

Comparison of Inflating the Endotracheal Tube Cuff with Air, Saline or Alkalinized Lignocaine and Assessment of Post Extubation Sequelae



Medical Science

KEYWORDS : Endotracheal tube cuff pressure, alkalinized lignocaine, normal saline, emergence phenomenon.

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ABSTRACT

Endotracheal intubation is a routine part of delivering general anaesthesia and sore throat is the most common complaint following intubation. Cough, hoarseness are other post extubation sequelae. Injury to the tracheal mucosa due to high intracuff pressure is thought to be the cause for these problems. Inflating the cuff of an ETT with alkalinized lignocaine and normal saline instead of air may decrease the incidence and severity of post intubation sore throat and other post intubation problems by preventing the rise in intracuff pressure and also anaesthetizing the tracheal mucosa.

INTRODUCTION:

Intubation is a routine part of delivering general anaesthesia. Cuffed endotracheal tube, used during general anaesthesia acts as a means of supplying oxygen (O₂) to the lungs and as a conduit for volatile anaesthetic agents¹.

Postoperative sore throat is the most common complaint following tracheal intubation².

Nitrous oxide use may increase ETT cuff pressure perioperatively. Overinflation of the ETT cuff might lead to serious complications, ranging from tracheal mucosal pressure necrosis, stenosis, laryngeal nerve palsy to tracheal rupture and tracheoesophageal fistula formation.⁴

Adequacy of ETT cuff inflation is usually checked by one of the following techniques: Manual palpation of the pilot balloon, disappearance of audible air leak through the mouth or the use of either an aneroid manometer or continuous automatic ETT cuff pressure controller^{3,4}.

The cough receptors in the tracheal mucosa can be blocked topically by filling the ETT cuff with buffered lidocaine, as this helps in the diffusion of the uncharged base form of the drug across the hydrophobic polyvinyl chloride (PVC) wall of the ETT cuff⁷.

Filling the cuff with saline instead of air prevents the increase in cuff pressure due to nitrous oxide diffusion^{6,7}.

Tracheal tube cuff pressure monitor, a small hand-held device, is the ideal method for objective measurement of cuff pressures via pilot balloon⁹.

Lignocaine has been shown to diffuse across the cuffs of endotracheal tubes made of polyvinyl chloride and studies have shown that alkalinization of lignocaine could further enhance this diffusion and thus reduce the incidence and severity of postoperative sore throat and other problems that follow intubation.^{2,4,8,10,11,12,13}

This study was conducted to evaluate the protective role of 2 ml 2% lignocaine (40 mg) + NaHCO₃ 8.4% [alkalinized lignocaine] and 0.9% Normal saline used to inflate the cuff of an endotracheal tube in preventing post extubation sequelae.

MATERIALS AND METHODS:

One hundred and fifty (150) patients, aged 20-60 years undergoing elective surgery under General Anaesthesia at JSS Hospital attached to JSS Medical College and University, Mysore from November 2013 to June 2015 were included in the study.

A comparative clinical study was conducted to evaluate the post extubation problems like cough, hoarseness, sore throat and dysphonia by inflating the cuff of an endotracheal tube with air, normal saline and alkalinized lignocaine and measurement of cuff pressure with manometer intraoperatively.

Institutional Ethical Committee approval and written informed consent taken.

150 patients scheduled for elective surgeries under general anaesthesia were randomly allocated to one of the three groups of 50 patients in each group and post operative complications were studied in post anaesthesia care unit for 24hrs after extubation. Patients were randomly assigned into three groups.

GROUP A : Endotracheal tube cuff inflated with air

GROUP B : Endotracheal tube cuff inflated with saline

GROUP C : Endotracheal tube cuff inflated with alkalinized lignocaine

INCLUSION CRITERIA :

- Patients of ASA grade 1 & 2
- Age group of 20 to 60 years
- Elective surgery under general anaesthesia
- Patients with only one attempt at intubation

EXCLUSION CRITERIA :

- Ear, nose, or throat procedures
- Sensitivity or allergy to lidocaine
- Laryngoscopic view by Cormack and Lehane grading of III & IV
- Difficult intubation
- URTI /preoperative sore throat
- Delayed extubation due to any cause
- Prolonged surgeries exceeding 3hours
- Patients requiring placement of a nasogastric tube

Pre anaesthetic evaluation:

All patients were examined a day prior to surgery. A systemic examination was done to rule out any of the above mentioned exclusion criteria. The hemodynamic variables, heart rate, systolic blood pressure and diastolic blood pressure and mean arterial pressure are recorded preoperatively.

