International Journal of Medical Science and Education

An official Publication of Association for Scientific and Medical Education (ASME)

www.ijmse.com

Original Research Article

pISSN- 2348 4438 | eISSN-2349- 3208

RETROSPECTIVE REVIEW OF OUR ANESTHETIC PRACTICES IN PEDIATRIC THORACIC SURGERY

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Received:14/06/2018 ***Revised:27/06/2018*** ***Accepted:7/07/2018***

ABSTRACT

Background: Several types of pediatric thoracic surgeries has been increasingly performed in clinical practice. In this retrospective study, we evaluated the demographic characteristics and anesthetic management of pediatric patients who underwent thoracic surgery under eighteen years of age at the University of Health Sciences Kartal Dr. Lutfi Kirdar Education and Research Hospital, Istanbul. **Material and Methods:** After obtaining approval from the ethics committee. We investigated a retrospective analysis of the database of all patients undergoing pediatric thoracic surgery in our clinic from January 2010 to December 2017. Demographic data of the patients, type of the operations, duration of surgeries, ASA classifications and the anesthesic methods were all evaluated. Furthermore, we tried to determine surgical and anesthetic methods applied, intraoperative hemodynamic changes, length of stay in the intensive care unit, and postoperative complications. **Results:** During this period, a total of 90 pediatric patients had been operated. While 68.2% (n=62) of all patients were ASA I, 23.2% (n=21) of them ASA II, 7.8% (n=7) of all patients ASA III. The most common surgical procedure were wedge resection 25.6%, (n=23) and the most common airway device was double lumen endotracheal tube 53.3%, (n=48). In all patients balanced general anesthesia was performed. **Conclusion:** Due to the technologic advances in surgery and anesthesiology, various anesthesic techniques could be performed safely with proper selections due to the patient characteristics in pediatric thoracic surgery.

Keywords: Anesthesia, pediatric, thoracic surgery

INTRODUCTION

Thoracic surgery anesthesia in infants and children poses special challenges for the anesthesiologist. Furthermore, the anatomical and physiological differences between children and adults should always be taken into account. During the last three decades, it has been in wide use recently in pediatric patients moreover the thoracic anesthetic management is more difficult than adults because of the following problems: carbon dioxide insufflation, difficulty in one-lung ventilation, and the effect of lateral decubitus position. Anesthesia related morbidity and mortality is higher in pediatric patients than adults. A complete preoperative assesment of pediatric patients is one of the key steps of the

decreased mortality and morbidity rates **(1)**. Pediatric physiology and the principles of pediatric and thoracic anesthesia have important role in mantaining the safety during the procedure **(2)**.

We aimed to evaluate the medical records of our pediatric cases who underwent thoracic surgery in a 8 years period about the anesthesia methods we applied.

MATERIALS AND METHODS

After approval of local ethical committee, we conducted the study with accordance to the guidelines of the Declaration of Helsinki. We evaluated retrospectively the peroperative and postoperative database of all patients in the pediatric age group underwent thoracic surgery from January 2010 to December 2017, University of Health Sciences Kartal Dr. Lutfi Kirdar Education and Research Hospital, Istanbul. After retrospective evaluation of the medical records, a total of 90 pediatric patients were included. Pediatric patients undergoing emergency surgery, revision surgery, minor procedures like biopsy or thoracotomy for non-pulmonary surgeries were excluded.

The patients' age, height, weight, American Society of Anesthesiologists (ASA) physical status, and comorbidities were recorded, furthermore, type and the duration of surgery, complications, and the postoperative states during transfer to the intensive care unit were recorded.

The development of haemodynamic complications (hypotension, hypertension, bradycardia, tachycardia, and arrhythmia) and the drugs administered for the development of complications (ephedrine, perlinganit, and atropine) were evaluated. Hypotension was defined as systolic arterial pressure below 90 mmHg; hypertension was defined as systolic arterial pressure above 160 mmHg. Heart rate below 50 beats/min was defined as bradycardia, while that above 100 beats/min was considered as tachycardia. Arrhythmias observed beyond the sinus rhythm in the electrocardiograms were recorded. The data was entered on the excel data sheet.

Statistical analysis

Statistical analysis of the study was performed by using SPSS version 13.0. Normal distribution of data was checked by Kolmogorov – Smirnov test. For non-normal distributed data, Kruskal – Wallis was used for four group and Mann – Whitney U test for two group comparisons. For normal distributed data, ANOVA was used for four group and t-test for two group comparisons. Pearson Chi-Square test and Fisher's Exact Chi-Square tests were used for analysis of categorical data. Paired t-test and Wilcoxon test were performed for interval comparison.

