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Comparison of mixture of sevoflurane in 50% N_2O/O_2 with sevoflurane in 100% O_2 in neonates undergoing TEF/EA repair

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Abstract
Background: The efficient recognition and prompt management of illness in the neonatal period may be lifesaving. Perioperative airway management in the neonate undergoing tracheoesophageal fistula (TEF) repair could be a challenge for anesthesiologist. We need to place the tip of the endotracheal tube (ETT) below the fistula but above the carina to ensure airway protection, adequate ventilation and avoid gastric dilatation during positive pressure ventilation (PPV).
Materials 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 was 32.91 sec. which was significantly less than that in group-II 54.60. The mean intubation time in group-I was 112.35 sec. which was significantly less than that in group-II 134.53. In both cases P-value is highly significant. In group I mean SpO_2 value was 96.18, which is slightly less than in group-II 98.22. Here the P-value is slightly significant. In both the groups there was no difference in heart rate.
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, TEF repair, induction

Introduction
Newborns undergoing emergency operations present several difficult challenges for the anaesthesiologist. Many surgical emergencies in the neonate are life threatening and are frequently accompanied by multiple organ system failure. Communication and cooperation between the entire health care team, including the surgeons, anaesthesiologists and neonatologists, are of utmost importance to ensure the best possible care of the neonate [1-3]. The efficient recognition and prompt management of illness in the neonatal period may be lifesaving. Perioperative airway management in the neonate undergoing tracheoesophageal fistula (TEF) repair could be a challenge for anesthesiologist. We need to place the tip of the endotracheal tube (ETT) below the fistula but above the carina to ensure airway protection, adequate ventilation and avoid gastric dilatation during positive pressure ventilation (PPV). The difficulty lies in maintaining proper position of the ETT during surgical manipulation especially in Gross type C, with esophageal atresia (EA) and a large fistula just above the carina. To prevent gastric dilatation of newborns, application of a balloon-tipped embolectomy catheter [4, 5] or a Fogarty catheter [6] with the aid of fiberoptic broncho-scope is recommended to occlude the TEF. 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.

Materials and Methods
The present study was conducted in the Department of Anesthesiology of the MGM medical College, Navi Mumbai. The ethical clearance for the study was approved from the ethical committee of the hospital. After obtaining institutional ethical committee approval and written informed consent from the parents 80 infants aged between 1 day to 7 days were included in this study. The patients were randomized into two groups of 40 patients each.

A detailed pre-anaesthetic checkup, weight, blood investigations, chest x-ray, echocardiography and abdominal ultrasound was done for every patient to rule out any associated congenital anomaly. 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 jaw relaxation was achieved intubation was done. All the patients were intubated by experienced neonatal anaesthetist in single attempt. Intubating condition was assessed using Copenhagen scale. Induction time, intubation time, SpO2, quality of intubation, pre-induction 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.

The statistical analysis of the data was done using SPSS version 11.0 for windows. Chi-square and Student's t-test were used for checking the significance of the data. A p-value of 0.05 and lesser was defined to be statistically significant.

Results

The demographic profile of age, sex, weight was comparable in both the groups. The mean induction time in group-I was 32.91 sec. which was significantly less than that in group-II 54.60. The mean intubation time in group-I was 112.35 sec. which was significantly less than that in group-II 134.53. In both cases P-value is highly significant. In group I mean SpO_2 value was 96.18, which is slightly less than in group-II 98.22. Here the P-value is slightly significant. In both the groups there was no difference in heart rate. HR in group-I was 159 and group-II 156, although there was slight increase in heart rate from baseline.

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. These patients also have associated other congenital anomalies like congenital heart disease which includes VS..D, 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. Thwaites A *et al.* [7] conducted a randomized, double-blind comparison of 8% sevoflurane and propofol as induction agents for day-case cystoscopy in 102 patients. All patients received an i.v. cannula and breathed oxygen 5 litre min-1. Anaesthesia was induced with propofol i.v. or inhalation of 8% sevoflurane and 10% Intralipid (as a placebo) i.v., delivered by a blinded observer. Anaesthesia was maintained in all patients with 2% sevoflurane via a face mask. Induction of anaesthesia with sevoflurane was significantly slower compared with propofol (mean 84 (SD 24)s vs. 57 (11)s), but was associated with a lower incidence of apnoea (16% vs. 65%) and a shorter time to establish spontaneous ventilation (94 (34)s vs. 126 (79)s). Induction complications were uncommon in each group but the transition to maintenance was smoother with sevoflurane and was associated with less hypotension compared with propofol. Emergence from anaesthesia induced with sevoflurane occurred significantly earlier compared with propofol (5.2 (2.2) min vs. 7.0 (3.2) min) and anaesthetic induction was also significantly cheaper with sevoflurane. According to a postoperative questionnaire, the majority of patients found both anaesthetic techniques acceptable. Nevertheless, significnatly more patients (14%) rated induction with sevoflurane as unpleasant compared with propofol (0) and significantly more patients (24%) would not choose sevoflurane induction compared with propofol (6%). They concluded that inhalation induction with 8% sevoflurane would appear to offer several objective advantages compared with induction with propofol in day-case patients, although a significant minority may dislike this technique. Wang KY *et al.* [8] assessed the efficacy and safety of induction with high concentration sevoflurane and of nasotracheal intubation without muscle relaxant in infants with increased or decreased pulmonary blood flow (PBF) and undergoing surgery for congenital heart diseases. Fifty-five infants aged 2 - 12 months, weighing 4.7 - 10.0 kg, and scheduled for congenital cardiac surgery were enrolled. Subjects were divided into those with increased (IPBF group, n = 29) and decreased (DPBF group, n = 26) pulmonary blood flow. All infants received inhalational induction with 8% sevoflurane in 100.0% oxygen at a gas flow rate of 6 L/min. Nasotracheal intubation was performed 4 minutes after induction. Sevoflurane vaporization was decreased to 4.0% for placement of a peripheral intravenous line and invasive hemodynamic monitors. Five minutes later, sedatives and muscle relaxant were administered and the vaporizer was adjusted to 2% for maintenance of anesthesia. Bispectral index (BIS) scores,