Airway assessment was done using various methods. Movements of neck, rule of 1-2-3, Samssoon and Young's modification of Mallampati grading, teeth were assessed in each patient.

Routine investigations were performed in all patients.

Haemoglobin (Hb%),Platelet count,Random blood sugar,Blood urea,Serum creatinine,Chest X-ray,Electrocardiogram.

An informed written consent was obtained from the patients. All the patients were premedicated with oral alprazolam 0.5 mg and oral ranitidine hydrochloride 150 mg the night before surgery.

As soon as the patient entered operation theatre, intravenous line was started and psychological assurance was given to the patient. The following monitors were connected before induction.

- Pulse oximeter
- Non invasive blood pressure monitor
- ECG monitor

Pre induction parameters: Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, oxygen saturation (SPO₂), EtCO₂(end tidal carbon dioxide) and ECG were noted.

Patients were premedicated with Inj.Ondansetron 0.08mg/kg, Inj. Glycopyrrolate 0.01mg/kgIV; Inj Midazolam 0.01mg/kg, Inj Fentanyl 1ug/kg or Inj Pethidine 1mg/kg IV.

Preoxygenated with 100% oxygen was done for 3 minutes using Bain's circuit. Anaesthesia was induced with Inj. Propofol 1.5mg/kg and Inj.Succinylcholine 1.5mg/kg was used for facilitation of intubation. Mask ventilation was done for 1min after injection of succinylcholine with Bain's circuit.

The cuffs of the endotracheal tubes were lubricated with 2% lignocaine gel. After obtaining ideal intubating conditions, trachea of the male patients were intubated with 8/8.5/9.0mm ID cuffed endotracheal tubes and those of the females with a 6.5/7.0/7.5mm ID cuffed oral endotracheal tubes with a high volume low pressure cuff made of polyvinylchloride.

Endotracheal tube cuffs were inflated according to a computerized randomization. The cuffs were inflated to minimal occlusive volume(i.e., no leakage detected under controlled ventilation)and measuring cuff pressure by manometer at intubation,30min,60min,90min and before extubation.

In Group A, the cuff was slowly inflated with air to obtain minimal occlusive volume (5 – 8 ml)

In Group B, the cuff was slowly inflated with normal saline

5-8ml, to obtain minimal occlusive volume.

In Group C, Lignocaine 2% 2 ml with sodium bicarbonate (NaHCO₃) 8.4% (3 – 6 ml) was added to obtain minimal occlusive volume

The endotracheal tube was connected to Bain's circuit. Position of tube was confirmed by EtCO₂ and by auscultation. The endotracheal tube was secured and controlled ventilation was instituted.

Anaesthesia was maintained using O₂ and N₂O (33%:67%) and 1% Isoflurane at 12-14 breaths per minute. For muscle relaxation Inj. Vecuronium bromide 0.08mg/kg was given as loading dose and one fourth of loading dose was used for maintenance.

At the end of the surgery, neuromuscular blockade was reversed with Inj. Neostigmine 0.05 mg kg-1 and Inj. Glycopyrrolate 0.01mg kg-1 both IV after ensuring adequate recovery from neuromuscular blockade. Cough at extubation was observed in all the three groups.

Patients were asked for any complaints of sore throat and the degree of sore throat was measured using a point scoring system at specified time intervals of 30 minutes, 1 hour, and 24 hours following extubation.

Also the secondary end points of the endotracheal tube induced emergence phenomena like cough, hoarseness, were recorded using a point scoring scale.

Scoring system for postoperative sore throat, cough and hoarseness

Sore throat

- 0 No sore throat at any time since the operation
- 1 Minimal sore throat
- 2 Moderate sore throat
- 3 Severe sore throat

Cough

- 0 No cough at any time since the operation
- 1 Minimal cough or scratchy throat
- 2 Moderate cough
- 3 Severe cough

