Prospective, comparative, randomized, and controlled study of endotracheal intubation conditions without muscle relaxant in children receiving general anesthesia

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Introduction Intubation without the need for a muscle relaxant is a common practice in pediatric patients. Many drugs are used; sevoflurane and propofol are used to improve the intubation score and to decrease the usage of a muscle relaxant and avoid its side effects.

Aim This study aimed to compare intubation conditions and hemodynamic responses to two induction regimens, without a muscle relaxant using an anesthetic, sevoflurane versus propofol, in children, who required general anesthesia.

Patients and methods A prospective controlled study was carried out on 90 patients with ASA physical status I and II scheduled for elective pediatric day case surgeries. Patients were divided into three equal groups of 30 patients each. The patients in the S group received inhalational induction sevoflurane. The P group received 3 mg/kg propofol intravenously. The C group received 2 mg/kg succinylcholine after 3 mg/kg propofol intravenously as a control group; maintenance was performed by inhalation using sevoflurane after intubation in all groups. The intubation conditions, hemodynamic parameters (heart rate, peripheral oxygen saturation) induction time, and recovery time were all recorded and statistically analyzed.

Results With respect to the intubation conditions, no patient in any of the two groups (S and P groups) needed rescue a muscle relaxant for intubation. The S group showed more acceptable and excellent intubation conditions versus the propofol groups (100 and 96.7%, respectively). The heart rate was comparable in all groups at all readings; except during intubation, reading was highly significantly low in the sevoflurane group. Induction time was longer in the sevoflurane group than in the other groups. The recovery time was short in the S group than in the propofol group.

Conclusion Endotracheal intubation without neuromuscular blocking agents in pediatric patients undergoing day case surgeries was achieved with no severe respiratory or hemodynamic adverse events by using propofol (3 mg/kg) or sevoflurane 8% at induction and then reduced to a maintenance level after intubation.

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Introduction

There are several complications and side effects with the use of a muscle relaxants; these range from inability to save the patient if endotracheal intubation is difficult, delayed recovery, succinylcholine apnea, etc. [1–3]. However, some anesthesiologists still defend the use of muscle relaxants for tracheal intubation and argue that omitting these agents from the induction regimen may lead to potential risks and complications, which include difficult tracheal intubation [4]. Additional incentives to avoid neuromuscular blocking drugs were provided by a perceived risk for increased postoperative nausea and vomiting (PONV) after neostigmine use, the risk of residual paralysis in the postoperative period, and the added cost of the neuromuscular blocking drugs and reversal agents. The recent and up-to-date anesthetics (sevoflurane and propofol) make anesthesia easier and safe as they allow rapid induction and recovery, and are associated with an acceptably low incidence of PONV [5–7]. Day case surgeries have become widespread and available; thus, more precautions, safe anesthetics, and techniques are indicated.

The aim of this study is to compare intubation conditions and hemodynamic responses to two induction regimens without a muscle relaxant using an anesthetic, sevoflurane versus propofol, in children who required general anesthesia.

Patients and methods

This prospective, comparative, randomized, and controlled study was carried out at Al-Hussain Hospital, Al-Azhar University, Cairo, Egypt. After obtaining consent from guardians, 90 patients with ASA physical status I and II, aged 1–10 years,

