Section: Anaesthesiology

Original Research Article

EFFECTIVENESS OF LOW FLOW OXYGEN NASAL CANNULA DURING INTUBATION IN PEDIATRIC PATIENT WITH HYDROCEPHALUS: A RANDOMISED CONTROL TRIAL

Sateesh Verma[1], Kartikey Vaish[2], Prem Raj Singh[3], Sudhir Singh[4]

[1]Additional Professor, Department of Anaesthesiology, King George's Medical University, Lucknow, Uttar Pradesh, India.
[2]Senior Resident, Department of Anaesthesiology, King George's Medical University, Lucknow, Uttar Pradesh, India.
[3]Additional Professor, Department of Anaesthesiology, King George's Medical University, Lucknow, Uttar Pradesh, India.
[4]Professor, Department of Paediatric Surgery, King George's Medical University, Lucknow, Uttar Pradesh, India.

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Corresponding Author:
Dr. Sateesh Verma,
Email: sateeshverma24@gmail.com

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ABSTRACT

Background: Infant children are prone to develop decreased SpO2 level during intubation attempts. Furthermore, infants with congenital hydrocephalus may have difficult and prolong intubation time due to associated airway difficulty caused by increased head size. Our hypothesis was that supplementing oxygen by conventional paediatric nasal cannula would prevent or reduce rate of drop in SpO2 level during apnoea period at the time of intubation in these infants. The primary outcome was to compare the incidence of fall in oxygen saturation (SpO2) to ≤95% during intubation attempt. Secondary Objective were to measure elapsed time for pulse-oximetry value falling to 95%. **Materials and Methods:** 74 participants with congenital hydrocephalus, aged less than 1 year were randomized equally into two groups. Group-AO received apnoeic oxygenation with nasal cannula during intubation attempt. In this group nasal cannula was applied before induction and oxygen was started at 5 l/ min through nasal cannula during intubation procedure. Group-C underwent intubation by conventional method without nasal cannula oxygen supplementation during intubation. Data of incidence of fall in SpO2 values and time taken to fall in SpO2 values was recorded and compared among both groups. **Result:** Drop in SpO2 ≤ 95% were present in 4 (10.8%) participants in group AO and 8 (21.6%) in group C (p value 0.031). There was 1 patient which showed a drop in SpO2 ≤92% in group AO and those were 3 in group C. The mean time for drop in SpO2 up to 95% in group AO and C was 28.31± 6.23 seconds and 21.42± 5.81 seconds respectively and this difference was statistically significant (p value 0.045). In group AO, 1 (2.7%) participant and in group C 3 (8.10%) participant needed to restart face mask ventilation due to a drop in SpO2 up to 92% during prolonged intubation attempt. **Conclusion:** Oxygen supplementation through nasal cannula was effective for preventing drop in SpO2 level during apnoea period at the time of laryngoscopy and intubation in infant with hydrocephalus.

INTRODUCTION

While doing laryngoscopy and endotracheal intubation, there is a period without ventilation called the apnoeic period. Infants with hydrocephalus are particularly vulnerable during this period, as they are predisposed to difficult intubations due to large head size which make mask ventilation as well as glottic visualisation and intubation difficult in these children. Prolongation of intubation time can lead to increase in apnoeic time and risk of oxygen desaturation.[1-3]

Apnoeic oxygenation is the passive diffusion of oxygen to the alveoli in a non-breathing patient, which extends the safe duration of apnoea during procedures like intubation. This technique is achieved by delivering a continuous flow of oxygen to the nasopharynx using devices such as nasal cannulas, pharyngeal catheters, or a laryngoscope with side-port. Supported by studies in adult, paediatric, and obstetric populations; apnoeic oxygenation has been shown as an effective technique to prevent hypoxia.[4-8]

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A conventional nasal cannula can be used for pre-oxygenation apnoeic oxygenation during intubation. After anaesthetic induction and subsequent face mask positive pressure ventilation, when the mask is removed for laryngoscopy, the nasal cannula continues to deliver oxygen into the pharynx. This achieves two key benefits: it flushes expired CO2 from the upper airway, and allows for passive oxygen diffusion to the lungs, extending the safe apnoea time during the intubation attempt.[9-11]

The purpose of this study was to determine the efficacy of a low-flow nasal cannula during apnoea at the time of laryngoscopy and intubation in paediatric patients with hydrocephalus. Our hypothesis was that supplementing oxygen by low flow nasal cannula will prevent or reduce drop in SpO2 level during apnoea period at the time of intubation. The primary outcome was to compare the incidence of fall in oxygen saturation (SpO2) to ≤95% during intubation attempt. Secondary Objectives were to evaluate time taken for pulse-oximetry (SpO2) falling to 95%, need of restarting face mask ventilation again to prevent hypoxia and difficulty during face mask ventilation due to nasal cannula in situ.

