Inhalational Induction with High Concentration of Sevoflurane in Neonates Undergoing TEF/EA Repair. A Comparison of Mixture of Sevoflurane in 50% N_2O/O_2 with Sevoflurane in 100% O_2

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ABSTRACT

Introduction: Anaesthetic induction of newborn for repair of tracheoesophageal fistula and esophageal atresia with high concentration of sevoflurane is commonly practiced but there is a myth for using 100% oxygen so that SpO_2 does not fall during induction. The present study was designed to evaluate whether addition of 50% N_2O to 8% sevoflurane produces any significant fall in SpO_2 in addition to providing benefit of significantly decreasing induction and intubation time, maintaining haemodynamics and fast post operative recovery.

Material and Methods: Thirty neonates undergoing TEF repair were taken for the study. Neonates were randomised into two groups of 15 each. In group-I induction was done with 8% sevoflurane in 50% N_2O and 50% O_2 and in group-II with 8% sevoflurane in 100% oxygen.

Results: The mean induction time in group-I (34.86 ± 2.35 sec) was significantly lower than in group-II (50.60 ± 1.72 sec), ($P < 0.0001$). The mean ($t = 20.93$) intubation time in group-I (101.73 ± 1.94 sec) was significantly lower than in group-II (123.93 ± 1.57 sec) ($P < 0.001$) ($t = 34.45$) in group-I SpO_2 value is slightly less then in group-II. P-value is only slightly significant ($t= 7.04$). Both the groups showed hoemodynamic stability, incidence of agitation was 10% in group-II.

Conclusion: Thus, induction of anaesthesia with a mixture of 8% sevoflurane in 50% N_2O and 50% O_2 was faster, smoother with only slightly significant decrease in SpO_2 which was acceptable during induction and with minimal side effects as compared to group-II.

Keywords: Sevoflurane in Neonates, TEF/EA Repair, Mixture of Sevoflurane, 50% N_2O/O_2 with Sevoflurane

INTRODUCTION

Tracheoesophageal fistula (TEF)/ Esophageal atresia (EA) is a relatively common congenital anomaly the incidence is approximately 1:3000-4500 live births. The anaesthesia induction in TEF is extremely demanding as incidence of prematurity low birth weight, congenital heart disease and other congenital anomalies (VATER) is very high. The lungs of these neonates are consolidated and atelectatic due to spillage of secretions from the blind esophageal pouch and gastric contents come up from the stomach.

The patients for TEF repair needs rapid intubation as they have low oxygen reserve and chances of aspiration / regurgitation are very high. Sevoflurane has shown potential to be an ideal inhalational induction agent[1, 2, 3, 4, 5] in neonatal and pediatric age group as it produces smooth and rapid induction of anaesthesia due to its low blood gas solubility, precise rapid adjustment of anaesthetic depth and rapid recovery in addition to providing muscle relaxation for intubation, analgesia and cardiovascular stability. Although it has already been studied that addition of N_2O to sevoflurane decreases the MAC value[3], thus providing faster induction but the patients with TEF / EA have poor oxygen reserves so clinicians wish to use 100% oxygen for induction.

The purpose of the present study was to compare whether addition of 50% N_2O to 8% sevoflurane decreases the induction and intubation time significantly without decreasing SpO_2 significantly.

MATERIAL AND METHODS

After obtaining institutional ethical committee approval and written informed consent from the parents 30 infants aged between 1 day to 7 days were included in this prospective study. The patients were randomized into two groups of 15 each by sealed envelope technique. In all infants detailed pre-anaesthetic checkup, weight, blood investigations, chest x-ray, echocardiography and abdominal ultrasound was done to rule out any associated congenital anomaly. Identification of the side of aortic arch was also done. In preoperative period infants were kept in semi-upright position with a drainage catheter on low suction in the upper esophageal pouch.

All patients were pre-medicated with 0.20 µg/kg. of atropine. All patients were pre-oxygenated for 3 min with 100% oxygen. Ayer's T-piece with J.R. modification was filled with 8% sevoflurane in 50% N_2O / O_2 mixture in group-I and 8% sevoflurane in 100% O_2 in group-II. Patients were tapped on their feet before putting facemask to make them breath deeper and faster.

