ORIGINAL RESEARCH

To determine the state of tracheal intubation after sevoflurane and propofol induction in the absence of muscle relaxants

[1]Debashisa Padhi, [2]Beda Prakash Dash, [3]Subrat Kumar Nayak, [4]Swatee Shatarupa Subhadarshini

[1,3]Assistant Professor ECMO Unit CTVS Department, SCB Medical College, Cuttack, Odisha, India
[2]Assistant Professor Plastic Surgery Department, [4]Assistant Professor, AnastheologyDepartment, SCB Medical College, Cuttack, Odisha, India

Corresponding Author
Swatee Shatarupa Subhadarshini
Assistant Professor, Anastheology Department, SCB Medical College, Cuttack, Odisha, India

Received: 26 December, 2023 Accepted: 25 January, 2024

ABSTRACT
It was the aim of this study to investigate the circumstances of tracheal intubation after induction with propofol and sevoflurane without the use of muscle relaxants, as well as to compare the two medicines in terms of the intubation conditions that they simultaneously produce. In the beginning, it was thought that there would be twenty-five people who would be suited for the experimental medicine. These patients were randomly allocated to one of two groups throughout the induction process, and they were either administered propofol or sevoflurane in a paired form throughout the process. All of the patients in both groups were administered midazolam and atropine by oral administration forty-five minutes prior to the beginning of the operation. Following the induction of the patient, a laryngoscopy was carried out, and all of the circumstances that contributed to the intubation were evaluated and appraised. There were a number of qualities that were included in this category, including the ease with which a laryngoscopy could be performed, motions of the vocal chords, coughing, relaxation of the jaw, and limb movements. The oxygen saturation, blood pressure, and pulse rate of both groups were evaluated at the beginning of the procedure, after the induction, one minute, two minutes, five minutes, and ten minutes after the intubation. These measurements were taken at both the beginning and the end of the process. These measures were obtained before the start of the procedure, following the induction, and throughout the intubation. After analyzing the study's findings, it was determined that the two groups' intubation durations were similar (P value = 0.303). However, compared to group B, a greater percentage of children in group A, 20% vs. 7.5 percent, respectively, needed second and third intubation.
Notably, compared to the propofol group, the sevoflurane group demonstrated far superior clinically acceptable circumstances (P value = 0.012). The results demonstrated that compared to sevoflurane, propofol increased the frequency of coughing fits and limb movements. Despite a decrease in blood pressure in the sevoflurane group, the propofol group showed a significant improvement in heart rate.

Key words: Propofol induction, Sevoflurane induction, Intubation, Tracheal intubation, Anesthesia, Congenital anomalies.

INTRODUCTION

When it comes to the delivery of general anaesthesia, endotracheal intubation is a crucial technique. This is particularly the case when it comes to infants and toddlers who are dealing with airway abnormalities like cleft lip and palate.These deformities can result in difficulty in eating, speech development, and facial deformity. Anaesthetists face a challenge when dealing with these patients because of the early age of the patients, accompanying congenital disabilities, different degrees of problematic airways, and the requirement to share the airway with surgeons. Endotracheal intubation was initially carried out using ether for deep inhalation anaesthesia; however, since then, it has been carried out using halothane and sevoflurane, particularly in the pediatric age range [2-5]. Although neuromuscular drugs make the procedure of tracheal intubation simpler, they also present patients with the possibility of experiencing adverse effects [6,7]. Up until 1990, the only medication that was utilized for tracheal intubation was suxamethonium. This was due to the fact that it had a quick start of action and a very short duration of action. Myalgia, raised intraocular and cerebral pressures, hyperkalemia, prolonged hypopnea, masseter spasm, and malignant hyperthermia are some of the potential adverse effects that may occur [7]. During the year 1993, the Food and Drug Administration (FDA) of the United States issued a

warning against the practice of frequently prescribing suxamethonium to children and adolescents.

Regarding the usage of suxamethonium, this caution was issued. This was because children who had taken the medication experienced a higher frequency of cardiac arrests that were either deadly or almost fatal [2,7]. The majority of these cardiac arrests were attributable to hyperkalemia in individuals who had not been diagnosed with muscular dystrophies. The hyperkalemia was precipitated after the administration of suxamethonium [8].

