Section: Anaesthesiology

Original Research Article

THE EFFECT OF SALINE VERSUS AIR FOR CUFF INFLATION ON THE INCIDENCE OF HIGH INTRA-CUFF PRESSURE IN PAEDIATRIC MICRO CUFF TRACHEAL TUBE: A COMPARATIVE PROSPECTIVE STUDY

Received : 02/01/2023
Received in revised form : 20/02/2023
Accepted : 06/03/2023

Keywords:
Tracheal cuff pressure, Stridor, Upper airway obstruction, Desaturation, Bradycardia.

Corresponding Author:
Dr. Gowri Sankar. C
Email: drgowrisankar2@gmail.com

DOI: 10.47009/jamp.2023.5.2.134

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (2); 638-641

Hema Alamelu. G[1], T. Gayathri[2], Ishwarya. C[3], Gowri Sankar. C[4]

[1] Senior Resident, Department of Anaesthesiology, Madurai Medical College, Tamilnadu, India.
[2]Assitant Professor, Department of Anaesthesia, Government Theni Medical College, Tamilnadu, India.
[3]Postgraduate, Department of Anaesthesiology, Madurai Medical College, Tamilnadu, India.
[4]Assitant Professor, Department of Anaesthesiology, Madurai Medical College, Tamilnadu, India.

Abstract

Background: New anatomically based Micro cuff tracheal tubes have helped overcome the damage caused by using traditional cuffed endotracheal tubes in the paediatric population. In this study, we compared the effects of saline versus air for cuff inflation. We also studied the incidence and effects of high intra-cuff pressure in paediatric micro cuff tracheal tubes and whether the high intra-cuff pressure affects post-extubation adverse events. **Materials and Methods:** 80 children undergoing general anaesthesia were randomly allocated to the saline versus air group. During anaesthesia, tracheal cuff pressure was continuously monitored using an arterial line pressure transducer attached to the pilot balloon through a three-way tap. The initial tracheal cuff pressure was recorded and then checked every 15 min. **Result:** There was a statistically insignificant difference in age, gender, and weight between groups. A significant difference in the duration of tracheal intubation (p=0.033) between the two groups. The tracheal cuff pressure increases more significantly in the air group due to increased volume and pressure due to nitrous oxide diffusion. Post-extubation adverse events were similar in both saline and air groups. **Conclusion:** The clinical study results showed that the use of saline is associated with a lesser increase in intra-cuff pressure than the air group, and the incidence of post-extubation adverse events was similar in both groups.

INTRODUCTION

The use of cuffed endotracheal tubes in paediatric anaesthesia has become more common. Fear of airway mucosal injury, post-extubation stridor, and upper airway obstruction in the post-operative period has limited the use of cuffed paediatric tracheal tubes. The potential damage to the tracheal mucosa by excessive tracheal tube cuff pressure is balanced against better airway protection, improved ventilation, and reduced leakage of anaesthetic gases. Newer anatomically based designs (micro cuff tracheal tubes) have helped to overcome potential Problems.[1,2] The trachea's architecture is uneven, D-shaped, non-circular, and non-uniform. Tiny channels are formed when a cuff made of PVC material is inflated, which promotes micro aspiration. PVC cuffs have been sealed using intra-cuff pressures as high as 50 cm of water to prevent microaspiration. In micro-cuffed ETT, the cuff can be sealed in the tracheal lumen at pressures as low as 15 cm of water or lower since it is composed of ultrathin (10 microns) polyurethane rather than conventional PVC (50-80 microns).[3,4]

It is particularly challenging to determine an exact safe amount of airway sealing pressure in children because of the considerable variation in capillary perfusion pressure. As a safe limit, 20 cmH20 of safe pressure was chosen. Nitrous oxide use during paediatric anaesthesia raises intra-cuff pressure. The very thin cuff makes it easier for gases to diffuse, which raises volume and pressure and increases the likelihood of post-operative airway problems. This issue has been reduced by using saline rather than air to fill the tracheal tube cuff.[4,5]

In this study, we have compared the effect of saline versus air on the incidence of excessive intraoperative cuff pressure in children <16 years of age undergoing balanced anaesthesia with nitrous oxide.

MATERIALS AND METHODS

This prospective comparative study was conducted in the Institute of Anaesthesiology in the department of paediatric surgery at Government Madurai Medical college on 80 (40 in each group) children of age group <16 years, from October 2021- October 2022 (12 months). This study has received institutional ethical committee approval and informed consent from the parents.