MATERIALS AND METHODS

Study design and patient inclusion criteria

This prospective randomized controlled trial was conducted at our state-owned tertiary level heath care centre in India. We recruited the patient for study after getting approval from institutional ethics committee with registration number XIV-PGTSC-IIA/P18. Patients below 1 years, American Society of Anaesthesiologists (ASA) physical status I or II, who underwent elective or emergency VP shunt surgery under general anaesthesia were chosen as participants. Exclusion criteria were patient not able to achieve SpO2 99-100% on room air, difficult airway other than hydrocephalus, recent history of upper or lower respiratory tract infection, presence of crepts or rhonchi on auscultation.

Randomization, concealment and group allocation: Study subjects were randomized to either the group-AO (apnoeic oxygenation with nasal cannula during intubation) or group-C conventional method without oxygen supplementation during intubation) in 1:1 ratio allocation using computer-generated block randomization table created on Microsoft excel by an independent statistician. The random allocation sequence was kept separately in sealed opaque envelopes with sequential numbers. Blinding was not possible in this study because a nasal cannula was used for the intervention which was visible to all.

Anaesthesia and intraoperative management

Upon arrival in the OR, standard monitors of pulse oximeter, NIBP, and ECG were applied prior to proceeding for induction of anesthesia. Proper positioning during induction was achieved with a folded towels kept under the upper back, neck and head of the child lying supine on the OT table. Width of towel folds was such that tragus of ear and suprasternal notch came at same level.

All participants were administered with 100% oxygen at 5 liters per minute using an adequately sized facemask connected to the Ayes t-piece. Induction of anesthesia was conducted with intravenous fentanyl 2.0mcg/kg and propofol 2-3 mg/kg in incremental manner followed by atracurium 0.5 mg/kg. After induction ventilation was done via tight-fitting facemask till muscle paralysis was expected to be achieved.

In the Apnoeic oxygenation group, a nasal cannula with no oxygen flow was applied prior to preoxygenation with facemask and oxygen was started at 5 l/ min through nasal cannula when facemask was removed for intubation procedure. In conventional group, a nasal cannula was not applied, and intubation was performed without apnoeic oxygenation.

We monitored and recorded any drop in SpO2 until it reached the primary endpoint. The primary endpoint was defined drop in (SpO2 decreased to 95%) or successful intubation. Study participants were intubated by 3rd year post graduate or senior anaesthesia residents who had adequate exposure to paediatric airway management. They had experience and performing about 100 intubations in infants. If SpO2 dropped to 92% during intubation attempt, procedure comprised jaw thrust and positive pressure ventilation via facemask ventilation was initiated. Intubation was then reperformed after the SpO2 increased to 99-100%.

We recorded incidence of drop in SpO2 to 95% during intubation, elapsed time for pulse-oximetry (SpO2) falling from 99-100% to 95%, incidence of need of restarting face mask ventilation again to prevent hypoxia during intubation, and difficulty encountered in face mask ventilation. The time to intubation was taken from the insertion of laryngoscope to EtCO2 confirmation of tracheal intubation. We also recorded complication like nasal injury caused by nasal prong insertion.

Sample size estimation and statistical analysis

Assuming 0.05 level significance, and 80% power, we calculated sample size based on finding from previous study conducted by Aroonpruksakul N et al.[10] Sample size came as 36.84 which was rounded up to 35 participants in each group.

Data was entered into the Microsoft excel sheet. The data was analysed using SPSS version 22.0. Descriptive summary using frequencies, percentages, graphs, mean, median and standard deviation have been used to present study results. Probability (p) was calculated to test statistical significance at the 5% level of significance. Categorical variables were analysed using chi square test. Continuous variables were analysed using independent t test.

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RESULTS

74 participants of hydrocephalus with age less than 1 year were included in the study and were divided into 2 groups. Group AO included patients received oxygen flow at 5 litre per minute via regular paediatric nasal cannula during intubation. Group C didn't receive oxygen during intubation. Flow of participants is shown in [Figure 1].

The mean age in group AO and group C was 4.95±1.24 months and 5.77±1.36 months respectively (p value-0.226). The mean weight across group AO and C was 6.42±2.47 kg and 6.86±1.89 kg (p value- 0.240). The mean height across group AO and C was 62.04±8.25 cm and 63.31±7.81cm, difference was statistically not significant (p value-0.642). The mean Head Circumference across group AO and C was 54.81±1.45 cm and 55.43±1.53 cm respectively (p value- 0.280). The mean of baseline O2 saturation across group AO and C was 99.57±.647 and 99.59±.551, which was statistically not significant. [Table 1].