A study that Steyn and colleagues conducted [9] evaluated the practicability and safety of tracheal intubation without neuromuscular inhibition using propofol-alfentanyl. The study was conducted to determine whether or not this procedure was feasible. Participating in the study were 108 healthy youngsters who had just received adenotonsillectomy. Children ranging in age from two to fourteen were included in this group. Based on the findings of the research [4,9], it was concluded that the majority of the children who took part in the study were positively affected and did not experience any adverse effects as a consequence of it. Eighty percent of the patients achieved optimum intubating conditions according to the results of another research carried out by Akhilesh Gupta and colleagues. The dosage of propofol was 3 mg/kg and the quantity of fentanyl was 3µg/kg. This was accomplished without significantly lowering the heart rate or slowing the pressor response to tracheal intubation [10].

According to the findings of study conducted by Coghlan and colleagues, the use of a combination of alfentanyl and propofol for nasopharyngeal intubation, as opposed to neuromuscular blocking, was able to diminish the cardiovascular response to intubation and establish suitable intubating conditions. Those who conducted the study discovered this. Furthermore, sevoflurane is an additional inhalational drug that has the support of the recommendation. The reason for this is that it has a nice perfume, produces minimal irritation to the airway, is poorly soluble in blood gas, has a very little amount of myocardial depression, and is arrhythmogenic. All of these characteristics contribute to its ability to enhance intubating circumstances. A combination of 8% sevoflurane, nitrous oxide in oxygen, and manually assisted breathing was shown to be successful in certain instances by Thwaites et al. [11]. This mixture was proven to be an alternative to propofol and succinylcholine. The tracheal intubation procedure demonstrated that this is really the case. In pediatric patients, sevoflurane was shown to be a suitable alternative for intubation and induction, according to the findings of the research that was conducted by Swadia and colleagues [12]. The patient's hemodynamic stability was preserved, and the induction went off without a hitch. The intubating conditions were also optimal. Intubating with either halothane or sevoflurane has similar results, according to research by Pramod Kumar Bithal and colleagues. Nevertheless, sevoflurane was chosen due to its stronger tendency to increase heart rate and its reduced myocardial depression [13]. Sigston PE and colleagues revealed that sevoflurane had a more pleasant anesthetic effect on children and adolescents. For children, a safe way to administer propofol and succinylcholine is by tracheal intubation and induction with 8% sevoflurane for three minutes, according to Blair et al. [14]. In addition to evaluating the circumstances that occur during tracheal intubation without the use of muscle relaxants, the purpose of this study was to compare and contrast the intubation conditions that are induced by propofol and sevoflurane.

MATERIALS & METHODS

For the purpose of this study, eighty patients from SCB Medical College in Cuttack who were scheduled to have elective cleft lip and palate surgery between the years 2016 and 2018 were included. This research included the years 2016–2018 in its scope. One group of patients would get sevoflurane, while the other group would receive propofol in accordance with the envelope approach. The patients were picked at random and split into two groups. Following that, they provided the patients with a selection of medications. After receiving authorization from the institutional ethics committee and obtaining the parents' signed informed consent, the objective of the study effort was eventually fulfilled. Children between the ages of one and ten years old were required to meet the inclusion requirements, which included having a physical condition that was classified as ASA I or. Participants were not permitted to take part in the trial during the three weeks leading up to the experiment if they had a history of urinary tract infections (URTIs) or if they were allergic to any of the medications that were being investigated. A local anesthetic cream was given topically to either the back of the hand or a visible vein one hour before to the surgery. This was done in order to provide further pain relief. The activity was carried out, as was said before, in order to ensure that the patient was prepared for the therapy. One half an hour before to the planned medical treatment, the children were given an oral dose of a combination that included twenty milligrams per kilogram of atropine and half a milligram per kilogram of midazolam. At the time that the patient entered the anaesthetic room, their pre-operative baseline vitals, which included their blood pressure, oxygen saturation, and heart rate, were recorded. In addition, the instant the patient entered the room, a standard monitoring system that did not involve any intrusive procedures was immediately put into place. The "4-2-1" formula was used in order to initiate the infusion of crystalloid lactated ringer's solution. For the purpose of this computation, the patient's weight as well as the duration of their fast are taken into account. In each of the groups, a dose of fentanyl equal to two

micrograms per kilogram was administered to each participant for a period of thirty seconds.

