ORIGINAL ARTICLE

Comparison of Propofol and Ketamine with Sevoflurane for Laryngeal Mask Anesthesia for Cardiac Catheterization of Pediatric Patients

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ABSTRACT

Background: Sedation and anesthesia are required for procedures in pediatric patients for cardiac catheterization. In this study, we compare anesthetic agents in providing ideal anesthetic conditions with hemodynamic stability. **Materials and Methods:** A total of 100 patients were randomized into two groups. One group was anesthetized using propofol and ketamine and other group received inhaled sevoflurane (Sevo) as sole anesthetic. Variables were recorded and outcome was compared. **Results:** Sevo provided faster onset and offset times ($P < 0.01$), albeit with higher incidence of emergence delirium ($P < 0.01$) for all other variables both the groups were comparable. **Conclusion:** Both the groups provided essentially stable and safe anesthetic option for cardiac catheterization for pediatric patients. Sevo provided for faster induction and recovery as compared to IV anesthetics used in the study, but the recovery was complicated in the Sevo group by emergence delirium more frequently. This study failed to record any statistically significant hemodynamic variation between the two groups.

KEY WORDS: Cardiac catheterization, congenital heart disease, ketamine, laryngeal mask airway, pediatric, propofol, sevoflurane.

Introduction

Sedation techniques for pediatric cardiac catheterizations were described in anesthesia literature as early as 1950s. Agents which caught early attention being pethidine, promethazine, and chlorpromazine, usually administered intramuscular.[1] With advances in field of echocardiography, the scope and practice of pediatric cardiac catheterization shifted from diagnosis of anatomical defects to that of classifying physiological severity and interventional procedures, currently, a wide variety of these procedures are carried out in cardiac catheterization laboratory (CCL).[2]

These procedures are mostly of investigative origin and even if intervention is planned, it generally does not require prolonged anesthesia, and faster turnovers are desirable. Patient movements do adversely affect the efficiency and accuracy of the cardiologist. These targets are to be achieved in a manner that the hemodynamics are not affected significantly.[3] The hemodynamics and partial pressures of blood gases can get significantly influenced by the choice of anesthetic agents and technique. In our study, we aim to study how propofol and ketamine (PK) combined fare against sevoflurane (Sevo) in achieving ideal anesthetic characteristics of these agents for efficient and safe management of patients in CCL. Available data, after advent and regular use of supraglottic airway devices is not sufficient to describe any standard technique, in literature, of anesthesia for procedures in CCL.

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Aims and Objectives

With the aim of comparing Sevo with PK combination in the pediatric patients undergoing cardiac catheterization procedures, the following objectives were set as follows:

a. Primary objective: Compare anesthetic characteristics of both the groups

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b. Secondary objective: Compare the ability to maintain hemodynamic stability as close to baseline.

To achieve the above objectives, variables recorded were age, gender, weight, American Society of Anesthesiologists (ASA) grade, cardiac pathology, comorbidity (if any), procedure planned, patient movement, laryngeal mask airway (LMA) insertion and removal times, time to recovery and post-anesthesia emergence delirium (PAED) score, variation in heart rate, and blood pressure.

PAED score is a validated scoring system for diagnosing and measuring emergence delirium in pediatric patients, higher the score higher is the intensity of emergence delirium.[4]

Materials and Methods

Study population selected were pediatric patients between the ages of 2 and 8 years who presented for procedure in CCL. A prospective, open labeled, and randomized comparative study was planned. Patients who did not provide consent, ASA grade more than III, known drug allergies to any of the drugs used in study, and patients who require drugs other than those in the study were excluded from the study. Sample size calculation was done for continuous variable (time, PAED scores, etc.), alpha error was set at 0.05 and power at 80%, the numbers required in each group were 46 and 47, it was decided to recruit 100 patients with 50 in each group, randomized using sealed envelopes.

Institutional ethics clearance was obtained, and the study design could not include any blinding, randomization was achieved using sealed envelopes into the two groups, PK and Sevo. Patients were evaluated a day prior and written informed consents were obtained from parents after explaining the procedure, requisite pre-anesthetic instructions were given.

On arrival to CCL, the patients recruited a day prior were assigned into either of the two groups, PK or Sevo. Demographic data and baseline values for heart rate and blood pressure were recorded, premedication with midazolam 50 μg/Kg and glycopyrrolate 4 μg/Kg is administered intravenously. Once inside the procedure room, patient was connected to monitor before induction as per the protocol. Patients in the Sevo group were induced with Sevo at 6–8% and maintained at 1.5–2%. Those assigned to the PK group were induced with a bolus of propofol 1.5 μg/kg and ketamine 1.5 μg/kg iv thereafter maintained by infusion of propofol 50 μg/kg/min and ketamine 25 μg/kg/min. Even though a certain dose variation is included in the Sevo group to accommodate for managing anesthesia, for every episode of hemodynamic variations more than 20% are recorded, the maintenance dose of anesthetics in both the groups can be reduced transiently as per clinical requirement.

