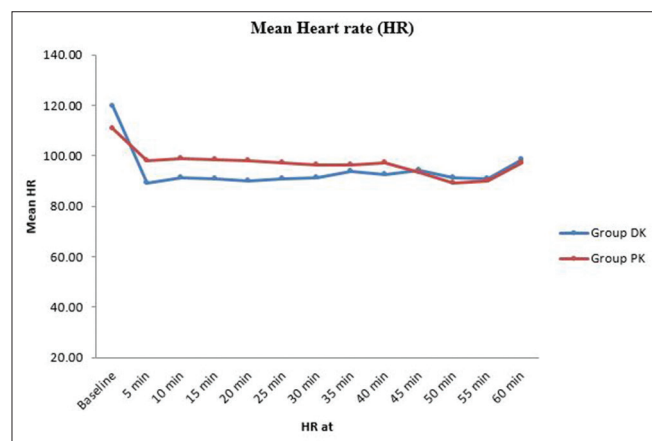


Figure 1: Comparison of mean heart rate in the two groups

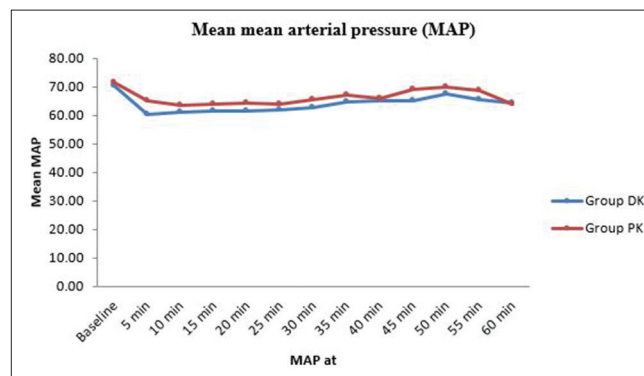


Figure 2: Comparison of mean blood pressure in the two groups

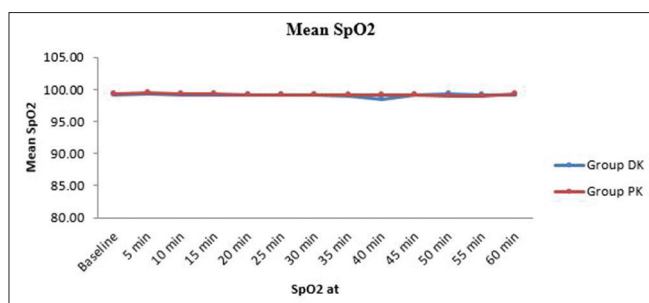


Figure 3: Comparison of mean oxygen saturation in the two groups

mean BP between the two groups during the procedure. In a similar study by Ali *et al.* which compared DK and PK as anesthetic agents in pediatric cardiac catheterization, clinical outcome of both groups was similar and there was no significant difference in the recovery patterns and hemodynamic status.^[11] In our study, we had similar results in terms of BP, SpO₂ and Respiratory rate between the two groups.

Propofol has been recommended for pediatric cardiac catheterization because of rapid emergence it produces. Gozal *et al.* studied the effects of propofol on the systemic and pulmonary circulations on the pediatric patients scheduled for cardiac catheterization.^[12] The patients were given 1 µg/kg fentanyl and 1–2 mg/kg propofol by bolus and then a 100 µg/kg/min infusion of propofol. They reported that propofol seemed to an adequate sedative agent for pediatric patients undergoing cardiac catheterization, including those with intracardiac shunts. Morray JP *et al.* assessed the hemodynamic effects of ketamine in children with congenital heart disease.^[13] Pulmonary and systemic vascular responses to ketamine (2 mg/kg, intravenously) were studied during cardiac catheterization in 20 children with congenital heart lesions. It was concluded that the hemodynamic alterations after ketamine administration in children undergoing cardiac catheterization were small and did not alter the clinical status of the patients or the information obtained by cardiac catheterization.

The alpha 2 agonist dexmedetomidine is a new sedative, analgesic, and anxiolytic agent. Its intraoperative administration reduces anesthetic requirements, speeds postoperative recovery, and blunts the sympathetic nervous system response to surgical stimulation. Munro *et al.* reported their experience using dexmedetomidine in 20 children aged 3 months to 10 years undergoing cardiac catheterization.^[14] A loading dose of 1 µg/kg dexmedetomidine was administered over 10 min followed by an initial infusion rate of 1 µg/kg/h. Hemodynamic parameters, bispectral index score, and sedation score were measured every 5 min. Their initial experience showed dexmedetomidine, with or without the addition of propofol, may be a suitable alternative for sedation in spontaneously breathing patients undergoing cardiac catheterization.

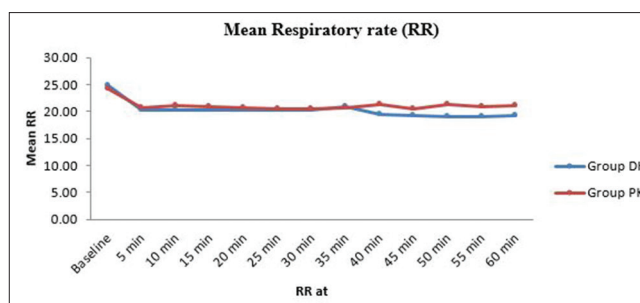


Figure 4: Comparison of mean respiratory rate in the two groups

In this study, the recovery time was significantly longer in DK group compared to the PK group (40.88 ± 8.19 vs. 22.28 ± 3.63 min) $P \leq 0.05$. The study conducted by Heard *et al.* which compared the Dexmedetomidine-Midazolam with propofol for maintenance of anesthesia in children undergoing magnetic resonance imaging suggested that the time to full recovery was significantly longer after dexmedetomidine administration than after propofol by 15 min.^[15] In a study conducted by Thimmarayappa *et al.*, airway patency was measured objectively during dexmedetomidine sedation under radiographic guidance in spontaneously breathing pediatric patients scheduled for cardiac catheterization procedures.^[16] The average recovery time from dexmedetomidine sedation after stopping the infusion was 39.86 ± 12.22 min with maximum being 70 min.

Ketamine boluses consumption was more in DK group than the PK group. Nine children in DK group required additional boluses of ketamine when compared to 2 children in PK group. Similar study by Tosun *et al.* which compared the same drugs for children undergoing minor cardiac procedures in cardiac catheterization laboratory, showed that ketamine consumption in dexmedetomidine group was more than the propofol group (2.03 vs. 1.25 mg/kg/h).^[10] Our study showed similar high utilization of ketamine in dexmedetomidine group compared to the propofol group. None of the children in both the groups showed any side effects like bradycardia, oxygen desaturation, hypotension requiring any treatment, convulsions, laryngospasm, agitation, hiccups, shivering, increased oral secretions, nausea, and vomiting.

Conclusion

This study which compared the dexmedetomidine and ketamine versus propofol and ketamine combinations on hemodynamic stability, respiratory variables, and recovery time in children undergoing minor cardiac procedures in cardiac catheterization laboratory concludes that the use of DK combination is a safe, practical alternative, without any hemodynamic or respiratory effects during the cardiac catheterization laboratory procedure but with some delayed recovery.

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Conflicts of interest

There are no conflicts of interest.

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