Using an envelope method that did not include any random variables, the patients were split into two groups. The focus of this particular research endeavor was on two distinct patient populations. Group A participants were given 3 mg/kg of propofol using a face mask linked to the Mapleson F breathing circuit, whereas Group B participants were given 8% sevoflurane. Both groups received the same dose of sevoflurane. Following an 8% sevoflurane priming, this step was completed with the subjects in Group A. Each subject in both groups used the Mapleson F circuit to obtain a 50% concentration of nitrous oxide in oxygen. Once the eyelid reflex was abolished, intrapulmonary pressure ventilation (IPPV) was initiated. The trachea was intubated every 150 seconds using the appropriate-sized oral RAE tubes.

The intubation's context was assessed using Steyn's modification of the Helbo Hansen intubating condition rating method [3]. The standard for determining whether intubation circumstances were sufficient was determined to be scores below two in each category. An improper evaluation was defined as a score higher than two in any area. The patient was given an additional 1 mg/kg bolus of propofol in case the laryngoscopy could not be carried out due to factors such as excessive movement or coughing. After two failed attempts at intubation, a dose of uxamethonium of 1 mg/kg was administered to complete the procedure. This step of the process was vital. Continuous monitoring of the patient's vitals, including blood pressure, heart rate, and oxygen saturation level, was done throughout the course of treatment. Data was recorded at the beginning of the trial, during the initial induction with sevoflurane and propofol, during intubation, and one, two, five, and ten minutes after intubation. It was these records that the researchers seized. The patients were instructed to remain undisturbed for ten minutes after tracheal intubation to ensure that they would not be exposed to any surgical stimulation. The EtCO2 concentration was maintained between 30 and 35 mmHg during the whole process.

STATISTICAL ANALYSIS

A precise assessment of the data's variability was provided by calculating the standard deviation and variance. We used the chi-square test to compare the two proportions and investigate the causes of intubation in each group. This test provides an alternative method of measurement and allows you to compare more than two groups. The unpaired t-test was used to evaluate the intubation time, intubation attempt count, and hemodynamic parameters observed in each group. If there were differences between the control and experimental groups, for example, or if there were actual differences in the group means, we might apply this test to determine the cause.

RESULTS

The results of the student unpaired t-test, which compared the two groups in terms of age and weight, did not suggest a statistically significant difference ($p > 0.05$). The categories were identical to one another in every respect. When we used a student unpaired t-test to compare and analyze the intubation lengths of the two groups, we discovered that there was no statistically significant link between them ($p>0.05$). After doing an evaluation of the intubation time, this was discovered. A chi-square test was used in order to get an understanding of the variations in vocal cord movement characteristics that existed between the two groups. In light of the fact that the p-value for the results was 0.122, it may be concluded that there was not a statistically significant difference between the groups. With a p-value of 0.014, the results of the chi-square test that compared the parameters of coughing were considered to be statistically significant. Upon conducting the exam, this became quite evident. A chi-square test was used to compare the jaw relaxation parameters of the two groups, and the results showed that there was no statistically significant difference between the two groups. Having a p-value of 0.462, the test demonstrated that this is really the case. For the purpose of comparing the jerky movements of the two groups, a chi-square test was used. The difference was certainly statistically significant, as shown by a p-value of 0.002, which indicated that the statistical importance of the difference was demonstrated. An additional comparison of the jaw relaxation features of the two groups was carried out with the use of a chi-square test. Based on the findings of the investigation, it was determined that the jaw relaxation parameters exhibited statistical significance ($p = 0.012$). When the intubating settings that were clinically acceptable for 57.5% of patients in group A were compared to those that were for 85% of patients in group B, there was a significant difference between the two groups. The two groups were compared using a student unpaired t-test to determine their baseline, induction, and intubation pulse rates, as well as their pulse rates at one, two, five, and ten minutes. At these intervals, the purpose of this experiment was to look at the heart rates of the participants. We compared each of these specific time periods in the order that they occurred. In accordance with the results, the initial data for both groups were comparable ($p > 0.05$ each). This was the option that was available. Despite the fact that the two groups were substantially different during induction and intubation, as well as at various intervals of 1 minute, 2 minutes, 5 minutes, and 10 minutes after intubation ($p < 0.05$), it was discovered that the two groups were distinct after intubation. The heart rate of group A decreased much more than that of group B. When compared to Group A, Group B did not demonstrate any signs of progress in this respect. The systolic blood pressures of the participants were taken at the beginning of the experiment, one, two, five, and ten minutes after the