circulatory parameters, satisfactory and successful intubation ratios, adverse reactions, and complications of intubation were recorded. Times to loss of lash and pain reflexes were longer for the DPBF group ($P < 0.01$). Satisfactory intubation ratios were 93.1% and 61.5% for the IPBF and DPBF groups, respectively (P = 0.008). Successful intubation ratios were 96.6% and 76.9% for the IPBF and DPBF groups, respectively (P = 0.044). Following sevoflurane inhalation, blood pressures decreased significantly in the IPBF group but remained stable in the DPBF group. BIS scores declined to similar stable values, and a "nadir BIS" was recorded for both groups. No obvious adverse reactions or complications of intubation were noted peri-operatively. They concluded that induction with high concentration sevoflurane, although faster for infants with IPBF, is safe for infants with IPBF or DPBF. However, nasotracheal intubation without muscle relaxant after induction with high concentration sevoflurane is less successful and less satisfactory for infants with DPBF and should be used with caution in this patient group.

Djaiani GN *et al.* [9] determined the respiratory and cardiovascular effects of a high concentration vital capacity induction with sevoflurane compared with an intravenous induction with etomidate in patients scheduled for elective coronary artery bypass graft (CABG) surgery. Twenty-two patients undergoing elective CABG surgery were included in the study. The study group (group S) received a vital capacity gaseous induction with sevoflurane 8% (n = 12) and the control group (group E) were given etomidate, 0.2 to 0.3 mg/kg (n = 10). Anesthesia was supplemented with fentanyl, 8 microg/kg, and vecuronium, 0.1 mg/kg, in both groups. The speed of induction of anesthesia was comparable between the groups. There was a significant increase in minute ventilation after induction of anesthesia in both groups. This increase was associated with a small reduction in $PaCO_2$. There were no clinically significant changes in pH and PaO(2). The incidence of breath-holding and the need for an oropharyngeal airway were similar between the groups. Both groups had similar reductions in mean arterial pressure and cardiac output during the study period; however, a downward trend in mean pulmonary artery pressure was noted in group S, whereas in group E it remained unchanged. Absolute plasma epinephrine and norepinephrine values were low during the pre-cardiopulmonary bypass period in both groups. In conclusion, the technique of vital capacity inhalation induction with 8% sevoflurane offers a rapid onset of anesthesia, satisfactory airway control, and a good hemodynamic profile. Consideration should be given to the benefits of single-agent anesthesia and lowered pulmonary artery pressure during the pre-cardiopulmonary bypass period. In addition to CABG surgery, this technique could be considered in patients with coronary artery disease undergoing non-cardiac surgery, particularly for procedures in which spontaneous ventilation is preferred. Datta PK *et al.* [10] compared standard low-flow technique through a randomized controlled trial. Fifty children, aged 1-5 years, scheduled for ophthalmic examination under anesthesia, were randomized into two groups. All children were induced with 8% sevoflurane in O_2:N_2O (40:60). In the Group S, anesthesia was maintained with 2% sevoflurane at 1 l·min-1 fresh gas flow [O_2:N_2O = 50:50]. In Group L, the sevoflurane vaporizer was turned off and fresh gas flow was reduced to 0.5 l·min-1 [O_2:N_2O = 50:50]. HR, BP, MAC, BIS, total sevoflurane consumption, ocular deviation, body movement, time to laryngeal mask airway removal (TWO), and airway complications were compared between the groups. Rescue propofol bolus was used, if needed. Median duration of examination was 14 min (IQR = 9-17) in Group S and 15 min (IQR = 10-17) in Group L. Sevoflurane consumption was lower in the Group L (7 ml) compared to Group S (9 ml). TWO was lower in Group L (86s) compared to Group S (131s). There was no difference in hemodynamic parameters, incidence of ocular deviation, movement or airway complications, and need for rescue propofol. They concluded that induction dose of sevoflurane is in itself, adequate for maintaining anesthesia for short noninvasive ophthalmic examinations lasting approximately 15 min. This method significantly reduces sevoflurane consumption and cost.

Conclusion

Within the limitations of the present study, it can be concluded that faster induction and better intubating conditions can be seen with Sevofurane in 50% N_2O and 50% O_2 as compared to Sevoflurane in 100% O_2.

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