Inclusion criteria: Children <16 years undergoing elective and emergency surgery for more than one hour using nitrous oxide in our Government Rajaji Hospital, Madurai, were included.

Exclusion criteria: Preterm babies, neonates weighing less than 3 kg, upper respiratory tract infection, Pts undergoing nose, throat, and airway surgery, and children requiring post-operative ventilation will be excluded.

A simple random sampling will be performed to allocate the children to any interventional groups (saline group VS Air group). All children >3 kg undergoing elective/emergency surgery between October 2021to October 2022 will be included in our study. Informed written consent will be obtained. The details such as gestational age, history, birth weight, general physical and systemic examination, congenital anomalies, and type of endotracheal tube and tube size were recorded for each child.

General anaesthesia was induced. After administration of the neuromuscular blocking drug (rocuronium 0.6-1.0 mg/kg or atracurium 0.5 mg/kg) trachea was intubated with an appropriately sized Micro Cuff tracheal tube (according to the manufacturer's recommendations). The tracheal tube cuff was then inflated with either saline or air. Inflation volume was determined using the air leak test. A stethoscope was placed in the oral cavity, and an audible air leak on ventilation was confirmed.

The tracheal tube cuff was then inflated slowly until the leak disappeared while maintaining continuous airway pressure of 20 cmH2O. The tracheal tube was changed to half a size smaller if there was the absence of a leak with the cuff un-inflated, and if the leak remained when the cuff pressure was > 20 cmH2O, the tracheal tube was changed to half a size bigger. Anaesthesia was maintained using oxygen, nitrous oxide (concentration range 50–70%), and sevoflurane. During anaesthesia, tracheal cuff pressure was continuously monitored using an arterial line pressure transducer attached to the pilot balloon through a three-way tap. The initial tracheal cuff pressure was recorded and then checked every 15 min.

If the tracheal cuff pressure exceeded 25 cmH2O for > 30 s (to exclude artefactual changes), the volume in the cuff was reduced until the pressure was returned to the initial level. Tracheal extubation was done.

Immediate post-extubation adverse events and any treatment required, rise in tracheal cuff pressure from baseline using cuff pressure monitor, Prolonged/ barking cough, Obstructed airway, drop in heart rate > 10% from baseline, decrease in peripheral oxygen saturations to < 92% or > 10% below baseline, Laryngospasm, Post extubation use of medications (steroids, epinephrine), Post extubation supplemental Oxygen or CPAP, and Reintubation for stridor. Also, the duration of surgery was recorded for both groups.

SPSS statistical software was used for the analysis. Continuous variables are typically expressed as a mean (SD). For a test of significance, the chi-square test is used. P-values less than 0. 05 were considered statistically significant.

RESULTS

A total of 80 cases were studied, 40 in each group. In our study, the demographic profiles, namely age, weight, gender, and ASA grading of patients, were compared.

There was a statistically insignificant difference in age, gender, and weight between groups, with a p-value of 0.753, 0.169, and 0.697. Further, the ASA between the two groups was compared, and whether the incidence of high intracuff pressure between saline and air group is associated with the ASA factor is ruled out. The p-value was 0.012 for Tracheal cuff pressure which was statistically significant. The maximal tracheal cuff inflation pressure in the saline group was significantly lower than in the air group, reducing the incidence of high intra-cuff pressure during anaesthesia. The p-value was insignificant for ASA, cough, Desaturation/bradycardia, and stridor comparison between the groups [Table 1].

Table 1: Comparison of clinical parameters between the groups

ASA	SALINE GROUP	AIR GROUP	p-value
ASA 1	24	26	0.736
ASA 2	13	10	
ASA 3	3	4	
ASA 4	0	0	
Tracheal cuff pressure			0.012
≤10	10	6	
>10	30	34	
MEAN±SD	11.375±1.254	12.075±1.163	
Cough			0.154
None	17	22	
mild: no intervention	20	18	

ISSN (O): 2687-5365; ISSN (P): 2753-6556

intervention required	3	0	
Stridor			0.494
none	40	38	
transient: no intervention	0	2	
LARYNGOSPASM			0.236
none	38	34	
mild: no intervention	2	4	
intervention required	0	2	
Desaturation/bradycardia			0.264
None	37	36	
transient: no intervention	3	4	

For the comparison of vitals, we have observed a significant difference only in the case of SPO2 [Table 2].