induction, throughout the intubation process, and at various additional times during the event. This was accomplished by the use of the unpaired student's t-test. A substantial reduction in blood pressure was seen in Group A ($p < 0.05$) following induction, throughout the intubation process, and at one and two minutes after intubation. During the process of taking the patient's blood pressure, we became aware of this. Furthermore, this was seen in the ensuing time, despite the fact that the blood pressure remained relatively unchanged after the baseline. Twenty minutes after intubation, there was no statistically significant difference between the two groups ($p > 0.05$). This was the case five minutes after intubation. It was not until after the intubation procedure was finished that this was found. The diastolic blood pressure of the two groups was compared using an unpaired student's t-test at the beginning of the study, after the induction, and at one, two, five, and ten minutes into the intubation process. This was done in order to determine which group had the higher blood pressure. The objective of this experiment was to make a comparison of the blood pressure readings of the two groups. There was a statistically significant difference seen during induction, during intubation, and one and two minutes after intubation, with a p-value that was lower than 0.05 to indicate this. This was shown to be the case regardless of whether or not the blood pressure had been stable before to the beginning of the trial. After five minutes, there was no discernible difference between the two groups that could be considered statistically significant.

DISCUSSION

Due to the extensive usage of sevoflurane, propofol, and short-acting opioids in clinical practice, researchers have been advised that neuromuscular blocking medicines have been neglected during tracheal intubation. This disdain has been shown, according to the findings of the study. Some of the strongest, most rapidly acting opioids on the market today, including fentanyl, have a profound analgesic impact when combined with propofol. In addition, these opioids make intubation and laryngoscopy easier by lowering the pressure response. It was the same individual who administered 0.5 mg of midazolam orally and 20 micrograms of atropine per kilogramme. The pressure response to laryngoscopy and intubation is reduced and analgesia is increased when 2 micrograms per kilogramme of fentanyl is given five minutes before induction. Midazolam has sedative effects but also enough anxiolysis, but to a lesser extent. Research has shown that lignocaine may alleviate injection discomfort and the pressure and heart rate response that occur during procedures such as tracheal intubation and laryngoscopy. These advantages have been shown by the use of prescription medications. An increase in the intubation score is another consequence of the medicine's antitussive actions. After careful consideration, pediatric anesthesiologists now have sevoflurane inhalation induction as a vital technique to complement their existing toolbox. Sevoflurane induction using a mask is generally well-tolerated by newborns and children.

Patients in Group B were administered 8% sevoflurane, and they were given a face mask that had been primed with 8% sevoflurane. This mask was attached to a Mapleson F breathing circuit [15]. This information was gleaned from studies that participated in the actual treatment of patients. The lengths of time that Groups A and B spent intubating their patients were 14.43 and 14.7 seconds, respectively, which were consistent with one another. In light of the fact that the p-value of 0.303 did not meet the criteria for statistical significance, it is possible to draw the conclusion that the intubation method was not an essential component [15]. Researchers Sabapathy VA et al. [16] found that the intubation process took an average of 15.25 seconds for the group that received sevoflurane and 14.60 seconds for the group that received propofol. The findings of the research served as a guide for the collection of these data. The findings of our inquiry were consistent with those of this investigation. In accordance with their results, there was not a single category that exhibited a statistically significant link with any of the alternatives. A total of twenty percent of the newborns in Group A needed a second effort at intubation, while only seven and a half percent of the children in Group B required this second try. Based on the findings of the study that we conducted, this conclusion may be drawn. In contrast to the 17.5% of children in the propofol group, just 5% of children in the sevoflurane group needed more than three attempts at intubation, according to the findings of Sabapathy and colleagues [16]. The conclusions of their investigation are in agreement with the findings that we obtained [11–13]. When compared to Group A, which had 575 percent of patients with appropriate intubating conditions, Group B had 85 percent of patients with settings that were clinically acceptable. There was a statistically significant difference between the two groups, as evidenced by a p-value of 0.012. The findings of the study conducted by Sabapathy et al. [16] are in agreement with this result. The researchers discovered that there was a statistically significant difference between the propofol and sevoflurane groups in terms of the percentage of patients who had intubating circumstances that were considered clinically acceptable (p-value = 0.0015). The findings of this discovery are consistent with the conclusion that Sabapathy and his colleagues came at.