LMA was inserted after relaxation of mandible, patient was kept on spontaneous ventilation on air oxygen mixture with FiO_2 of 0.3, or higher if indicated by the procedure or patient condition. Variables were recorded at regular intervals, patient movements were observed when mentioned by cardiologist. On completion of the procedure, administration of the anesthetic agent(s) was stopped and LMA was removed when spontaneous swallowing movements were observed. This time from stopping of anesthetic agent to removal is noted as LMA removal time.

The time to spontaneous eye opening was recorded as time to recovery. Patient thereafter was detained in recovery room and PAED scoring was done for the diagnosis and severity of emergence delirium.

Results

During the study period, a total of 50 patients in each group were provided anesthesia for cardiac catheterization using LMA. No significant difference, between the two groups, was observed when demographic data was compared (Table 1).

Patients in the PK group had more number of movements and procedure interventions as compared to the Sevo group, as depicted in Table 2. In the Sevo group, 64% (n = 32) laid immobile as compared to 50% (n = 25) in the PK group. After analysis, the comparison of various parameters in the two groups using Mann–Whitney U-test yielded P = 0.099 and was not considered significant. Comparison between "0" movements and rest ("1," "2," "3," and ">3" movements) was done using 2 × 2 Chi-square test, this difference was also not statistically significant, P = 0.225. Procedure interruptions when compared between the two groups did not have any significant difference.

Hemodynamics were recorded for both the groups, namely, heart rate and blood pressure. More than

Table 1: Demographic data

Variable	PK group	Sevo group	All patients	*P*-value
Age, mean months (SD)	48.30 (21.077)	51.64 (25.866)	49.97 (23.534)	0.481
Male sex – *n* (%)	35 (70)	34 (68)	69 (69)	1
Female sex – *n* (%)	15 (30)	16 (32)	31 (31)	1
Weight, kg (SD)	13.62 (3.036)	12.72 (3.150)	13.17 (3.111)	0.149
ASA Grade II	11 (22)	11 (22)	22 (22)	Identical
ASA Grade III	39 (78)	39 (78)	78 (78)	Identical

PK: Propofol and ketamine, Sevo: Sevoflurane

Table 2: Episodes of movements and interruptions

Number	PK (%)	Sevo (%)	*P*-value
Movements			
0	25 (50)	32 (64)	0.099
1	15 (30)	14 (28)	Mann–Whitney U
2	6 (12)	2 (4)	0.225
3	2 (4)	1 (2)	Chi-square
>3	2 (4)	1 (2)	
Interruptions			
0	36 (72)	39 (78)	0.444
1	10 (20)	9 (18)	Mann–Whitney U
2	3 (6)	2 (4)	0.644
3	1 (4)	0 (0)	Chi-square
>3	0 (0)	0 (0)	

PK: Propofol and ketamine, Sevo: Sevoflurane

Table 3: Heart rate and blood pressure variability

Variability	PK (%)	Sevo (%)	*P*-value
Heart rate			
<20%	40 (80)	37 (74)	0.635
>20%	10 (20)	13 (26)	
Blood pressure			
<20%	41 (82)	37 (74)	0.469
>20%	9 (18)	13 (26)	

PK: Propofol and ketamine, Sevo: Sevoflurane

20% variation was considered clinically significant, the number of patients in each group are shown in Table 3. Comparison between the groups did not reveal any statistically significant difference.

None of the patients in the study population had any episodes of vomiting in the post-anesthesia period. Analysis of patients having post-anesthesia nausea was done, 8% ($n = 4$) of the patients in the Sevo group had post-anesthesia nausea as compared to 2% ($n = 1$) in the PK group. Again this difference was not of any statistical significance, $P = 0.362$, by Fisher's exact test.

Time for LMA insertion and removal was recorded in seconds and recovery time was recorded in minutes. Comparisons between these durations were done statistically using Mann–Whitney U-test. The times are as shown in the Table 4, the difference in LMA insertion time was statistically significant, $P = 0.001$, difference in LMA removal time was, again, statistically significant, $P < 0.01$. Recovery time for the PK group was more than the Sevo group and this difference was statistically significant, $P < 0.01$.

Statistically significant difference presents for all three durations between both the groups.

Mean ranks of PAED score of both the groups are as shown in Table 5 and observed to be significantly higher, $P < 0.01$, in the Sevo group (Figure 1).