Table 2: Comparison of vitals between the groups

Vitals	SALINE GROUP		AIR GROUP		p-value
	Mean	SD	Mean	SD	
Heart rate	105.78	21.53	102.78	21.49	0.535
Spo2	98.25	0.59	98.55	0.75	0.05
Respiratory rate	28.08	7.02	29.35	6.54	0.403

We compared CRT, duration of surgery, tracheal tube internal diameter, initial tracheal cuff inflation volume, and duration of tracheal intubation between the two groups. We have observed a significant difference only in the duration of tracheal intubation (p=0.033) between the two groups [Table 3].

Table 3: Comparison of CRT, duration of surgery, tracheal tube internal diameter, initial tracheal cuff inflation volume, and duration of tracheal intubation between the groups

CRT	SALINE GROUP	AIR GROUP	p-value
CRT 2	24	26	0.649
CRT 3	16	14	
MEAN± SD	2.4±0.496	2.35±0.483	
Duration of Surgery			
<150	19	19	0.645
>150	21	21	
MEAN±SD	138.875±30.77	141.75±24.483	
Tracheal tube internal diameter	4.537 ±4.295	1.082±1.018	0.308
Initial tracheal cuff inflation volume	0.81 ± 0.885	0.271 ± 0.327	0.267
Duration of tracheal intubation	138.875 ±151	30.77 ±17.254	0.033

The tracheal cuff pressure increases more significantly in the air group due to increased volume and pressure due to nitrous oxide diffusion with a significant p-value [Figure 4].

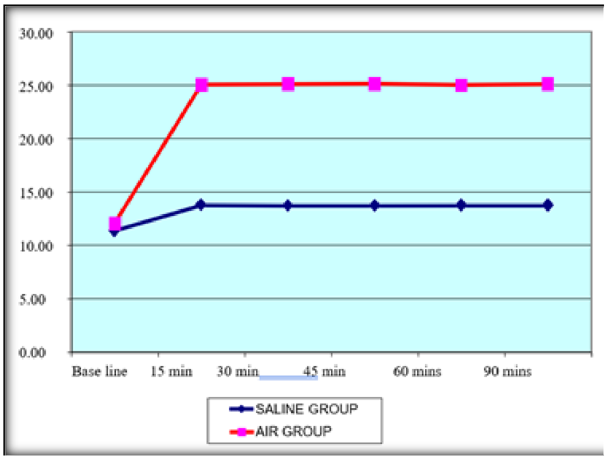

Figure 4: Comparison of maximum Tracheal cuff inflation pressure

DISCUSSION

The practice of using uncuffed endotracheal tubes has proven to be safe in children below eight years of age. Disadvantages of uncuffed tracheal tubes include air leaks, risk of aspiration, environmental contamination with anaesthetic gases, and difficulty in measuring end-tidal CO2 concentration. Cuffed endotracheal tubes avoid the above problems, but cuffed endotracheal tubes carry the risk of post-extubation stridor, fear of airway mucosal injury, and upper airway obstruction in the post-operative period.[1,3] These problems have limited the use of cuffed endotracheal tubes. Micro cuff endotracheal tubes are specially designed to suit the paediatric airway anatomy. The intubation depth marks and short cylindrical cuff near the tracheal tube tip allow the cuff to free sub glottic zone without the risk of endobronchial intubation. But maintaining safe tracheal tube cuff pressure remains important. The cuffs on the micro cuff tracheal tubes are very thin, allowing gases to diffuse more easily. The volume at the beginning of anaesthesia may not be the same at the end, leading to airway complications. So, the current study aims to compare the effect of saline versus air on the incidence of excessive intraoperative cuff pressure in children <16 years of age undergoing balanced anaesthesia with nitrous

ISSN (O): 2687-5365; ISSN (P): 2753-6556

oxide and whether the high intracuff pressure has any effect on post-extubation adverse events.[3,5,6] In our study, the tracheal cuff pressure in the saline group was 11.38, comparable to the air group 12.08, which is comparable to previous studies by Armstrong et al.[7]

The main reason was that nitrous oxide diffuses into the air-filled space more rapidly, which increases the volume and pressure in the tracheal tube cuff. Using saline to inflate the tracheal tube cuff does not prevent nitrous oxide from diffusing into the cuff, but the gas dissolves with the liquid, and hence the volume of the cuff remains the same. The paediatric micro cuff tracheal tubes are made up of micro-thin polyurethane to reduce the risk of tracheal mucosal injury, but it may increase the speed of gas diffusing in the cuff. Using saline to inflate the cuff eliminated the need for measures to decrease raised intra-cuff pressure.[8-11]