scheduled to undergo elective adenotonsillectomy, cleft palate, or herniorrhaphies were included in this prospective controlled study. This tight age group, due to the induction time of anesthesia has taken a different time at different age of children [8]. Any patient who fulfilled the criteria of difficult airway, bleeding disorder, cardiac or chest problem, contraindications to any of the drugs used, or a history of allergy to any of the studied drugs
was excluded. The participants were assigned randomly to three groups equally (30 patients each) using computer-generated randomization codes that were placed in sealed, sequentially numbered closed envelops. The patients in the C group (control group) received 2 mg/kg succinylcholine intravenously after routine induction of anesthesia by propofol and the intubation procedure was started when the patient's muscle fasciculation disappeared. The patients in the S group inhaled the sevoflurane; packed by KAHIRA pharmaceutical and chemical industries company under license for Abbovie UK, as an induction agent by minimum alveolar concentration 8% with hyperventilation by patient Owen self at starting of anesthesia then by the anesthetist in rest time of induction (assisted ventilation) till the patient appeared apneic then the intubation procedure started. The patients in the P group received 3 mg/kg propofol intravenously (propofol 1%; Corden Pharma SpA, Caponago, Italy; packed by AstraZeneca UK Ltd, Macclesfield, UK), and when the patient appeared apneic, the intubation procedure was started. Anesthetic technique: a total of 90 patients had an intravenous cannula inserted before admission to the operating room. All patients received premedication with midazolam (0.05 mg/kg, intravenous) 10 min before induction. Intraoperatively, the patients were monitored using three-lead ECG and pediatric pulse oximetry. Before induction, all patients received atropine (0.01 mg/kg, intravenous). All patients were maintained on anesthesia after endotracheal intubation with sevoflurane 2–3% (volume%). Anesthesia was administered using the pediatric circle systems and appropriately sized pediatric masks, with total flows maintained at 4–10 l/min throughout the procedure according to the child's weight, applying assisted ventilation as soon as possible with a pressure less than 20 cm H_2O. Oral airway of appropriate size was inserted when needed, especially in the S group. The anesthesia machine used was The Dräger Fabius (Dräger Ireland Ltd. Unit 2, 4075 Kingswood Road Citywest Business Campus Dublin 24) GS premium. When the patient became apneic, intubation was performed orally using a Macintosh (Techron Surgical, Sialkot, P, Pakistan) laryngoscope blade and an appropriately sized endotracheal tube without the use of any muscle relaxant for the S and P groups; the duration from injection of the drug in the C and P groups and inhalation of sevoflurane in the S group until insertion of the tube was calculated as the induction time. Intubation conditions were assessed using a scoring system for intubation condition (Table 1), where an excellent condition indicates that all criteria of the variable had a score of 1, an acceptable condition indicates that all criteria of an individual variable were equal to or less than 1, whereas any variable scoring more than or equal to 2 made the intubating condition unacceptable [9]. The sum of the scores of these five individual variables was computed as the Helbo–Hansen (Steyn's modification, Table 1) score. A total score of 5 is excellent, 6–10 is good, 11–15 is poor, and 16–20 is very poor (impossible) [5].

Single laryngoscopy attempt was allowed; inadequate intubation condition and the need for rescue drug were declared if the patient could not be intubated after 30 s or oxygen saturation decreased below 90%. In this case, succinylcholine 1 mg/kg was administered as a rescue drug for all the groups and then intubation was performed; no data were recorded from this patient and the patient was excluded from the study. All patients received a paracetamol rectal suppository 15 mg/kg as analgesia after intubation and before surgery. Heart rate (HR) and peripheral oxygen saturation were recorded at 1 min after atropine as

Table 1 Steyn's modification of the Helbo–Hansen scoring system

Parameters	Scores			
	1	2	3	4
Laryngoscopy	Easy	Fair	Difficult	Impossible
Vocal cords	Open	Moving	Closing	Closed
Coughing	None	Slight	Moderate	Severe
Jaw relaxation	Complete	Slight	Stiff	Rigid (jerky)
Limb movement	None	Slight	Moderate	Severe
Total score	Excellent	Good	Poor	Bad
	5	6–10	11–15	16–20

Endotracheal intubation condition score system [5].

baseline data, during intubation, and 6 min after intubation, and intubation time (which is the time from drug injection until intubation), the ease of intubation (intubation score), and the recovery time (which is the time from closing inhalational anesthesia until eye opening to command), together with the demographic data, were recorded.

Statistical analysis

The required sample size was calculated using G*Power software, version 3.1.0 (Institute fur Experimentelle Psychologie, Heinrich Heine Universität, Düsseldorf, Germany). The primary outcome measure was acceptability of intubating conditions. It was estimated that a sample of 30 patients in each study group would have a power of 80% to detect a medium effect size (W) of 0.33. The *P* value of less than 0.05 was considered statistically significant. Pearson's χ^2-test was used to compare the categorical variables. The change in continuous parameters and its statistical significance was tested using Levene's test for equality of variances and the *t*-test for equality of means. The results were expressed as means, SD, and percentage.

Results

In terms of demographic data, there was no significant difference between groups for age, sex, body weight, and ASA grade (Table 2).

Statistical analysis of the overall intubation conditions (Table 3) and the intubation conditions was clinically acceptable in 30 (100%) children in the C and S groups versus 29 (96.7%) children, and unacceptable in one (3.3%) child in the P group.

