ORIGINAL ARTICLE

Does intra-cuff alkalinized lidocaine prevent tracheal tube induced emergence phenomena in children?

Mona S. Ahmady*, Sayed Sadek**, Roshdi R. Al-metwalli***

**Lecturer, Department of Anesthesiology, Mansoura University, Mansoura (Egypt)*
***Lecturer, Department of Anesthesiology, El-Fayoum University, El-Fayoum (Egypt)*
****Associate Professor, Department of Anesthesiology & Intensive Care, University of Dammam (KSA)*

Correspondence: Roshdi R. Al-metwalli, University of Dammam / King Fahad Hospital, PO Box 40081; Al-Khobar (KSA) 31952; Tel: 0096638982219; Fax: 009668966770; E-mail: rmetwalli@yahoo.com

ABSTRACT

Aim: To study and investigate the efficacy of intra-cuff alkalinized lidocaine in the prevention of the endotracheal tube (ETT) induced emergence phenomena in children.

Methodology: Fifty children, ages 6-12 years, ASA physical status I-II, scheduled for elective dental surgery under N_2O free general anesthesia with an expected duration of 120 min or more, were randomly assigned one of the two groups (25 patients each); lidocaine group in which the cuff of ETT was inflated with a mixture of lidocaine 2% and sodium bicarbonate 8.4% and the saline group, in which tube cuff was inflated with 0.9% saline solution.

Results: There were significant reduction in the incidence and severity ($p=0.005$ & $p=0.014$) of cough at extubation and in the PACU ($P=0.048$ & $P=0.014$). The incidence and severity of postoperative sore throat was also reduced in the lidocaine group compared to the saline group ($p=0.025$ and 0.031 respectively). Moreover, there was a significant prolongation of the time to spontaneous ventilation before extubation in the lidocaine compared to the control group (16.4 ± 3.1 min and 9.4 ± 1.7 min respectively) with p value < 0.0001.

Conclusion: Intra-cuff alkalinized lidocaine reduces the incidence of cough, sore throat, improved ETT tolerance and inducing smooth extubation in paediatric patients, but prolongs time to spontaneous ventilation before extubation.

Keywords: Lidocaine; Alkalinization; Post-extubation; Tracheal tube cuff; Laryngospasm

Citation: Ahmady MS, Sadek S, Al-metwalli RR. Does intra-cuff alkalinized lidocaine prevent tracheal tube induced emergence phenomena in children? Anaesth Pain & Intensive Care 2013;17(1):18-21

INTRODUCTION

The fears of tracheal mucosal injury due to ischemia and subsequent subglottic stenosis have prevented widespread use of cuffed endotracheal tube (ETT) in pediatric population below the age of eight,[1,2] although studies using the modern anatomically designed high-volume, low-pressure cuffs have not shown any significant increase in the incidence of post-extubation complication compared to un-cuffed ETTs.[3-7] Cough and stridor (laryngospasm) are the most recorded post-extubation morbidity in pediatrics patients.[8-11] Recent studies have shown that lidocaine hydrochloride placed inside an ETT cuff can diffuse across its hydrophobic membrane and topically block cough receptors in the tracheal mucosa.[11,12] Moreover, alkalinization of lidocaine enhanced its diffusion across the cuff membrane and allowed smaller amounts to be used, 40 mg, compared to 500 mg in a previous published study.[13]

To our knowledge intra-cuff lidocaine has been only tested in adult population. With advancement in the manufacture of pediatric cuffed tubes and the possibility to use safe small doses of intra-cuff lidocaine by its alkalinization, the anesthesiologists can use cuffed ETT's with more confidence. The aim of our study was to evaluate the use of alkalinized intra-cuff lidocaine in pediatric patients undergoing dental surgery, and its efficacy in the prevention of the ETT induced emergence phenomena.