The duration of tracheal intubation increases the exposure to nitrous oxide. The volume and pressure in the cuff increase in an air-filled group compared to the saline-filled group. The tracheal cuff pressure increases with a mean of 151 compared to the saline group, which increases with a mean of 138.87. Thus, significantly increasing tracheal cuff pressure in prolonged surgery in the air-filled group. When the tracheal cuff pressure increases more than the safety limit (20-25cm H20), periodic reduction of tracheal cuff pressure at regular intervals is needed. Using cuffed endotracheal tubes in paediatric patients causes fear in most anaesthesiologists of the risk of post-extubation adverse events. The risk of post-extubation adverse events in the saline and air groups was equal in occurrence with a p-value of 0.236, which is statistically insignificant and alleviates the fear of post-extubation adverse events. Post-extubation stridor is difficult to compare between studies, as the time assessment varies from immediately after extubation to discharge from the recovery room. Post-extubation airway obstruction may be due to secretions, anaesthetics, and pain must also be considered.

One of the major drawbacks of using MPTT is its high cost in our setup and the need for constant monitoring of cuff pressure for those surgeries where nitrous oxide usage as a part of anaesthetics has been observed.

CONCLUSION

In our clinical study, we compared the effect of saline versus air on the incidence of excessive intraoperative cuff pressure in children <16 years of age undergoing balanced anaesthesia with nitrous oxide. It showed that the use of saline is associated with a lesser increase in intra-cuff pressure than the air group, and the incidence of post-extubation adverse events was similar in both groups.

REFERENCES

1. De Orange FA, Andrade RG, Lemos A, Borges PS, Figueiroa JN, Kovatsis PG. Cuffed versus uncuffed endotracheal tubes for general anaesthesia in children aged eight years and under. Cochrane Database Syst Rev 2017; 17:11: CD011954.
2. Bhardwaj N. Pediatric cuffed endotracheal tubes. J Anaesthesiol Clin Pharmacol 2013; 29:13–8.
3. Flynn PE, Black AE, Mitchell V. The use of cuffed tracheal tubes for paediatric tracheal intubation, a survey of specialist practice in the United Kingdom. Eur J Anaesthesiol 2008; 25:685–8.
4. Saito M, Maruyama K, Mihara T, Hoshijima H, Hirabayashi G, Andoh T. Comparison of polyurethane tracheal tube cuffs and conventional polyvinyl chloride tube cuff for prevention of ventilator-associated pneumonia: A systematic review with meta-analysis: A systematic review with meta-analysis. Medicine (Baltimore) 2021; 100: e24906.
5. Taylor C, Subaiya L, Corsino D. Pediatric cuffed endotracheal tubes: an evolution of care. Ochsner J 2011; 11:52–6.
6. Mhamane R, Dave N, Garasia M. Use of Microcuff(®) endotracheal tubes in paediatric laparoscopic surgeries. Indian J Anaesth 2015; 59:85–8.
7. Armstrong J, Jenner P, Poulose S, Moppett IK. The effect of saline versus air for cuff inflation on the incidence of high intra-cuff pressure in paediatric MicroCuff® tracheal tubes: a randomised controlled trial. Anaesthesia 2021; 76:1504–10.
8. Sheraton TE, Gildersleve CD, Hall JE. The use of nitrous oxide in paediatric anaesthetic practice in the United Kingdom: a questionnaire survey. Anaesthesia 2007; 62:62–6.
9. Dullenkopf A, Gerber AC, Weiss M. Nitrous oxide diffusion into tracheal tube cuffs: comparison of five different tracheal tube cuffs. Acta Anaesthesiol Scand 2004; 48:1180–4.
10. Felten M-L, Schmautz E, Delaporte-Cerceau S, Orliaguet GA, Carli PA. Endotracheal tube cuff pressure is unpredictable in children. Anesth Analg 2003; 97:1612–6.
11. Tu HN, Saidi N, Leiutaud T, Bensaid S, Menival V, Duvaldestin P. Nitrous oxide increases endotracheal cuff pressure and the incidence of tracheal lesions in anesthetized patients. Anesth Analg 1999; 89:187–90.