A statistical analysis of clinical results of individual variables of endotracheal intubation conditions was carried out; complete jaw relaxation was observed in all groups, easy laryngoscope was easy in all groups. Open vocal cords were observed in 30 (100%) children in the C and S groups versus 29 (96.7%) and movable in one (3.3%) child in the P group. No cough or limb movement was found in any of the groups (Table 4).

The induction time was longer in the S group to make the child apneic because there are factors (child holding, leakage inflow) affecting inhalation uptake, but was shorter in C and P groups (Table 5).

The recovery time was shorter in the S group than the other groups because the elimination process of sevoflurane was not dependent on renal or liver functions (Table 5). With respect to the need to rescue drugs, no patient in all groups needed.

According to the cardiorespiratory changes, there was comparability between all groups except in group S during intubation was lower with high stastistically significance than other groups (Table 6). In addition, there were no statistical differences between any of the groups with respect to oxygen saturation at any time point (Table 6).

Discussion

Successful and safe home discharge with minimum complications, for example, PONV of anesthetized patients, especially in children is the aim and goal of an anesthetist and his/her team in the recovery and day case department. The target points of an anesthetist are to select the drugs, technique, tools, and endorse the operating field (is it ready and suitable to perform anesthesia and his aims and goals of patient's safty or not) [10]. In the present study, the use of sevoflurane and propofol resulted in a higher incidence of acceptable and excellent intubation conditions:30 (100%) children versus 29 (96.7%) children, respectively. This was in line with the study by Lerman *et al.* [11] and Taha *et al.* [12] they reported an incidence of excellent intubation conditions of 90%, and in the current study, it was 100% in the sevoflurane group and 96.7% in the propofol group. In terms of the intubation condition, in the present study, the total sum of Steyn's modification of the Helbo–Hansen scoring system was 5 (excellent endotracheal condition) for 30 (100%) children in sevoflurane and for 29 (96.7%) children in the propofol group versus a score of 6 (good endotracheal conditions) for one (3.3) child in

Table 2 Demographic characteristics of the patients included in study

Parameters	Groups			
	C group (*n*=30)	S group (*n*=30)	P group (*n*=30)	*P*-value
Age (years)	6 (5–6.5)	6 (5–6.4)	6 (5–6.7)	0.698
Weight (kg)	20 (17–22)	20 (17.7–21)	19 (18–20.5)	0.790
Sex (female/male)	12/18	13/17	13/17	0.950
ASA (I/II)	22/8	23/7	21/9	0.870

Data presented as median (range) or ratio; C group, succinylcholine (control group); S group, sevoflurane group; P group, propofol group.

the propofol group. This was in line with the study by Oberer *et al.* [13]; they reported that propofol decreases laryngotracheal reactivity and muscle tone, thus allowing easy intubation, but the intubating conditions are not optimal because of the expiration reflexes and cough, which are reported most frequently during propofol anesthesia, whereas laryngospasm is more frequent with sevoflurane.

In the present study, the use of sevoflurane alone resulted in a 100% incidence of acceptable intubating conditions because the endotracheal intubation procedure started when the child slept and was apneic, same as the apneic condition in the C group. However, this result was not in

Table 3 Overall endotracheal intubation

	Acceptable	Unacceptable
Group C	30 (100)	–
Group S	30 (100)	–
Group P	29 (96.7)	1 (3.3)

Data presented as median *n* (%); C group, succinylcholine (control group); S group, sevoflurane group; P group, propofol group.

Table 4 Intubation conditions

Parameters	Groups	Number of patients according to the Steyn's modification of the Helbo–Hansen scoring system [*n* (%)]				
		1	2	3	4	*P*-value
Jaw relaxation		Complete	Slight	Stiff	Rigid (jerky)	1.000
	Group C	30 (100)	–	–	–	
	Group S	30 (100)	–	–	–	
	Group P	30 (100)	–	–	–	
Laryngoscopy		Easy	Fair	Difficult	Impossible	1.000
	Group C	30 (100)	–	–	–	
	Group S	30 (100)	–	–	–	
	Group P	30 (100)	–	–	–	
Vocal cords		Open	Moving	Closing	Closed	0.890
	Group C	30 (100)	–	–	–	
	Group S	30 (100)	–	–	–	
	Group P	29 (96.7)	1 (3.3)	–	–	
Coughing		None	Slight	Moderate	Severe	1.000
	Group C	30 (100)	–	–	–	
	Group S	30 (100)	–	–	–	
	Group P	30 (100)	–	–	–	
Limb movement		None	Slight	Moderate	Severe	1.000
	Group C	30 (100)	–	–	–	
	Group S	30 (100)	–	–	–	
	Group P	30 (100)	–	–	–	

Data presented as median (range) or ratio; C group, succinylcholine (control group); S group, sevoflurane group; P group, propofol group.

