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Comparison of sedation method in pediatrics cardiac catheterization

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Abstract. – OBJECTIVE: Purpose of this study is to compare the effects of various anaesthetic combinations on hemodynamics, sedation level, recovery period and complications in the patients which undergo pediatric cardiac catheterization.

PATIENTS AND METHODS: Four groups of anaesthetic combinations was created. The groups are classified as propofol-ketamine (group 1), propofol-dexmedetomidine (group 2), dexmedetomidine-ketamine (group 3), midazolam-ketamine (group 4) (for each group n=20). Baseline heart rate (HR), mean arterial blood pressure (MAP), respiratory rate (RR), peripheral oxygen saturation (SpO_2) were recorded. This parameters values were recorded at 0., 5., 10., 15., 20., 25., 30. minutes; and the groups were compared according to these measurements data.

RESULTS: For heart rate, Group 2 and 3 reduce the HR more than the drugs of Group 1 and 4 ($p < 0.05$). The SpO_2 values of Group 1 were measured to have 5% further reduction compared to the Group 2 and 3; and Group 4 has the same SpO_2 recordings compared to the Group 3 ($p < 0.05$). Comparing the recovery times; Group 4 was found to have the highest recovery time compared to the other drug groups. It is found that additional doses are needed for recovery in Group 4 ($p < 0.008$). Side effects were lowest for Group 3 and highest for Group 4.

CONCLUSIONS: Considering the complication rates, it is concluded that Group 3 is spotted as the better sedation method among the other groups. In terms of additional propofol dose, Group 1 would be the better choice. Thus, the clinician should choose the suitable methods for the patient.

Key Words:
Sedation, Catheterization, Ketamine, Propofol, Dexmedetomidine, Midazolam.

Introduction

Recent medical technologies made a gradual increase in the success rate in treatment of the diagnosed congenital heart diseases. This medical improvement has provided a new working field to anaesthetists; to observe a different patient group. The recent pediatric catheterization units are widely used to diagnose diseases and utilize their treatment.

The anaesthetist should offer the best hospital conditions to pediatric cardiology so that the diseases can be diagnosed and treated accurately. In addition to the satisfactory standards, protection of patients' physiology is vital for accurate treatment. The anaesthesia methods are mainly divided into two groups as "deep sedation" and "general anaesthesia" in pediatric catheter labs. Clinicians generally prefer the deep sedation for better results. During deep sedation, the patient should not move and should not feel any pain. Patient's respiration system and vital functions should not be suppressed as well. However, today's pharmacologic technology is still unable to offer a single anaesthetic agent having all the needed properties which can provide the needed kind of anaesthesia. Recently; propofol, ketamine, dexmedetomidine, midazolam and their combinations are the most commonly used sedation agents on patients for pediatric cardiac catheterization[1-8].

In the medical studies that are observed before starting this research, authors choose between only one of these medical combinations; which are propofol[2,3,6], ketamine[2,5] or propofol-ketamine[1,4,6,7], dexmedetomidine-ketamine[4]) and midazolam-ketamine[5].

During our study, sedation methods used in the pediatric cardiac catheterisation laboratory are combined as in four different groups in order to have a general point of view about the sedation methods. Our groups consist of propofol-ketamine, propofol-dexmedetomidine, ketamine-dexmedetomidine and midazolam-ketamine drug combinations. In our study, it is aimed to compare the efficiency and side effects of the chosen sedation methods. Besides, the complications and the recovery times of these methods were recorded in order to choose the best possible sedation method which can be used in medical operations.

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Patients and Methods

Written consents were taken from the Scientific Advisory Board of the hospital and the patient's relatives. Patient were 5 days-12 years old, of American Society of Anesthesiology (ASA) physical status II-III, scheduled for cardiac catheterization under deep sedation between January 2014-April 2014. 20 patients from each group are distributed randomly four equal groups using the sealed opaque envelope technique. The patients who need mechanical ventilation support or who are under inotropic support treatment, were excluded from the study. After 4 and 6 hours of fasting period, the patients were taken to the angiography unit. All patients were premedicated with intranasal midazolam (0.3 mg/kg). Before premedication is given to the patients, their baseline heart rate (HR), mean arterial blood pressure (MAP), respiratory rate RR), peripheral oxygen saturation (SpO_2) and Ramsey sedation score (Table I) were recorded. Premedication was supported with intranasal midazolam 0.3 mg/kg. For insertion of intravenous catheter, patients were taken into the Angiography Unit.