METHODOLOGY

After approval from local Research and Ethics committee and written informed consents, fifty

children with age between 6-12 years old, and ASA physical status I or II were enrolled in this prospective controlled, randomized, blinded study. All patients were scheduled for elective dental surgery under N_2O free general anesthesia with an expected duration of 120 min or more. Any patients who had a recent attack of upper respiratory tract (URT) infection, history of bronchial asthma, or in whom intubation was difficult (two or more attempts) were excluded from the study.

All patients were premedicated with 0.2 mg/kg oral diazepam 90 minutes before anesthesia induction, and xylometazoline hydrochloride 0.05% nasal drops 10 minutes before induction. After attaching standard monitors e.g. pulse oximetry, blood pressure and ECG, and pre-oxygenation for 2-3 min, a standard anesthetic technique was conducted by consultant anesthesiologist who was blind to the study design. Anesthesia was induced with fentanyl 2 μg/kg and propofol 2.5 mg/kg. Nasal tracheal intubation was facilitated with rocuronium bromide 0.6 mg/kg, using nasal RAE tube (RUSCHELIT™) with high volume, low-pressure cuff and with an inner diameter calculated according to the Khine´s formula (I.D. = age/4+3).[14] Patients were randomly assigned by opening a sealed envelope into two groups (25 patients each), lidocaine group and saline group. The ETT cuff was aspirated as much as possible and then inflated with syringe loaded with either a mixture of 1.5 ml of lidocaine 2% and 1.5 ml sodium bicarbonate 8.4% (Lidocaine group) or 3 ml normal saline (Saline group).

In both groups the cuff was inflated by the same anesthesiologist to prevent air leaks (minimal occlusion pressure) during the inspiratory phase of mechanical ventilation of the patient when peak airway pressure was 20 cmH_2O. If the minimal occlusion pressure exceeded 20 cmH_2O (the recommended upper limit intra-cuff pressure), the patient then was excluded from the study. The cuff pressure was measured using hand-held, manometer P-V gauge (Mallinckrodt Medical, St. Louis, MO) by the same anesthesiologist, who also assessed air leak by both audible technique and by observing the difference between inspiratory and expiratory tidal volume.

Anesthesia was maintained with sevoflurane (2-3% end-tidal) and 50% oxygen in air. Additional boluses of fentanyl (1–2 μg/kg) were administered to maintain surgical analgesia. Mechanical ventilation was controlled and adapted to maintain end-tidal carbon dioxide at 30-35 mmHg. At the end of the surgery, sevoflurane was discontinued, the lungs were ventilated with 100% O_2 and the pharynx was gently suctioned. The residual muscle paralysis was reversed by neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. Patients were extubated when they fulfilled the following criteria; (1) Efficient spontaneous respiration (2) Ability to follow the verbal commands; and ability to do purposeful movement (attempting self-extubation) (3) Full reversal of neuromuscular block (ulnar nerve T4/T1 ratio = 1).

The time to spontaneous ventilation before readiness as well as post-extubation stridor, were recorded. Post-extubation coughing was graded and recorded based on the modified four point scale as follows; Grade 0 = No cough; Grade 1 = (Mild) single bout of cough; Grade 2 = (Moderate) more than one episodes of unsustained ($\leq$ 5 sec) coughing and Grade 3 = (Severe) sustained ($>$ 5 sec) bouts of coughing.

The duration of surgery and intubation were recorded. Paracetamol suppository (15 mg/kg) was inserted for postoperative analgesia. The same blinded anesthesiologist recorded coughing as above grading, and recorded sore throat and hoarseness using verbal analogue scale score (VAS: 0-10 cm) before discharge from PACU and 24 hours after tracheal extubation.

Statistics: To calculate the sample size, we estimated that using alkalinized lidocaine would decrease the rate of cough and postop erative sore throat by 30-40% as evaluated by pilot study. Based on this estimation and at a significance level of 0.05 with a power of 80%, 25 subjects were needed in each group. Demographic data, duration of surgery and intubation, the volume of alkalinized lidocaine injected into the ETT cuff and the time of spontaneous ventilation before extubation, were statistically compared using the unpaired Student's t test. Gender and other ratios data were analyzed using Fishers exact or Chi square tests. Man-Whitney U-tests were used for non-parametric data. Statistical significance was defined as $P < 0.05$. Analysis was performed using Statistica software version 7.0 for windows (Statsoft, Inc).