Table 5 Induction, recovery times, and need for rescue drugs

Parameters	Groups			
	C group (*n*=30)	S group (*n*=30)	P group (*n*=30)	*P* value
Induction time (s)	106 (99–118)	200(190–210)	105 (100–111)	<0.000
Recovery time (s)	470 (454–490)	270 (254–290)	370 (354–390)	<0.000
Rescue drugs	Nil	Nil	Nil	–

Data presented as median (range); C group, succinylcholine (control group); S group, sevoflurane group; P group, propofol group.

Table 6 Cardiorespiratory changes in terms of heart rate (beats/min) and peripheral oxygen saturation

Parameters	Groups			
	C group (*n*=30)	S group (*n*=30)	P group (*n*=30)	*P* value
Heart rate 5 min after atropine (beats/min)	119 (107–123)	119 (107–123)	119 (107–123)	1.000
Heart rate during intubation (beats/min)	115 (105–120)	95 (90–100)	114 (105–120)	<0.001
Heart rate 5 min after intubation (beats/min)	111 (104–113)	109 (103–112)	109 (104–114)	0.122
SPO_2% 5 min after atropine	99 (98–99)	99 (98–99)	99 (98–99)	1.000
SPO_2 during intubation	99 (98–99)	99 (98–99)	99 (98–99)	1.000
SPO_2% 5 min after intubation	99 (98–99)	99 (98–99)	99 (98–99)	1.000

Data presented as median (range) or percentage; C group, succinylcholine (control group); S group, sevoflurane group; P group, propofol group.

line with the study by Hazem *et al.* [9]; they compared induction of anesthesia by sevoflurane alone versus fentanyl, propofol, and sevoflurane. Their result with sevoflurane alone was a 66.7% incidence of acceptable intubation conditions, but was 50% excellent conditions. The out of line issue may be explained by a study that was carried out by Politis *et al.* [8]; they showed that the persistence of spontaneous ventilation at the time of laryngoscopy was associated with poor intubation conditions. Deciding when to perform laryngoscopy and intubation can be based on a child's activity and breathing pattern (apneic condition, which was achieved by assisted ventilation, physical examination, or changes in the blood pressure, HR, or respiratory).

The present study shows that the induction time was highly statistically significantly long with the use of sevoflurane [200 (190–210) s] than propofol [106 (99–118) s]. This was in line with Kamal *et al.* [14], who found that the time to complete induction with the use of propofol was more rapid with statistically significant differences compared with the sevoflurane induction time, 42.9±5.1 and 133.3±25.8 s mean±SD, respectively. However, Politis *et al.* [8] found that the induction time of sevoflurane to achieve 80% successful intubation was187 (153–230) s, but excellent intubating conditions (≥80%) were achieved only when an adequate adjuvant was added. In the present study, the shortest recovery time was observed with the use of sevoflurane (S group), 270 s, whereas the longest recovery time was observed with the use of propofol (P group), 370 s. These readings were statistically significant, with a *P*-value of more than 0.001. The use of intravenous propofol was found to lead to a highly significant and more prolonged time to respond to commands and eye-opening compared with the use of sevoflurane in the study carried out by Kamal *et al.* [14]. The hemodynamic changes in the present study were statistically comparable for all readings, except during intubation; a low HR was found in the sevoflurane group than the other groups.

Only one child in the P group had prolonged apnea for more than 15 min and was excluded from the study.

Limitation of study

The tightness of age group, as the induction time has variable period at a different age in S group, and also, different techniques of induction in all groups.

Conclusion

Endotracheal intubation without neuromuscular blocking agents in pediatric patients undergoing day case surgeries was achieved with no severe respiratory or hemodynamic adverse events by using propofol (3 mg/kg) or sevoflurane 8% at induction and then reduced to maintenance levels after intubation.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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