Induction time was taken from the application of face mask to loss of eyelash reflex and intubation time is the time from application of facemask till jaw relaxation. As soon as the

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jaw relaxation was achieved intubation was done. All the patients were intubated by experienced neonatal anaesthetist in single attempt. Intubating condition were assessed using Copenhagen scale (Table-1). Induction time, intubation time, SpO_2, quality of intubation, preinduction and post induction heart rate and non invasive blood pressure were recorded for 10 min and any other side effects were noted.

The ETT was passed and fixed beyond fistula but above carina by checking B/L air entry by stethoscope. Injection atracurium was given in the dose of 0.3mg/kg. Anaesthesia was maintained with 1% sevoflurane in 50% N_2O and 50% O_2 in both the groups. If SpO_2 fell during surgery due to packing of lungs for mobilization of distal segment of esophagus then 100% O_2 was given. Injection fentanyl 1µg/kg, injection tramadol 2mg/kg and I.V. procetamol 10mg/kg were given for analgesia. K-90/91 was inserted in the upper esophageal pouch through nose. Infants were kept on heated fluid mattress and radiant heater in O.T. At the end of surgery inter-costal block was given with injection Ropivacaine 0.2% in the dose of 2mg/kg. Sevoflurane was stopped at the time of closure of chest. Patients were reversed with neostigmine and atropine. All patients were shifted to NICU on spontaneous respiration with or without ETT and kept on oxygen hood.

STATISTICAL ANALYSIS

The results of present study were expressed as mean+_ standard deviation. Students 't' test was used for testing the significance between the two study groups. 't' and 'p' values were used to see the significance.

RESULTS

The demographic profile of age, sex, weight was comparable in both the groups. The mean induction time in group-I was 34.86 ± 2.35 sec. which was significantly less than that in group-II 50.60 ± 1.72 sec. ($t = 20.93$, $P < 0.0001$). The mean intubation time in group-I was 101.73 ± 1.94 sec. which was significantly less than that in group-II 123.93 ± 1.57 sec. ($t = 34.45$, $P < 0.0001$). In both cases P-value is highly significant.

In group I mean SpO_2 value was 96.30 ± 93, which is slightly less than in group-II 98.73 ± 0.96 ($t = 7.04$, $P < 0.0001$). Here the P-value is slightly significant. In both the groups there was no difference in heart rate. HR in group-I was 151 ± 3.30 and group-II 151 ± 3.70, although there was slight increase in heart rate from baseline ($t=0.12$, $P > 0.92$). The mean blood pressure in group I was 59.86 ± 1.45 and group-II 59.8 ± 1.47 ($t = 0.11$, $P > 0.91$) which is not significant although the mean BP fell from the baseline.

The quality of induction and mask acceptability was good in both the groups. Intubating conditions were excellent / good in 14/1 patients in group- I and 10/5 in group-II. No movement of vocal cords was observed in any patient. Incidence of agitation was 10% in group-II.

	Clinically acceptable		**Clinically not acceptable**
Variables	Excellent	Good	Poor
Laryngoscopy	Easy	Fair	Difficult
Vocal Cords			
Position	Abducted	Intermediate	Closed
Movement	None	Moving	Closing

Table-1: Copenhagen scale

DISCUSSION

Induction of anaesthesia is the most physiologically traumatic phase of anaesthesia especially in infants with tracheoesophageal fistula (TEF) and esophageal atresia.

These infants have borderline oxygen reserves due to contamination of the lungs as a result of spillage of secretions from the blind esophageal pouch and / or aspiration of gastric contents through the distal tracheo-esophageal fistula which results in atelectasis and pneumonitis. In addition to this presence of tracheomalacia, vascular rings and fistula below the carina requires additional intervention[6]. These patients also have associated other congenital anomalies like congenital heart disease which includes VSD, ASD, TOF etc., anorectal anomalies, duodenal atresia, malrotation of gut, musculoskeletal and renal defects.

Considering the above conditions rapid intubation is required in these patients. In our study we avoided paralytic agent/IV induction technique as suxamethonium which has rapid onset and ultrashort duration of action has potential side effects like hyperkalemia, masseter spasm, malignant hyperthermia etc. In USA (1993) FDA has advised that suxamethonium be contraindicated for routine use in children. This justification was made due to incidence of cardiac arrest in children. Most of the cardiac arrests were attributed to hyperkalemia in patients with undiagnosed muscular dystrophies which triggered after use of suxamethonium[2]. TEF is also associated with musculoskeletal defects so suxamethonium was not used in this study.