RESULTS

Fifty patients participated in our study and none was excluded. There were no statistically significant differences between the two groups regarding demographic data, duration of surgery or intubation, or in the volume of alkalinized lidocaine injected into the ETT cuff (Table 1).

There was significant reduction in the incidence and severity ($p=0.005$ & $p= 0.014$) of cough at extubation and in the PACU ($P=0.048$ & $P=0.014$) as well as, the incidence ($p=0.025$) and severity ($p=0.031$) of postoperative sore throat in the lidocaine group compared to the saline group (Table 2). Furthermore there was a significant prolongation of the time to spontaneous ventilation before readiness to extubation in the lidocaine compared to the saline group (16.4 ± 3.1

Table 1: Patient's Demographic and operative data

Parameters	Lidocaine Group N (25)	Saline Group N (25)	P value
Age (year)	8.3±1	8.2±1	0.78
Sex (M/F)	16/9	15/10	1.00
Weight (kg)	30.8±3.1	30.7±3.3	0.86
Intra-cuff volume injected (ml)	2.56±0.1	2.55±0.2	0.92
Time of surgery (min)	134.8±10.8	133.7±11	0.70
Intubation time (min)	157.5±10.8	156.2±10.7	0.65
Time of spontaneous ventilation to extubation (min)	16.4±3.1*	9.4±1.7	< 0.0001

(*) Indicate significant difference.

Table 2: Tracheal tube-induced emergence phenomena; data are expressed as number (percentage), mean (SD) or median (Interquartile range)

	Lidocaine Group		Saline Group		P value	
	Incidence	Severity	Incidence	Severity	Incidence	Severity
Cough						
Extubation	N=12 (48)	0.0 (0-2)	N=22(88)	0.0 (1-2)	0.005*	0.014*
PACU	N=1(4)	0.0 (0-0)	N=7(28)	0.0 (0-1)	0.048*	0.014*
24 hours	N =1 (4)	0.0 (0-0)	N=2(8)	0.0 (0-0)	1.000	1.000
Post-extubation stridor	N=2(8)		N=4(16)		0.667101	
Sore throat						
PACU	N=3(12)	0.64±1.8	N=11(44)	2.16±2.8	0.025*	0.031*
24 hours	N=1(4)	0.12±0.6	N=7(28)	0.82±1.5	0.048*	0.0373*
Hoarseness						
PACU	N=2(8)	0.28±0.96	N=4(16)	0.52±1.2	0.667101	0.4489
24 hours	N=0	----	N=0	--------	------	-------

(*) Indicate significant difference.

min. and 9.4±1.7 min. respectively) with p value <0.0001 (Table 1). The two groups showed no significant differences in either incidence of post-extubation stridor or postoperative hoarseness (Table 2).

DISCUSSION

This is the first prospective, randomized, controlled, blind study in which the ETT cuff filled with alkalinized lidocaine was evaluated in pediatric population. It showed a significant reduction in the incidence and severity of cough at extubation and at PACU, as well as, the incidence and severity of postoperative sore throat in the lidocaine group compared to the saline group. However, the incidence and severity of both extubation stridor and postoperative hoarseness were similar in the two groups.

The study of Estebe et al[13,15-17] was the first study, that reported that alkalinization of intra-cuff lidocaine, increased the diffusion rate of its neutral base across the hydrophobic structure of the cuff membrane from 1% to 65% within 6 hours period. This allowed the use of a low (20-40 mg) safe and effective dose compared to a higher but risky dose (200-500 mg) of non-alkalinized lidocaine.[11,12,18] This report encouraged us to design our study using intra-cuff alkalinized lidocaine in pediatric patients.