Statistically, significance was described as p value under 0.05.

RESULTS

During the study period, a total of 423 patients were operated in our thoracic surgery clinic and 90 (21.2%) of them were included in the pediatric age group.

From the patients included in the study; 66 of the 90 patients (73.3%) were male and 24 (26.7%) were female with an average age of 13.2 ± 4 years. Seventeen of the patients (18.8%) were below 10 years of age and 73 (81.1%) were above 10 years of age. Our oldest age was 17 years old and our youngest one was 2 years old.

The mean weight was determined as 46.2 ± 14.7 kg (min = 13-max = 68) and the length was 150.8 ± 23.4 cm (min = 89 - max = 182). ASA score was assessed as ASA I (68.9%, n = 62), ASA II 23.2% (n = 21) and ASA III 7.8% (n = 7) (Table 1). The most common comorbidities in ASA II and ASA III cases were; chronic bronchiectasis (n =11), cancer(n =9).

In the evaluation of operation types; wedge resection (12 video-assisted thoracic surgery(VATS) + 11 thoracotomy), 22 (24.4%) bilateral sympathectomy, 18 (20%) cystectomy + capitonage, 11 (12.2%), VATS due to empyema decortication, 10 (11.1%) anatomic lung resections (8 patients, 1 pneumonectomy, 1 patient segmentectomy), 5 (5.6%)

pulmonary or mediastinal biopsies and 1 patient (1.1%) diaphragmatic hernia.

42 patients (46.6%) were premedicated with midazolam (0.5–0.75 mg/kg, I V) before surgery. General anesthesia was applied to all the patients (100%).

The most common technic for intubation was double lumen endotracheal tube 53.3% (n=48), (Bronchopart, Teleflex, Research Triangle Park, NC, USA). In 25 patients (27.8%) Univent (Fuji Systems, Tokyo, Japan) was used. Laryngeal mask airway (The LMA Company Limited Le Rocher, Victoria, Mahe, Seychelles) was used in 9 patients(10.0%) and in 8 patients (8.9%) we used single lumen intubation tube (Smiths Medical International Ltd Hythe, Kent, UK) (Table 2).

Propofol was generally used in induction of anesthesia, sevoflurane (n=77), 86%) or desflurane (n=13, 14%), in the maintenance of the anesthesia, rocuronium for muscle relaxation, and remifentanil for intraoperative analgesia were preferred. Only 10 patients (11.3%) underwent total intravenous anesthesia with propofol during the operation. Volume control ventilation was used in 62 patients (69%) and in 27(31%) patients pressure-controlled ventilation was apllied, though this difference was not statistically significant (p = 0.75). We ventilated the patients with a FiO2 of 1 and used 5 cm H2O PEEP during one-lung ventilation.

Routine monitorization (ECG, blood pressure, SpO2, CO2) was performed in 71 patients (78.8%) and invasive monitorization (intra-arterial and/or central venous cannulation) was performed in 69 patients (76.6%).

Seventeen cases (18.9%) had 23 different complications peroperatively (n=11 hypotension, n=5 hipoxia, n=3 tachycardia, n=3 bradicardia and n=1 hypercapnia). Complications were more common in patients younger than 10 years (p = 0.05) and in patients with higher ASA scores (p = 0.02). It was determined that there was no effect on complication by gender (p = 0.776), operation type (p = 0.217) and the intubation type (p = 0.120). Complications were found in 12.9% (n = 8) of cases with ASA I, which was 28.6% (n = 6) in ASA II patients and 42.9% (n = 3) in ASA III patients (ASA1 vs ASA2; p=0.100, ASA1 vs ASA3; p=0.04, ASA2 vs ASA3; p=0.502).

The mean amount of bleeding during the perioperative period was 133.1 ± 117.9 ml. The amount of crystalloid perioperatively was 1156.7 ± 350.8 ml. Colloid transfusion was performed in 25.6% (n = 23) of the cases, and peri-blood transfusion was performed in 11.1% (n = 10) of the cases. The mean amount of colloid was 397.8 ± 136.9 ml and mean blood volume was 440 ± 157.7 ml.

The mean duration of operation was 87.5 ± 30.3 minutes (min=63, max=235) in patients.