An intravenous catheter was inserted. Monitorization of the patients were provided to be able to routinely follow up the electrocardiography, peripheral oxygen saturation and non invasive blood pressure. In all groups, drug infusion was prepared in the solution of 5% dextrose. The induction was provided with 2 mg/kg intravenous propofol. Also, to avoid any case of inadequate sedation and patient discomfort, in all of the groups, the sedation depth was increased with 1 mg/kg intravenous propofol. After the propofol induction, the study/research has been started with an infusion of propofol 50 mcg/kg/min and ketamine 25 mcg/kg/min respectively in the propofol-ketamine group (Group 1). In the propofol-dexmedetomidine group (Group 2); after 10 minutes administration of a loading dose of dexmedetomidine 1 mcg/kg, continued with maintenance infusion dose of 1 mcg/kg/h, and propofol 50 mcg/kg/min infusion has been started. In the dexmedetomidine-ketamine group (Group 3); after 10 minutes administration of a loading dose of dexmedetomidine 1 mcg/kg, the infusion has been started at a rate of 1 mcg/kg/h infusion and ketamin 25 mcg/kg/min. All patients were followed and monitored under the spontaneous breathing. With the beginning of the catheterization procedure, at the 0., 5., 10., 15., 20., 25. and 30. minutes, mean arterial blood pressure (MAP), heart rate (HR), peripheral oxygen saturation SpO_2, respiratory rate (RR) values were recorded. The complications during the procedure were also recorded. During the procedure, cases' propofol doses which were used at the superficial sedation were recorded. As the catheterization process has been ending and the groin bandage was applied, anaesthetic drug infusion was discontinued. Patients were taken to the recovery room after the procedure, and were followed up until the Steward modified score becomes 6 (Table II). Recovery times were recorded. Afterwards, the patients were transferred to the pediatric intensive care unit. Descriptive statistics were given for median, minimum, maximum, frequency and percentage values.

Table I. Ramsey Sedation Score.

1. Nervous, agitated and/or restless
2. Cooperative, oriented, quite patient
3. Only obeying the orders
4. Sleeping, hitting the glabella and responding to high voice suddenly
5. Sleeping, hitting the glabella and responding to high voice slowly
6. No responce to any of these stimulations

Statisstical Analysis

The four groups of measurements were statistically evaluated using the Kruskal-Wallis ANOVA tests. When a significant difference has been detected by the Kruskal-Wallis H test; Mann-Whitney U test with Bonferroni correction used for pairwise comparisons to identify the source of the difference ($\alpha = 0.008$). The chosen categorical data comparison test for this study was Pearson's Chi-square. Statistical analysis was done with the SPSS statistical package Assessed for Windows 18.0 (SPSS Inc., Chicago, IL, USA). All tests are two-sided at a significance level of 0.05.

Table II. Recovery Scoring System*.

Consciousness	
Awake	3
Responds to verbal stimuli	2
Responds to tactile stimuli	1
Not responding	0
Airway	
Cough on command or cry	2
Maintains good airway	1
Requires airway assistance	0
Motor	
Moves limbs purposefully	2
Non purposeful movement	1
Not moving	0

*Modified from Staward.

Table III. Demografic data.

Variables	Group 1 median (min-max)	Group 2 median (min-max)	Group 3 media (min-max)	Group 4 median (min-max)	p
Age (year)	4.5 (6 days-12 years)	6.5 (5 days-12 years)	2.75 (5 days-12 years)	5.5 (6 days-12 years)	0.611
Gender (M/F)	11/9	13/7	7/13	13/7	0.183
Weight (kg)	19 (3.6-41.6)	20.5 (7.0-55.0)	11.5 (3.25-58.0)	19.0 (3.8-42.0)	0.400