Discussion

General anesthesia for pediatric patients undergoing cardiac catheterization had been described in 1965, before which patients were kept lightly sedated usually using a mixture of drugs given through intramuscular route.[5] Episodes of respiratory depression were recorded, also noted were increase in pulmonary vascular resistance, decrease in systemic vascular resistance thus increase in any right to left shunt.[1,6] It was acknowledged that general anesthesia would interfere with hemodynamics, so would controlled ventilation along with the partial pressures of blood gases, in effect this would lead to interference in results of the procedure for which the patient has presented.[5] Both ketamine and propofol have been used as sole

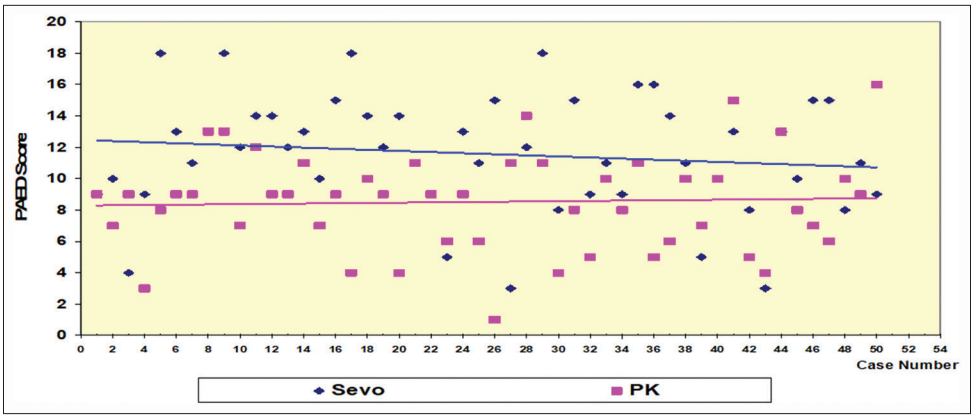

Figure 1: Trend line of post-anesthesia emergence delirium score across the study in both the groups

Table 4: Mean LMA insertion, removal, and recovery times for the patients in both groups

Variable	PK group Mean (SD)	Sevo group mean (SD)	All patients mean (SD)	*P*-value
LMA insertion time (s)	128.86 (38.085)	104.38 (29.820)	116.62 (36.185)	0.001
LMA removal time (s)	323.48 (56.755)	151.94 (33.046)	237.71 (97.804)	0.000
Recovery time (min)	18.904 (4.1237)	10.888 (4.1190)	14.896 (5.7481)	0.000

PK: Propofol and ketamine, Sevo: Sevoflurane, LMA: Laryngeal mask airway

Table 5: PAED scores of patients in each group

PAED score	PK group	Sevo group	*P*-value
Mean rank	38.34	62.66	0.000
Sum of ranks	1917.00	3133.00	

PK: Propofol and ketamine, Sevo: Sevoflurane, PAED: Post-anesthesia emergence delirium

agent, and each has its unique hemodynamic and anesthetic properties.[7-13] In this study, we have used subanesthetic doses of both to provide anesthesia with the aim to utilize the beneficial properties of both and reduce the incidence of undesirable effects of both the drugs.

In the other group, Sevo is used as sole anesthetic both for induction and maintenance. Among the inhalational agents which are popular for pediatric age group, Sevo provides excellent hemodynamic stability.[14] The airway was maintained under anesthesia using LMA, it provided us the advantage of maintaining spontaneous ventilation at near atmospheric FiO_2 of 0.3, maintaining airway patency.

From our study, we infer that Sevo provides faster LMA insertion and removal times compared to combined use of PK, the trend was maintained when recovery timings were compared. Emergence characteristics were better in the PK group as compared to the Sevo group, it was noted that patients emerging from Sevo anesthesia had higher PAED scores. These findings are in line with some other studies conducted in patients other than those presenting for endovascular procedures in CCL.[15-18] No statistical difference was recorded on comparison of incidences of PONV between both the groups.

Higher frequency of movements was recorded in the Sevo group, even though this was statistically insignificant could probably be attributed to lack of any analgesic used in that particular group.

The secondary end point for the study was to compare hemodynamic variability. In our study, we had compared variability in heart rate and non-invasive blood pressure (NIBP) recordings taken at regular intervals. There was no significant difference between both the groups when these were compared. The findings are in line with other studies on these anesthetic agents, but with a different subgroup of patients.[19,20] The heart rate and NIBP may actually provide very limited information of hemodynamic status, particularly in this subset of patients.

Overall Sevo provided for better anesthetic characteristics, as desired for short procedures with faster inductions and recovery, the recovery though is marred by higher incidences of emergence delirium.

Conclusion

From our study, we can conclude that laryngeal mask anesthesia using the anesthetic agents used in this study can provide desirable anesthetic conditions in a safe manner. Sevo provides for efficient anesthesia management in a safe manner, special consideration for emergence will be required though. However, our particular study provides very limited information with regard to the ability of these agents to maintain stable or near baseline hemodynamics. What we gained mainly by the data and experience is that anesthesia using LMA and anesthetics at these doses can be safely administered for almost all varieties of congenital cardiac pathology patients presenting to CCL. Every definitive work of research requires some pilot program, this study can be considered as pilot for subsequent better designed, probably a cross-over study recording invasive pressures in real time, to provide for definitive and stronger evidence on hemodynamics, which were the secondary outcomes of this study.

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