Hoarseness

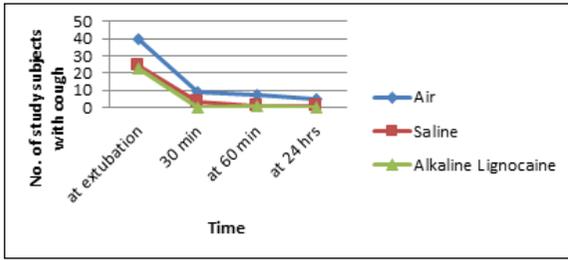
- 0 No evidence of hoarseness at any time since the operation
- 1 No evidence of hoarseness at the time of interview
- 2 Hoarseness at the time of interview noted by patient only
- 3 Hoarseness that is easily noted at the time of interview

RESULTS:

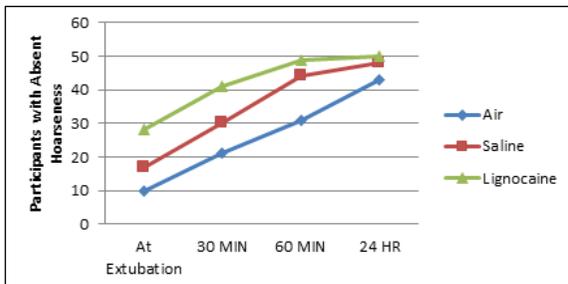
The patients in three groups were compared with respect to the demographic characteristics.

Sl. No.	Particulars	Group I n = 50	Group II n = 50	Group III n = 50	P value
1.	Mean age (years)	33.7 ± 10.8	40 ± 11.9	39.4 ± 12.6	0.02
2.	Male : Female ratio	9 : 41	15 : 35	16 : 34	0.02
3.	Mean duration of surgery (minutes)	99.27 ± 34.69	96.20 ± 26.00	98.40 ± 37.27	0.9
4.	Mean cuff volume (ml)	6.31 ± 0.57	5.81 ± 0.52	5.68 ± 0.48	
	At intubation	6.78 ± 0.64		6.50 ± 0.64	<0.0001
	At extubation			6.03 ± 0.61	<0.0001
5.	Mean Change in cuff volume (ml)	0.47 ± 0.25	-0.13 ± 0.18	-0.47 ± 0.36	<0.0001
6.	Mean cuff pressure changes (Cm of H2O)	24.36 ± 2.13	27.48 ± 1.71	28.60 ± 1.91	<0.001
	Cuff pressure at intubation				
	Cuff pressure at 30min	24.84 ± 2.10	27.24 ± 1.51	27.92 ± 1.76	<0.001
	Cuff pressure at 60min	26.36 ± 2.38	26.77 ± 1.51	26.61 ± 1.90	0.6
	Cuff pressure at 90min	27.08 ± 2.21	26.40 ± 1.29	25.91 ± 1.65	0.08
	Cuff pressure at extubation	28.12 ± 2.90	25.76 ± 1.44	24.96 ± 1.68	<0.001
7.	Comparison of changes in cough with time (%)	80	48	46	0.001
	Cough at extubation				
	Cough at 30 min	18	6	0	0.003
	Cough at 60 min	14	2	2	0.01
	Cough at 24 hrs	10	2	0	0.03

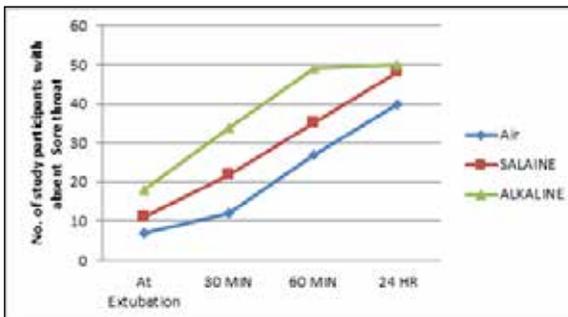
Graph 1
Comparisons of cough status between study groups with time



Graph 2
Comparison of disappearance of Hoarseness between groups with time



Graph 3
Comparison of disappearance of Sore throat between study groups with time



DISCUSSION:

Endotracheal tubes are extremely useful as ventilatory and intubation devices in the management of anaesthesia and critical care patients. The main indications for endotracheal intubation are¹⁴

- Airway protection
- Maintenance of patent airway
- Pulmonary toilet
- Application of positive pressure ventilation
- Maintenance of adequate oxygenation.

Cuffed endotracheal tubes are often used to achieve a seal between the cuff and trachea with a pressure enough to protect airway from aspiration. Two different types of cuffed tubes are available, the low volume high pressure cuffed tubes and the high volume low pressure cuffed tubes.