When compared to Group A, the intubation procedures that were carried out by Group B were carried out in settings that were much more favorable. Furthermore, earlier research has shown that the findings are in agreement with one another [11–13]. According to Blair et al. [14], the administration of 8% sevoflurane in 60% nitrous oxide in oxygen

resulted in favorable intubating circumstances for 87.5% of the children who were being hospitalized. Upon the completion of the distribution of the mixture, this was found out. In 81.25 percent of the patients who were under their care, Promad Kumar Bithal and his colleagues were successful in establishing suitable intubating circumstances via their efforts [13]. A combination of oxygen, 8% sevoflurane, and nitrous oxide was administered to the children in the study that was conducted by Thwaites and colleagues [11]. The researchers discovered that 91% of the children were able to establish an acceptable environment for intubation. As a consequence of the mixing procedure, this is the final product.

In the course of our investigation, we discovered that 92.5% of children in Group A and one hundred percent of children in Group B saw laryngoscopy as a straightforward procedure. Despite this, it was not judged significant since the difference between the two sets of data was not determined to be significant enough to merit statistical analysis. According to the findings of a previous study conducted by Sabapathy VA and colleagues [16], the laryngoscopy procedure was successfully performed by 95% of patients in Group A and by 100% of patients in Group B. Their findings are in agreement with our own results. At the time of the laryngoscopy, it was discovered that the voice cords were open in 52 percent of Group A and 72 percent of Group B. However, 32% and 17% of the samples, respectively, exhibited indications of moving vocal chords. This is in contrast to the previous statement. It was shown that 52.5% of Group A showed signs of coughing, whereas 77.5% of Group B showed signs of coughing. The two groups coughed less often than one another when compared to one another. However, in accordance with the criteria, the difference was not substantial enough to call for more inquiry. The results of our experiment showed that whereas 5% of people in Group A reported experiencing jaw stiffness, 95% of them indicated that their jaws were completely relaxed.

On the other hand, individuals of Group B exhibited almost little jaw strain at all with their jaws. Three-fifths of the individuals in Group A had practically no limb movement, thirty-two and a half percent displayed little motion, twenty-two and a half had moderate motion, and ten percent displayed severe motion. On the other hand, out of the total number of participants in Group B, 75% reported experiencing virtually no movement at all. On the other hand, 12.5 percent reported mild motions, 5 percent reported moderate motions, and 7.5 percent reported severe motions. In addition, the results of Sabapathy VA et al. [16] were corroborated to a significant degree by the statistical significance of these alterations. Blair et al. [14] discovered that the group that received propofol-succinyl choline performed better on numerous metrics when compared to the group that received 8% sevoflurane. This was the case despite the fact that there was no statistically significant difference between the groups. Laryngospasm, the posture of the voice cords, coughing, jaw relaxation, and limb movements were some of the criteria that were evaluated. This must be taken into consideration by us. An individual who was a part of the halothane group was found to have frequent coughing, according to research that was carried out by Pramod Kumar Bithal [13]. Nevertheless, it is important to point out that the patients had complete relaxation of their jaws and did not have any limbs that were moving.

No change was seen in the assessment of the laryngoscopy or the vocal cord when halothane or sevoflurane were administered. A different research conducted by Brein et al. [17] compared the effects of 5% halothane and 60% nitrous oxide in oxygen to those of 8% sevoflurane and 60% nitrous oxide mixtures. This was done with the intention of determining which of the two possible permutations was more successfully implemented. Each and every youngster was able to successfully complete the intubation procedure on the very first attempt. In the group that received sevoflurane, there was a patient who exhibited significant movement of their vocal cords.