Our study showed a significant prolongation of time to spontaneous ventilation and time to extubation in the lidocaine group, which could be explained by induced effective soothing of the tracheal mucosa by released lidocaine across the cuff membrane. Although the incidence of post-extubation coughing in children emerging from general anesthesia has not been previously recorded, our study showed an 88% incidence in the control group, which significantly reduced to 48% in the lidocaine group. These results are in agreement with previous studies conducted on adult population using a small dose[13,15-17] or a larger dose[11,12] of intra-cuff lidocaine.

Because most of the published studies investigated the post-extubation emergence phenomena in pediatric population were conducted on young children (below) the age of 6 years, there is no reported incidence of post-operative sore throat in school age group. The significant reduction in the incidence and severity of postoperative sore throat in our lidocaine group (Table 2) is quite similar to the result of Christopher Crerar et al,[19] who reported that intra-cuff alkalinized lidocaine was significantly effective in prevention of postoperative sore throat than direct instillation of

topical lidocaine on the cuff of ETT in adult patients.

The incidence of post-extubation stridor in children intubated with cuffed or un-cuffed tube has been estimated to range from 3.4% to 15.1%.[6,20] In our control group, stridor was reported in 16% of patients and insignificantly reduced to 4% in lidocaine group. Although our results are quite comparable to previous studies useing intra-cuff lidocaine[11,12,15-17] (in adults), Baraka et al[21], Pernille Leicht et al,[22] Sanikop and Sonal Bhat[23] reported significant reduction in the incidence of laryngospasm with the use of IV lidocaine 1.5 mg/kg prior to extubation (in young children). This could be explained by the differences in the study designs regarding population, age group, sample size, type of surgery and the route of lidocaine administration.

One limitation of our study is that, we did not evaluate ETT emergence phenomena in children below the age of 6 years, who might have higher incidence of these complications. This could be explained by; first, the fact that most children have their dental treatment during school age, second; the age of six is the minimal age to report the subjective feeling of pain (sore throat), third; traditionally it has been taught that only un-cuffed endotracheal tubes should be used for children under the age of 8 years. The second limitation is that, we applied a safe upper limit cuff pressure of 20 cmH_2O, based on the recommendation of Weiss M. et al,[6] although there is no published data regarding perfusion pressures of the tracheal mucous membrane or the highest safe ETT cuff pressure in children. This is the goal of another of our ongoing study.

CONCLUSION

In children with N_2O free anesthesia, filling ETT cuff with alkalinized lidocaine significantly reduces the incidence and severity of post-extubation cough, as well as, the postoperative sore-throat, but prolongs time to spontaneous ventilation before extubation.