High pressure cuffs are associated with more ischemic damage to the tracheal mucosa and are less suitable for intubations of long duration. Low pressure cuffs may increase the likelihood of sore throat (larger mucosal contact area), aspiration, spontaneous extubation and difficult insertion. None the less, because of their lower incidence of mucosal damage, low pressure cuffs are

more commonly recommended.

Endotracheal tube cuff design, cuff pressure, tube size and tube lubrication are the important factors that affect the incidence of sore throat¹. Most modern tubes are made of polyvinyl chloride. Diffusion of nitrous oxide into the cuff is dependent on the permeability coefficient of the cuff wall and inversely proportional to the thickness of the cuff wall. In the new portex soft seal tube cuff, the plasticizer added to soften the PVC makes the cuff less permeable to nitrous oxide^{1,2,3}.

Estimation of endotracheal tube cuff pressures is by minimal occlusive volume technique and cuff pressure manometer(Endotest) to assess the adequacy of intracuff pressure. Change in the cuff volume from intubation to extubation differs depending on the inflating agent used.

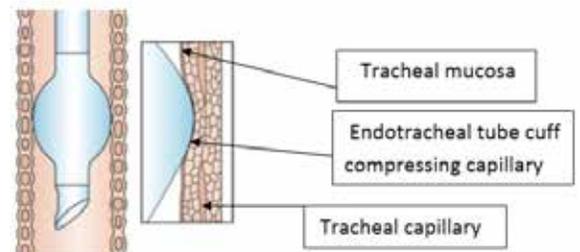
Although the exact pathophysiology of post intubation airway symptoms is not fully elucidated, mucosal damage occurring at the cuff level is thought to be an important causative factor for tracheal morbidity. Decrease in tracheal mucosal perfusion occurs when the cuff exerts pressure greater than 30 cm H₂O⁷.

A wide range of pressures from 19-40cmH₂O have been reported as 'safe'. The recommended 25cmH₂O as the maximal 'safe' pressure to prevent aspiration and air leaks past the cuff as well as tracheal injury. However, a pressure of >24cmH₂O has been suggested as being required to reduce the risk of aspiration. Tracheal arterial capillary pressure decreases at cuff pressures exceeding 30cmH₂O. It is important to note that, since venous and lymphatic pressures are much lower at 16cmH₂O and 4-7cmH₂O respectively, an ET tube cuff pressure maintained below 30cmH₂O may impair venous and lymphatic drainage of the trachea. Cuff pressures above a critical value may cause congestion and edema of the tracheal mucosa which can potentially increase the frequency of symptoms after tracheal extubation.

Lignocaine has been shown to diffuse across the cuff of an endotracheal tube made of PVC, a largely hydrophobic chemical substance. It can act as a potential reservoir for local anaesthetic allowing diffusion and subsequent anaesthesia of the underlying mucosa. Increase in the non ionized fraction enhances the local anaesthetic to diffuse more rapidly across an ETT cuff, resulting in a 63 fold more diffusion. An increase in the pH alkalization of the solution can predictably increase the percentage of non ionized form of a local anaesthetic thus increasing the rate of diffusion^{8,11} allowing a reduction of the lignocaine dose while achieving an effective seal. Injecting buffered lignocaine into the ETT cuff not only reduces the incidence of sore throat but also enables improved ETT tolerance and helps in producing smooth extubation.

The principal effect of the use of saline is to keep endotracheal cuff pressure low during the course of an operative procedure by the prevention of inward diffusion of nitrous oxide.

A diagrammatic representation of mechanism of tracheal mucosal perfusion injury secondary to endotracheal tube cuff overinflation.



The ETT cuff served as a reservoir to release local anaesthetic to the subjacent tracheal tissues, intracuff alkalinized lignocaine prevents a significant rise in the cuff pressure during N₂O anaesthesia, secondary to continuous drug diffusion. This balance maintained adequate cuff pressure and protected the airway against air leak or aspiration of gastric content.

Overinflation of cuff pressure can exert too much pressure against the trachea and obstruct mucosal blood flow leading to ischemic complications and damage to tracheal wall. But, the pressure varies with nitrous oxide anaesthesia.

So, the study was taken up to compare the cuff pressures and to evaluate and reduce post operative problems associated with filling the endotracheal tube cuff with air, saline or alkalinized lignocaine.

The demographic profile of the patients was similar in both the groups. There was no difference between the three groups with respect to the type of surgery, duration of surgery and the anaesthetic management.