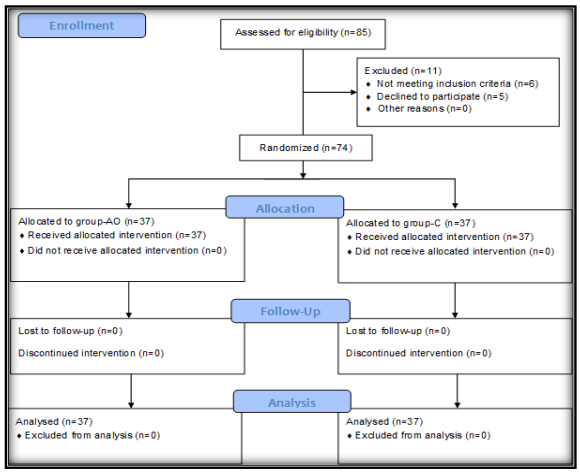

Figure 1

Table 1: Demographic and baseline characteristics of participants

Variables	Group AO (n=37)	Group C (n=37)	t-value/ χ^2-value	p-value
Age in month	4.95±1.24	5.77±1.36	1.223	0.226
Gender M/F	25/12	20/17	0.575	0.234
Weight in kg	6.42±2.47	6.86±1.89	1.184	0.240
Height in cm	62.04±8.25	63.31±7.81	0.467	0.642
Head circumference in cm	54.81±1.45	55.43±1.53	1.081	0.280
Chest circumference in cm	43.11±1.02	44.35±.815	0.755	0.453
Associated MMC	5 (13.51%)	6 (16.21%)	0.106	0.743
Baseline SpO2	99.57±.647%	99.59±.551%	0.193	0.847

Drop in SpO2 up to or below 95% were present in 4 (10.8%) participants in group AO and in 8 (21.6%) in group C (p value- 0.345). There was 1 patient which showed a drop in SpO2 ≤92% in group AO and 3 in group C.

The mean time for drop in SpO2 up to 95% in group AO and C was 28.31± 6.23 and 21.42± 5.81 respectively, which was statistically significant (p value- 0.045).

In group AO, 1 (2.7%) participant and in group C 3(8.10%) participant had to restart face mask ventilation due to drop in SpO2 up to 92% during prolonged intubation attempt. [Table 2].

Table 2: Oxygenation and respiratory characteristics of participants.

Variables	Group AO (n=37)	Group C (n=37)	t-value/ χ^2-value	p-value
Drop in SpO2<= 95%				
No	33 (89.2%)	29 (78.4%)	6.84	0.031*
Yes	4 (10.8%)	8 (21.6%)		
Drop in SpO2 ≤92%				
No	36 (97.3%)	34 (91.9%)	6.75	0.034*
Yes	1 (2.7%)	3 (8.1)		
Time for drop in SpO2 to 95% (sec)	28.31±6.23	21.42±5.81	1.69	0.045*
Intubation time (sec)	24.22±3.45	24.26±5.33	2.42	0.675
Need to restart of face mask ventilation				
No	36 (97.3%)	34 (91.9%)	0.21	0.720
Yes	1 (2.7%)	3 (8.10%)		
Need of Gudel airway insertion				
No	34 (91.9%)	35 (94.6%)	1.38	0.493
Yes	3 (8.1%)	2 (5.4%)		

DISCUSSION

The supplementation of oxygen has been proposed to reduce the risk of hypoxaemia during endotracheal intubation. Furthermore, the benefits of apnoeic oxygenation for children may be even more as they are prone to hypoxemia during airway management owing to their physiological characteristics. The decreased functional residual capacity (FRC) and higher oxygen consumption rate in children contribute to reduction in the duration of safe apnoea.[12,13]

In the intervention group we used the apneic oxygenation by oxygen flow at 5 litre per minute via

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regular pediatric nasal cannula during intubation to evaluate its effectiveness by measuring episodes of falling SpO2 to 95%, and mean time for drop in SpO2 to 95% during airway management etc.

We observed falling of SPO2 up to or below 95% were present in 4 participants in group AO and 8 in group C. There was 1 patient which showed a drop in SpO2 ≤92% in group AO and 3 in group C. It means there was less incidence of drop in SpO2 when oxygen was supplemented during the apnea period. This observation indicates that oxygen supplementation during apnea period was effective in reducing oxygen content in the blood. These findings align with the previous studies which also showed that oxygen therapy during the process of intubation reduced oxygen saturation drops in apnea oxygenation groups.[10,14,15]

The mean time for drop in saturation down to 95% in group AO and C was 28.31± 6.23 seconds and 21.42± 5.81 seconds respectively, which was statistically significant. This finding indicates that apneic oxygenation with nasal cannula decreases rate of fall in oxygen saturation during the period of apnea. These findings are supported by observation from other studies which have also found same pattern with apnea time and oxygen saturation.[16,17]

In group AO only in 1 case had to restart face mask ventilation while in group C 3 cases had to restart face mask ventilation as SpO2 level fell below 92% during intubation. This finding again underlines the importance of oxygen supplementation during apnea at the time of intubation, especially it is prolonged.

Face mask difficulty measured by need of guedel insertion was equal in both groups, indicating applying nasal cannula on child face doesn't increase leak around face mask and subsequent increase in difficulty in mask ventilation.

This study has several limitations. First, its single-center design may limit the generalizability of our findings to other clinical settings. Second, our methodology relied on the measurement of SpO2 which have some lag-time with fall in oxygen content in blood. Furthermore, sample size in our study was comparatively smaller so strength of conclusion may be week.[18]

CONCLUSION

Our study revealed that supplementing oxygen through nasal cannula during intubation in hydrocephalus infants decreases incidence of fall in oxygen saturation. Furthermore, oxygen supplementation also decreases rate of fall in SpO2 values.

Based on these findings, we recommend using oxygen supply through nasal cannula during apnoea period at the time of intubation to prevent hypoxia in children with hydrocephalus under one years of age.

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