In the cases, sex and age were not significant on colloid transfusion (p = 0.106 and p = 0.760). The increase in ASA score (p = 0.02) and the type of operation (p = 0.03) were found to be significant on colloid transfusion. Colloid transfusion rate was 19.4% (n = 12) in ASA I cases, 33.3% (n = 7) in ASA II cases and 57.1% (n = 4) in ASA III cases (ASA I vs ASA II; p=0.192, ASA I vs ASA III; p=0.02, ASA II vs ASA III; p=0.281). When colloid transfusion was applied in 40% (n = 4) of patients who underwent anatomic lung resection and 50% (n = 9) of cystectomy cases, This rate was found to be 4.5% (n = 1), 18.2% (n = 2) in decortication cases and 26.1% (n = 6) in wedge resection cases in sympathectomy cases. There were no statistically difference between under 10 years old (p=0.103), increase ASA score (p=0.757), type of operation (p=0.800), colloid transfusion (p=0.261) and blood transfusion (p=0.292) with lenght of stay in ICU.

Blood transfusions were performed in 4.8% (n = 3) of cases with ASA I, 19.0% (n = 4) of ASA II cases and 42.9% (n = 3) of ASA III cases (ASA I vs ASA II; p=0.04, ASAI vs ASA III; p=0.001, ASA II vs ASA III; p=0.222). Blood transfusion was statistically significant with the type of operation (p = 0.001). Blood transfusion was applied in 40% of patients who underwent anatomic lung resection (n=4) and in 22.2% (n=4) of cystectomy patients. This rate was 4.3% in wedge resection (n=1). Blood transfusion

was not performed in patients who underwent sympathectomy and decortication (n = 0). In our cases, it was determined that gender was not significant on blood transfusion (p = 0.723). As the age decreases, blood transfusion tends to increase, but the increase was not statistically significant (age (year)<10 %23.5, age(year)>10 %8.2, p=0.09). Between the increase of ASA score and the application of blood transfusion were found statistically significant (p = 0.001).

In 58 patients (64.4%), neostigmine+atropine combination was used as a reversing agent and sugammadex was used in 30 patients (35.6%).

Chest radiography was performed immediately after surgery or on the following morning for all patients. In the postoperative period; pain (84%) and nausea(43 %) were the most frequently observed complications. In the postoperative period, seventy-six (84%) patients received additional medication for analgesia. Postoperative analgesia was administered either by tramadol and dexketoprofen as intravenous (IV) or intramuscular (IM).

13.3% (n=12) of the cases were followed up in the intensive care unit postoperatively. There was no statistically significant difference between admission to the intensive care unit and gender (p = 0.575) and intubation type (p = 0.303). Under 10 years of age (p = 0.03), The increase in ASA score (p <0.001), Type of operation (p=0.05), colloid transfusion administration (p=0.005) and blood transfusion (p<0.001) between adminstriation to intensive care unit were statistically significant (Table 3). The mean day of hospitalization for ICU patients was 2.9 ± 0.7 (min=2, max=4).

In the induction of anesthesia, (zero minutes) systolic blood pressure 110.7 ± 9.2 mmHg, diastolic blood pressure 51.1 ± 7.7 mmHg, MAP 61.8 ± 5.6, heart rate 106.9 ± 13.4 / min, BIS 89.5 ± 3.6, SaO2 98.0 ± 1.0% and ETCO2 42.8 ± 1.3 were founded.

While the systolic blood pressure, diastolic blood pressure, heart rate, SaO2 and ETCO2 values did not change during the operation, only the BIS value decreased about 35.5 mmHg from the mean level of after the first 10 minutes and remained at the same level afterwards.

DISCUSSION

During the preparation for thoracic surgery in pediatric patients, we should be careful about possible complications like the risk of postoperative ventilation. In addition to routine monitors, including capnography, for measurement of the arterial CO2 tension, transcutaneous CO2 monitoring may useful **(3)**.

Previously, researchers showed that ASA scores has strong, independent associations with post-operative medical complications across procedures **(4)**. Only 7.8% of the cases were ASA III (n = 7), and the majority of our cases were in the ASA I and ASA II groups. Similarly, only 18.9% of our cases developed perioperative complications. In 19 patients (21.1%) following induction of anesthesia, it was determined that the placement of an intravenous catheter and arterial catheterization should be performed. In literature it was documented that arterial cannulation for pressure and arterial blood samples is useful in pediatric patients and is needed if extensive blood loss is expected **(5)** We performed central venous monitoring in 59 patients (65.5%). We think that this central venous monitoring is used less commonly but can be helpful for guiding extensive intravenous fluid therapy.