Amount of lignocaine used in the present study correlates with the studies of Dollo et al, Estebe et al, Navvaro et al.

Ali NP et al, Nancy et al, Fagan et al who used non-alkalinized lignocaine

Diffusion of non alkalinized lignocaine is slow across the cuff and alkalinization enhances diffusion of lignocaine across the cuff of endotracheal tube.

Mean Cuff volumes inflated and recovered: In our study the mean cuff volume inflated in the air group was 6.31 (0.57) ml, in the saline group was 5.81(0.52)ml and in the alkalinized lignocaine group was 6.50 (0.64) ml. There was no significant difference in the initial volume between the three groups.

In air group there was 0.5 ml increase, 0.13 ml decrease in saline group and alkalinized group decrease of 0.47 ml. The difference was statistically significant and correlates with the Navvaro et al, Estebe et al studies.

The increase in the amount of the air recovered at the time of extubation is explained by the fact that nitrous oxide diffuses into the cuff during anaesthesia and nitrogen is unable to diffuse out, leading to an increase in cuff volume.

The decrease in the amount of saline was minimal in our study.

The decrease in the amount of alkalinized lignocaine recovered is due to diffusion of lignocaine across the cuff of the PVC tube.

Cuff pressure changes between study groups with time:

In present study, there was increase in the cuff pressure in air group from intubation to extubation (mean- 24.36 to 28.12). This increase was statistically significant. However, there was statistically significant decrease in cuff pressure from intubation to extubation in saline group (mean- 27.48 to 25.76).

In alkalinized lignocaine group there was steady decrease in cuff pressure over time from 28.6 to 24.96 mm hg. This decrease was statistically significant.

At 30 min after intubation also this difference in cuff pressure was maintained between groups. However, at 60 min and 90 min after intubation there was no difference between groups. In cases where surgery prolonged for more than 90 min, there was significant difference in cuff pressure at extubation between groups. In air group, it was maximum 28.12 mm of Hg, and saline group 25.76mm of Hg and alkalinized lignocaine group 24.96 mm of Hg.

Over all, this trend of change in cuff pressure over time in three groups was statistically significant (p=0.01) and correlates with the studies of Navvaro et al, Patel et al, Mitchell et al and Ibrahim et al. Though there was reduction in cuff pressure in saline and alkalinized lignocaine groups, the cuff pressure didn't go below safer pressure limits for aspiration(25mm of Hg).

SORE THROAT:

In air group, severe sore throat decreased from extubation to 30 min after extubation from 8 (16%) to 3(6%), then at 60 min to 0, and 24 hr 0. This decreasing trend was statistically significant.

Similarly, moderate sore throat also decreased from 11(22%) to 0 and minimum sore throat decreased from 25 (50%) to 10 (20%) at 24 hr (p<0.0001) this entire trend was statistically significant.

In saline group, also severe sore throat statistically decreased from 3 (6%) at extubation to 0 after 24 hr, but, notable point is, that it was much less compared to air group even at extubation itself. Minimum sore throat and moderate also has similar decreasing trend in saline group. **This decreasing sore throat and its severity over time was statistically significant (p<0.0001) and correlates with the Combes et al and Ibrahim et al studies.**

In alkalinized lignocaine group, there was no one with severe sore throat at extubation. Moderate and minimal sore throat decreased significantly by 24 hr to 0. **This decreasing sore throat and its severity over time was statistically significant (p<0.0001) correlates with the Jaichandran et al, Estebe et al and Navvaro et al studies.**

The decrease in the post intubation sore throat in alkalinized lignocaine group is explained by the diffusion of lignocaine across the ETT cuff, resulting in anaesthesia of the tracheal mucosa and blockade of tracheal pain receptors, involved in the post extubation sore throat.

The increase in the post extubation sore throat in the air group could be due to an increase in intracuff volume and pressure, resulting in an increase in tracheal mucosal lesions and subsequent sore throat.

Cough between study groups with time:

Coughing induced by an endotracheal tube can complicate emergence from general anaesthesia.

In the present study in air group, 40/50 (80%) participants had cough at extubation which significantly reduced to 9 (18%), 7 (14%), and 5 (10%) at 30 min, 60 min, and 24 hr after extubation respectively. This change was statistically significant.

Similarly in saline group, 24/50 participants had cough at extubation which significantly reduced to 3 (6%), 1(2%),1(2%) at 30 min, 60 min, and 24 hr after extubation respectively. This change was statistically significant.