REFERENCES

1. Motoyama EK. Endotracheal intubation. In: Motoyama EK, Davis PJ, Eds. Smith's anesthesia for infants and children, 5th ed. St Louis, MO: CV Mosby, 1990:269–75.
2. Fisher DM. Anesthesia equipment for pediatrics. In: Gregory GA, editor. Pediatric Anesthesia. 4th ed. Churchill Livingstone; New York: 2001. pp. 207–8.
3. Goel S, Lim SL. The intubation depth marker: the confusion of the black line. Paediatr Anaesth 2003;13:579–83. [Medline]
4. Weiss M, Dullenkopf A, Gerber AC. Microcuff pediatric tracheal tube. A new tracheal tube with a high volume–low pressure cuff for children (German). Anaesthesist 2004;53:73–9 [Medline]
5. Weiss M, Gerber AC, Dullenkopf A. Appropriate placement of intubation depth marks in a new cuffed paediatric tracheal tube. Br J Anaesth 2005;94:80–7. [Medline] [Free Full Text]
6. Weiss M, Dullenkopf A, Fischer J. E, Keller C, Gerber AC. Prospective randomized controlled multi-centre trial of cuffed or uncuffed endotracheal tubes in small children. Br J Aneath 2009;103:867-73. [Medline] [Free Full Text]
7. Dorsey DP, Bowman SM, Klein MB, Archer D, Sharara RS. Perioperative use of cuffed endotracheal tubes is advantageous in young pediatric burn patients. Burns 2010;36:856-60. [Medline] [Free Full Text]
8. Newth CJL, Rachman B, Patel N, et al. The use of cuffed versus uncuffed endotracheal tubes in pediatric intensive care. J Pediatr 2004;144:333–7. [Medline]
9. Roy WL, Lerman J. Laryngospasm in paediatric anaesthesia. Can J Anaesth 1988;35:93–8. [Medline]
10. Gulhas N, Durmus M, Demirbilek S, Togal T, Ozturk E, Ersoy MO. The use of magnesium to prevent laryngospasm after tonsillectomy and adenoidectomy; a preliminary study. Paediatr Anaesth 2003;13:43–7. [Medline]
11. Fagan C, Frizelle HP, Laffey J, et al. The effects of intracuff lidocaine on endotracheal-tube-induced emergence phenomena after general anesthesia. Anesth Analg 2000;91:201–5. [Medline] [Free Full Text]
12. Altintas F, Bozkurt P, Kaya G, Akkan G. Lidocaine 10% in the endotracheal tube cuff: blood concentrations, haemodynamic and clinical effects. Eur J Anaesthesiol 2000;17:436-42 [Medline]
13. Dollo G, Estebe JP, Le Corre P, et al. Endotracheal tube cuffs filled with lidocaine as a drug delivery system: in vitro and in vivo investigations. Eur J Pharm Sci 2001;13:319-23. [Medline]
14. Khine HH, Corddry DH, Kettrick RG, Martin TM, McCloskey JJ, Rose JB, et al. Comparison of cuffed and uncuffed endotracheal tubes in young children during general anesthesia. Anesthesiology 1997 Mar;86(3):627-31. [Medline] [Free Full Text]
15. Estebe JP, Dollo G, Le Corre P, Le Naoures A, Le Verge R, Ecoffey C. Alkalinization of intracuff lidocaine improves endotracheal tube-induced emergence phenomena. Anesth Analg 2002; 94:227-30. [Medline] [Free Full Text]
16. Estebe JP, Delahaye S, Le Corre P, Dollo G , Le Naoures A, Chevanne F , Ecoffey C. Alkalinization of intra-cuff lidocaine and use of gel lubrication protect against tracheal tube-induced emergence phenomena. Br J Anaesth 2004; 92(3):361-6. [Medline] [Free Full Text]
17. Estebe JP, Gentili M, Le Corre P, et al. Alkalinization of intracuff lidocaine; Efficacy and safety. Anesth Analg 2005;101:1536-41. [Medline] [Free Full Text]
18. Hirota W, Kobayashi W, Igarashi K, et al. Lidocaine added to a tracheostomy tube cuff reduces tube discomfort. Can J Anesth 2000;47:412-4. [Medline]
19. Christopher Crerar, EdwardoWeldon, Jamie Salazar, Kelly Gann, Joseph A. Kelly,Joseph E. Pellegrini. Comparison of 2 laryngeal tracheal anesthesia techniques in reducing emergence phenomena. AANA J 2008 December;76(6): 425-31. [Medline]
20. Deakers TW, Reynolds G, Stretton M, et al. Cuffed endotracheal tubes in pediatric intensive care. J Pediatr 1994;125:57–62. [Medline]
21. Baraka A. Intravenous Lidocaine controls extubation laryngospasm in children. Anesth Analg 1978;57:506–7. [Medline] [Free Full Text]
22. Leicht P, Wisborg T, Chraemmer-Jerrgensen B. Does intravenous lidocaine prevent laryngospasm after extubation in children? Anesth Analg 1985;64:1193–6. [Medline] [Free Full Text]
23. Sanikop CS, Sonal Bhat. Efficacy of intravenous lidocaine in prevention of post extubation laryngospasm in children undergoing cleft palate surgeries. Indian J Anaesth. 2010 Mar-Apr;54(2):132–136. [Medline] [Free Full Text] [Journal Free Full Text]

★★★★★