Non depolarizing neuromuscular blocking agents are alternative, but are slower in onset and they have a prolonged neuromuscular blockade and also an inability to reverse the paralysis quickly if airway management via mask or tracheal intubation is not possible. High dose of propofol with fentanyl was used by Sabapathy et al.[2] for intubation but in their study most of the patients required suxamethonium for intubation.

Thus in our study we used the technique of inhalational induction with high concentration of sevoflurane. Sevoflurane has low blood gas solubility of 0.66 in newborns which is less than that in big children 0.69 [3,8]. Thus in neonates sevoflurane has rapid wash-in and rapid wash-out leading to rapid induction and reversal of anaesthesia. Lerman and Jerrold[3] has described the overpressure technique of inhalational induction in which the inspired concentration of induction agents is increased to values that are several fold greater than the MAC for that age group. Lewis et al.[8] in their study also mentioned that speed of inhaled induction depends on concentration of the anaesthetic agent.

Thus induction with 8% sevoflurane produced rapid induction of anaesthesia. We further decreased the induction time by

prefilling[9, 10] the anaesthesia circuit with 8% sevoflurane in respective mixture and neonates were tapped on their feet to make them breath deeper and faster thus converting the tidal breathing technique to that of vital capacity technique.

The induction time in our study was lower as compared to Dr. Usha Kiran et al. (52.80 ± 8.5 sec.)[9] and Manish Patil et al. (91.57 sec.)[1]. It was comparable with that of G. Lejus's study (30 sec.)[11].

After the loss of eyelash reflex high frequency low volume IPPV was done to avoid excessive positive pressure ventilation which may result in aspiration[12]. The intubation time in our study was significantly lower in group-I as compared to the studies of Sabapathy et al.[2] and Devy's et al[13].

Patients with TEF and esophageal atresia have poor oxygen reserves and anaesthetist usually intend to give 100% O_2 during induction to maintain SpO_2 but use of 100% O_2 increases the induction and intubation time significantly which may create risk for aspiration. So in order to decrease time for induction and intubation we added 50% N_2O in the mixture as N_2O increase the efficiency of sevoflurane [14]. We also pre-oxygenated all infants with 100% O_2 for 3 min. which even in worse scenario covered the intubation time thus maintaining the oxygen saturation above 95%. In our study SpO_2 levels were low in group-I but this was only slightly significantly. The lowest level did not go below 95% during induction.

In our study in order to prevent postoperative apnoeic episodes we used low dose of fentanyl, i.e., 1µg/kg. as we do not intend to ventilate the patient in NICU and we keep our patients on spontaneous respiration on oxygen hood with or without ETT. Thus for 100% µ receptor occupancy after giving fentanyl. We gave injection tramodol 2mg/kg. and IV procetamol 10mg/kg., which has got different pathway for pain inhibition.

In both the groups heart rate and non invasive blood pressure were comparable. In our study the incidence of agitation in group-II was equivalent to that of Lerman and Jerrold3.

In our study one patient had regurgitation during induction due to big shunt, after oral suction ETT was inserted and ETT suction was done with FG No. 5. Three patients in our study had imperforate anus for which colostomy was done. Five patients had small VSD but there was no change in induction time. Intracardiac shunts can alter the uptake of poorly soluble agents, as only large (>80%) left to rights shunts increase the rate of anaesthetic uptake from the lungs[9] and in our study patients has small VSD so there was no effect on induction time.

K. Ryu[15] in his study on the analgesic effect of sevoflurane had measured the intra-operative analgesic effect of sevoflurane by surgical plethysmographic waveforms (SPI). Wiklund et al. in their study has stated that sevoflurane produce muscle relaxation effect by inhibition of cholinergic neurotransmission[16] Rampil et al. had shown that sevoflurane produce depression of spinal motor neurons[17].

Thus Sevoflurane provides all the benefits of quick anaesthesia, analgesia, muscle relaxation for intubation and fast reversal.

CONCLUSION

The benefit of significant decrease in time for induction and intubation and decrease side effects like agitation surpass the incidence of slight drop in oxygen saturation in group-I in patients undergoing TEF repair.

Thus we conclude that in group-I sevofurane in 50% N_2O and 50% O_2 provide faster induction and better intubating conditions without any side effects as compared to group-II sevoflurane in 100% O_2.

Thus the combination of sevoflurane in 50% N_2O and O_2 in superior to sevoflurane in 100% oxygen in TEF patients.

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