Results

In our study, there was no significant differences between patients' age, sex, and weight ($p > 0.05$) (Table III). Heart rate values vary between the groups. According to the measurement results obtained at the 0., 5., 10., 15., 20., 25. and 30. minutes, baseline values were taken, and the ratio of the total number of measurements (according to a certain cut-off point, 20% or 5%) were viewed and interpreted as an increase and/or a decrease. For each parameter, a total of 140 measurement results were analyzed and examined. 20% increase at heart rate values in groups were observed according to the value of the baseline, and it is found as statistically significant ($p < 0.001$). In the bilateral comparison, a further increase in the heart rate of cases having the drugs of the group 1 = 39 (27.9%) and group 4 = 40 (28.6%) was observed according to the group group 2 = 2 (1.4%) and group 3 = 17 (12.1%). Comparing the groups of the study, the heart rates of the group 2 = 23 (18.9%) and group 3 = 13 (12.3%) have more reduction than the heart rates of group 1 = 1 (1%) and group 4 = 2 (2.2%) (Table IV). Assessing the SpO_2 values, a > 5% decrease was observed in group 1 = 16 (1.4%), group 2 = 5 (3.6%), group 3 = 1 (0.7%), group 4 = 10 (7.1%) respectively (Table IV). On the other hand, > 20% increase in the MAP value was observed in group 1 = 2 (1.4%), Group 2 = 9 (6.4%), group 3 = 5 (3.6%) and group 4 = 1 (0.7%) respectively. The p value could not be given statisically for the MAP > 20% increase because of the inadequate number of samples (Table IV). A significant difference in >20% reduction of MAP values was calculated between the groups ($p = 0.620$) (Table IV). Also, there was a significant difference between the durations of catheterization ($p = 0.001$) (Table V). When the recovery times were compared in our study; group 3 = 20 min (10-46) has the lowest recovery time whereas group 2 = 30 min has the highest recovery time (Table V). In our study groups, the most additional dose of propofol usage as an average of 19.05 mg value was found in group 4 ($p < 0.008$). Group 1 was found out to be least additional propofolol dosage using group with an average value of 1.5 mg ($p < 0.001$). When comparing the frequency of complications; the most complication occuring group with 14 (45.1%) cases was group 4, whereas the least complications were recorded with 3 (9.7%) cases in group 3. The most common complications that occured in the group 2 (10%) was increased oral secretion, and there was only 1 (5%) recorded case having bradycardia (Table VI).

Discussion

This study aims to compare the different sedation methods in the patients, which undergo pediatric cardiac catheterization, and to determine the

Table IV. Hemodynamic parameters.

	Group 1	Group 2	Group 3	Group 4	p
HR increase > 20% compared with baseline	39 (27.9%)	2 (1.4%)	17 (12.1%)	40 (28.6%)	< 0.001
HR decrease > 20% compared with baseline	1 (1.0%)	23 (18.9%)	13 (12.3%)	2 (2.2%)	< 0.001
MAP increase > 20% compared with baseline	2 (1.4%)	9 (6.4%)	5 (3.6%)	1 (0.7%)	–
MAP decrease > 20% compared with baseline	44 (31.4%)	41 (29.3%)	47 (33.6%)	51 (36.4%)	0.620
sPO_2 decrease > 5% compared	16 (11.4%)	5 (3.6%)	1 (0.7%)	10 (7.1%)	0.001

Table V. Catheterization and Recovery time.

	Group 1 median (min-max)	Group 2 median (min-max)	Group 3 media (min-max)	Group 4 median (min-max)	*p*
Duration catheterization (min)	45 (30-120)	75 (30-230)	32.5 (25-120)	87.5 (30-175)	0.001
Recovery time (min)	22.5 (15-45)	30.0 (10-90)	20 (10-46)	25 (10-60)	0.005