Urinary drainage may be useful for pediatric patients, particularly lengthy operations.

Although blood loss is generally minimal in pediatric thoracic procedures, the possibility of blood loss due to manipulation of inflamed tissues, as in the case of empyema, or possible injury to the great vessels exists and may necessitate blood transfusion especially pediatric patients **(6)**. In our study; only in 11.1% of patients peri-blood transfusion was found to be necessary, and there was a significant correlation between the pediatric cases with peri-blood transfusion and the ASA score and the type of operation. Sympathectomy decortication showed no blood donation. In our study, 25.6% (n=23) of our patients the additional colloids was used to recover

normovolemia with monitorisation promoting the literature findings **(7)**.

Colloid use was significantly associated with higher ASA score. In children with thorcic surgery, the choice of anesthetic agents depends on both the children's status and the surgical lesion **(8, 9)**. All of our cases were under general anesthesia; in 89.7% balanced general anesthesia was applied and in 11.3% TIVA was preferred.

We admistereted sevoflurane and desflurane in 100% O2 during maintenance of anesthesia. Isoflurane may cause less hypoxic pulmonary vasoconstriction but this property was not proved in children **(10)**.

Both in balanced general anesthesia and TIVA, intravenous opioids decrease the concentration of inhalational anesthetics **(11)**. In addition, muscle relaxants are used in children **(12, 13)**.

For maintenance of the airway, mostly double lumen endotracheal tube was used. Conventional plastic DLTs are available in smaller sizes. We used 26 Fr (Rusch, Duluth, GA, USA DLT in our study and this tube was recommanded for use in children as young as 8 years old **(14)**.

Although postoperative pain can cause significant splinting, intercostal or epidural blocks, coupled with judicious parenteral narcotics, can minimize the discomfort. In a study it was advised that before extubation the children must be awake, breathing well, able to cough and maintain an airway, and able to maintain acceptable oxygenation with no more than 40% inspired oxygen **(15)**. The expected postoperative course depends on both the surgical procedure and the underlying diseases.

Because of the retrospective design, this study did have a number of limitations. As with any retrospective study, it was not possible to control for bias and confounding factors because there was no randomization or blinding.

CONCLUSION

In thoracic anesthesia, in infants and children, the anesthesiologist should be alert in preoperative preparation and in preserving the ventilation-hemodynamics balance. Ensuring adequate monitoring, intravenous access, arterial cannulation and blood replacement, and constant communication with the surgeon about developing situations are essential to success.

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TABLES

Table 1. Demographic values of the patients.

Variables		Age < 10 (n=41)	Age > 10 (n=49)	P value
Gender				
	Female	10	14	0.431
	Male	31	35	
ASA				
	I	30	32	0.089
	II	10	11	0.028
	III	4	3	0.026
Age (year) (mean±SD)		8.6±1.3	17.4±1.1	<0.001
Height(cm) (mean±SD)		81.2±11.4	163.4±14.7	<0.001
Weight(kg) (mean±SD)		194±4.2	69.1±3.9	<0.001

ASA, American Society of Anesthesiologists, SD, Standart deviation

Table 2. Anesthesia and surgical properties of the patients.

Variables	Age (year) <10	Age (year) >10	p value
Airway maintanace method			
Double lumen intubation tube	2	46	<0.001
Univent	1	24	<0.001
LMA	5	4	0.055
Single lumen intubation tube	6	2	0.322
Duration of surgery(minutes) (mean±SD)	90.6±7.8	87.2±9.5	0.451
Bleeding (ml) (mean±SD)	118±23.2	380±41.6	0.644
Colloid (ml) (mean±SD)	108±34.7	530±34.4	0.760
Blood transfusion (ml) (mean±SD)	215±22.4	405±29.5	0.09

LMA, Laryngeal Mask Airway, SD, Standart deviation

Table3. Factors affecting intensive care hospitalization in patients.

Variables		ICU hospitalization (%)	p value
Gender	**Male**	12.1	
	Female	16.7	0.575
Age (year)	**<10**	29.4	
	10 <	9.6	0.03
ASA	**I**	4.8	
	II	19.0	
	II	71.4	<0.001*
Surgery			
	Anatomic lung resection	30	0.663
	cystectomy	22.2	
	Anatomic lung resection	25.6	
	+ cystectomy		0.01*
	Other	6.5	
Colloid	**(+)**	30.4	
	(-)	7.5	0.005
Blood tranfusion	**(+)**	70.0	
	(-)	6.3	<0.001*

*indicates significantly value ($p<0.05$)