Additionally, out of the twenty children in the group, only one of them exhibited conditions that were suitable for intubation. It was observed that children who were given propofol at doses of 2.5 mg/kg, 3 mg/kg, or 3.5 mg/kg in addition to a predetermined dosage of three microg/kg of fentanyl saw a consistent reduction in their mean arterial pressure. It was between sixteen and eighteen percent that the mean arterial pressure dropped before the event. The same thing was seen by Akhilesh Gupta and his colleagues [9]. It was observed that one of the three dosing groups saw a consistent drop in arterial pressure. When the maximal effective dosage of propofol, which is 3.5 mg/kg, was administered to children, the average heart rate of the youngsters significantly decreased by 11%. When children were given propofol and fentanyl, Uma Srivastava [15] found that the kids' heart rates and blood pressure significantly reduced from the baseline values they had set at the beginning of the experiment. Fentanyl and propofol were delivered to the children. According to the findings of Steyn et al. [18], the administration of alfentanil (15 micrograms/kg) and propofol (3 mg/kg) at the same time resulted in a considerable reduction in the mean arterial pressure during induction and after intubation. This is the result that was achieved by the combination. The rate at which the heart beats continuously stayed the same during this whole time span. According to the findings of Blair et al. [13], babies whose hearts were administered 10 micrograms/kg of alfentanil and 3 mg/kg of propofol had a decreased heart rate up to the time that they were intubated. Despite the fact that the youngsters were taking both drugs, this was still the case.

They did not see any changes in their heart rate or arterial pressure after they were intubated, which is the opposite of what they had anticipated. Not only that, but Coghlan et al. [10] found that after receiving propofol infusion, both the arterial pressure and the heart rate were dramatically lowered. The results of these clinical investigations indicate that propofol may have a sedative impact on the heart rates and blood pressure of children during the administration of the drug. On the other hand, the dose of propofol that is delivered has an effect on the degree to which the child's health deteriorates.

A great number of research have been conducted to investigate the effect that sevoflurane has on the hemodynamic stability of patients who are undergoing various kinds of surgical procedures. In accordance with the findings of O'Brien's research [17], every single patient remained completely motionless during the whole procedure. According to Cros et al.'s [19] research, the administration of remifentanil led to a reduction in both the mean arterial pressure and the heart rate, whereas tracheal intubation resulted in a hardly noticeable rise in both parameters. The data that were presented by Inomata et al. [20] indicate that the systolic blood pressure and heart rate experienced an increase during the process of intubation, but that this rise was followed by a drop shortly after the induction. The researchers Blair et al. [13] discovered that the heart rate significantly increased in the seconds leading up to the intubation procedure. Eighty percent of patients displayed hypotension, eight percent experienced tachycardia, and sixteen percent suffered from bradycardia, according to Swadia et al. [12], who uncovered this information when completing their investigation. The heart rates of the sevoflurane group were found to be considerably higher one minute after intubation, post-induction, and overall after the surgery, according to the findings of Kumar A. and Kumar ParmodBithal et al. Additionally, as compared to the data that was reported at the beginning of the trial, the average arterial pressure showed a little increase. It is as follows: [14].

CONCLUSION

According to the findings of the studies, the propofol group experienced a greater number of bouts of coughing and limb movements in comparison to the sevoflurane group. Furthermore, as compared to the sevoflurane group, the propofol group exhibited significantly lower levels of both heart rate and blood pressure. A significant difference was seen.

Conflict of interest:

The authors of the present study declare that there are no conflicts of interest among them.