most reliable and the least complication causing method between the different sedation methods. Modern pediatric cardiac catheterization has begun in 1947, when Bing described using catheterization for diagnosis of congenital heart diseases. Sedation regimens are varied, with the importance of evaluating the hemodynamic profiles of the patients[9]. A variety of drugs can be used for the cardiac catheterization procedures in children. A good preoperative assessment and a thorough understanding of the disease enable the anaesthesiologist to choose and use the right drug regimen for a safe anaesthetic management[10]. Ketamine is used as injectable anesthetic agent, and it has been used in pediatric cardiac catheterization[4,11,12]. Its potential advantages include adequate sedation and analgesia while conserving the airway reflexes and respiratory drive[13]. On the other hand, there are several potential disadvantages of ketamine use in children; it is associated with a prolonged recovery period and emergent delirium. Propofol seems to have a preferable profile for cardiac catheterization[2]). Lebovic et al[2] have shown that propofol infusion with fentanyl analgesia is associated with significantly shorter recovery times than ketamine/midazolam anesthesia in pediatric cardiac catheterization procedures. Propofol, used as the unique anesthetic may be not sufficient since it lacks an analgesia[2]. Midazolam is used as a sedative agent for children during cardiac catheterization procedures[5]. Midazolam can supply an adequate sedation with fast onset and short duration of action. On the other hand, intravenous midazolam may cause respiratory depression[14]. Dexmedetomidine is a sedative, analgesic and anxiolytic agent[7,8,15]. Its intraoperative administration reduces anesthetic requirements, speeds up the postoperative recovery, and blunts the sympathetic nervous system response to surgical intervention[16]. There are many studies on this subject. Kogan et al[1] aims to assess the safety of a propofol-ketamine mixture to induce and maintain anesthesia in spontaneously breathing pediatric patents during cardiac catheterization. They used ketamine (1-1.2 mg/kg) and propofol (1-1.2 mg/kg) for induction, followed by the infusion of 33.3 mcg/kg/min of propofol and 1 mg/kg/h of ketamine for maintenance, and they concluded that total intravenous anesthesia with the propofol-ketamine mixture appeared to be a feasible option in children presenting for cardiac catheterization. On the other hand, Tosun et al[4] compare the effects of dexmedetomidine-ketamine and propofol-ketamine combinations on hemodynamics, sedation level, and the recovery period in pediatric patients undergoing cardiac catheterization. The results of the their study shows that

Table VI. Complications.

	Group 1 median (min-max)	Group 2 median (min-max)	Group 3 media (min-max)	Group 4 median (min-max)	Total
Convulsion	–	1 (5.0%)	–	–	1 (3.2%)
Laryngospasm	2 (10%)	–	–	3 (15%)	5 (16.1%)
Bradycardia	1 (5%)	–	1 (5%)	1 (5%)	3 (9.7%)
Agitation	–	1 (5%)	–	1 (5%)	2 (6.5%)
Hiccup	–	–	–	2 (10%)	2 (6.5%)
Shivering	–	–	–	–	–
İncreased oral secretion	3 (15%)	5 (25%)	2 (10%)	7 (35%)	17 (54.8%)
Nausea and vomiting	–	–	–	–	–
Allergy	–	1 (5%)	–	–	1 (3.2%)
Total	6 (19.4%)	8 (25.8%)	3 (9.7%)	14 (45.1%)	31 (100%)

the dexmedetomidine and ketamine combination is not superior to propofol and ketamine in pediatric patients undergoing elective cardiac catheterization. On the contrary, Abbas et al[17] showed that ketamine with or without benzodiazepines has remained the drug of choice for about 4 decades.

Propofol with ketamine has provided near to ideal combination to accomplishing deep sedation with adequate analgesia while maintaining stable haemodynamics in a spontaneously breathing patient. Whereas Mester et al[10] found out that the combination of ketamine and dexmedetomidine is an effective choice by means of paediatric sedation in cardiac catheterization procedures. In our study, depending on the sedation method, we used propofol-ketamine, propofol-dexmedetomidine, dexmedetomidine-ketamine, midazolam-ketamine, and aimed to compare several parameters as heart rate (HR), mean arterial blood pressure (MAP), respiratory rate (RR), peripheral oxygen saturation (SpO_2), recovery time and frequency of complication among the groups. As a result, a variety of drug regimens can be chosen to use for the cardiac catheterization procedures in children.

Conclusions

According to these findings, Dexmedetomidine-Ketamine (Group 3) is found out to be the method of sedation, which is closest to the ideal, because of its low frequency of side effects considering the least decrease in the SpO_2 value. On the other hand, in terms of additional propofol dose, Group 1 would be better choice due to better maintain the level of sedation. Thus, the clinician should choose the suitable methods for patient.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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