REFERENCES

1. Qureshi S, Haque SZ, Waseem M, Marium W, Najmi N. EFFICACY OF SEVOFLURANE VERSUS PROPOFOL FOR INTUBATION WITHOUT USING NEUROMUSCULAR BLOCKERS IN CHILDREN UNDERGOING ELECTIVE SURGERY AT TERTIARY CARE HOSPITAL: http://doi. Org/10.46536/jpumhs/2023/13.03. 458. Journal of Peoples University of Medical & Health Sciences Nawabshah.(JPUMHS). 2023 Sep 30;13(3):114-21.
2. Babu VK, Rath S, Rao AM. Evaluation of intubating conditions using sevoflurane without using muscle relaxants. Journal of Evolution of Medical and Dental Sciences. 2016 Mar 17;5(22):1165-72.
3. Koshy S, Ramesh K. A Comparative Study of Tracheal Intubating Conditions without Muscle Relaxants between Propofoland Sevoflurane Induction. INDIAN JOURNAL OF ANAESTHESIA AND ANALGESIA. 2016:211.
4. Abdelhalim AA, Maghraby HH, ElZoughari IA, AlZahrani TA, Moustafa MS, Alfassih KM, Ahmad AE. Using fentanyl and propofol for tracheal intubation during sevoflurane induction without muscle relaxants in children: A randomized prospective study. Saudi Journal of Anaesthesia. 2017 Jul;11(3):312.
5. Plaud B, Baillard C, Bourgain JL, Bouroche G, Desplanque L, Devys JM, Fletcher D, Fuchs-Buder T, Lebuffe G, Meistelman C, Motamed C. Guidelines on muscle relaxants and reversal in anaesthesia. Anaesthesia Critical Care & Pain Medicine. 2020 Feb 1;39(1):125-42.
6. Sneyd JR, O'Sullivan E. Tracheal intubation without neuromuscular blocking agents: is there any point?. British journal of anaesthesia. 2010 May 1;104(5):535-7.
7. NAGELHOUT JJ. Neuromuscular blocking agents, reversal agents, and their monitoring. Nurse Anesthesia-E-Book. 2017 May 27;140.
8. Hovgaard HL, Juhl-Olsen P. Suxamethonium-induced hyperkalemia: a short review of causes and recommendations for clinical applications. Critical Care Research and Practice. 2021 Feb 25;2021.
9. Gupta A, Kaur R, Malhotra R, Kale S. Comparative evaluation of different doses of propofol preceded by fentanyl on intubating conditions and pressor response during tracheal intubation without muscle relaxants. PediatricAnesthesia. 2006 Apr;16(4):399-405.
10. Coghlan SF, McDonald PF, Csepregi G. Use of alfentanil with propofol for nasotracheal intubation without neuromuscular block. British Journal of Anaesthesia. 1993 Jan 1;70(1):89-91.
11. Thwaites AJ, Edmends S, Tomlinson AA, Kendall JB, Smith I. Double-anonymized comparison of sevofluran vs propofol and succinylcholine for tracheal intubation in children. British journal of anaesthesia. 1999 Sep 1;83(3):410-4.
12. Swadia VN, Mamta GP, Patel G. Comparison of induction and intubation characteristics of Sevoflurane and Halothane in paediatric patients. Indian J Anaesth. 2001;45(4):294-7.
13. Bithal PK, Soudagar A, Paul M, Bali A. Comparison of halothane with sevoflurane inhalation in children for tracheal intubation. Ind J Anaesth. 2000;44:47-54.
14. Blair JM, Hill DA, Bali IM, Fee JP. Tracheal intubating conditions after induction with sevoflurane 8% in children: a comparison with two intravenous techniques. Anaesthesia. 2000 Aug 17;55(8):774-8.
15. Srivastava U, Kumar A, Gandhi NK, Saxena S, Agarwal S. Comparison of propofol and fentanyl with

thiopentone and suxamethonium for tracheal intubation in children. Indian J Anaesth. 2001;45:263-6.
16. Sabapathy VA, Thilaak P, Gopal SS, Pongiyanadar S. Endotracheal intubation without muscle relaxants in children undergoing cleft lip, palate and alveolar surgery. A comparative study of sevoflurane and propofol. J Clin Diagn Res. 2011;5:1421-5.
17. O'Brien K, Kumar R, Morton NS. Sevoflurane compared with halothane for tracheal intubation in children. British journal of anaesthesia. 1998 Apr 1;80(4):452-5.
18. Steyn MP, Quinn AM, Gillespie JA, Miller DC, Best CJ, Morton NS. Tracheal intubation without neuromuscular block in children. British journal of anaesthesia. 1994 Apr 1;72(4):403-6.
19. Cros AM, Lopez C, Kandel T, Sztark F. Determination of sevoflurane alveolar concentration for tracheal intubation with remifentanil, and no muscle relaxant. Anaesthesia. 2000 Oct;55(10):965-9.
20. Inomata S, Yamashita S, Toyooka H, Yaguchi Y, Taguchi M, Sato S. Anaesthetic induction time for tracheal intubation using sevoflurane or halothane in children. Anaesthesia. 1998 May;53(5):440-5.