In alkalinized lignocaine group, 23/50 had cough at extubation which significantly reduced to 0, 1, and 0 at 30 min, 60 min, and 24 hr after extubation respectively. This change was statistically significant.

The lower incidence of cough in the alkalinized lignocaine group in comparison with air group at extubation correlates with Estebe et al, Jaichandran et al and Fagan et al studies, could be explained by the diffusion of lignocaine across the cuff resulting in blockade of tracheal irritant stretch receptors.

The lower incidence of cough in the alkalinized lignocaine

group in comparison with saline group at extubation correlates with Navarro et al, Fagan et al studies.

HOARSENESS:

In our study, the severe hoarseness was 5 (10%) in air group and 2 (4%) in saline group and 0 in lignocaine group at extubation. So, air group had highest incidence of hoarseness at extubation. At 30 min, in air group only 1 (2%) had severe hoarseness and other two groups had none. Hence, severe hoarseness is more in air group, at all time and it decreased over time and nil by 24 hrs.

In air group, hoarseness of all severity decreased over time from extubation to 24 hrs, and by 24 hr 43/50 (86%) had no hoarseness. This decreasing hoarseness and its severity over time was statistically significant ($p < 0.0001$).

In saline group, 17 (34%) had no hoarseness at extubation which was better than air group, and it increased to 30 (60%), 44 (88%), 48 (96%) at 30 min, 60 min, and 24 hrs respectively. Even the severe hoarseness decreased from 2 (4%) to nil by 24 hrs.

In alkalized lignocaine group 28(56%) had no hoarseness at extubation, which was better than alkaline lignocaine group. This increased to 41(82%), 49 (98%), 50(100%) by 30 min, 60 min and 24 hr respectively. Even, severe hoarseness was nil at extubation itself.

The lower incidence of sore throat in alkalized lignocaine compared with air and saline group correlates with Estebe et al, Navarro et al and Ibrahim et al studies.

CONCLUSION:

- Inflation of the cuff of an endotracheal tube with alkalized lignocaine results in a significant decrease in the post extubation sore throat when compared to inflation of the cuff with air and normal saline.
- Alkalized lignocaine used to inflate the cuff of an endotracheal tube results in better tolerance of the endotracheal tube.
- The incidence of cough and hoarseness, are significantly reduced by inflating the cuff of an endotracheal tube with alkalized lignocaine compared to inflation of the cuff with air and saline.
- The incidence of postoperative sore throat was significantly decreased when low cuff pressure was maintained during anaesthesia, suggesting that for a constant cuff-tracheal surface area, intracuff pressure was the determining factor for post extubation sore throat.

REFERENCE

1. Jesni, Vijaya, Ambareesha , "Et cuff pressures during ga using air vs 50% mixture of N2O & Oxygen" , Indian J. Anaesth. 2007; 51 (1) : 24 – 27. 2. J.-P Estebe, S. Delahaye, P. Le Corre, G. Dollo, A. Le Naoures, F. Chevanne and C. "Alkalinization of intra-cuff lidocaine and use of gel lubrication protect against tracheal tube-induced emergence phenomena", British Journal of Anaesthesia 92 (3): 361-6 (2004). 3. Stewart SL, Secrest JA, Norwood BR, Zachary R, "A comparison of endotracheal tube cuff pressures using estimation techniques and direct intracuff measurement", AANA J 2003; 71: 443-7. 4. Jain MK, Tripathi CB, "Endotracheal tube cuff pressure monitoring during neurosurgery — Manual vs. automatic method" J Anaesthesiol ClinPharmacol 2011;27:358-61. 5. Estebe JP, Dollo G, Le corre P, Le Naoures A, Chevanne F, Le verge R et al, "Alkalinization of intracuff lidocaine improves endotracheal tube – induced emergence phenomena", Anesth Analg 2002 ; 94 : 227 – 30. 6. Loeser EA, Orr DL, Bennet GM, Stanely TH, "Endotracheal tube cuff design and postoperative sore throat", Anaesthesiology 1976; 45: 684. 7. Jaichandran VV, , Bhanulakshmi IM, , Jagadeesh V. , "Intracuff buffered lidocaine versus saline or air – A comparative study for smooth extubation in patients with hyperactive airways undergoing eye surgery", SAJAA 2009; 15(2): 11-14. 8. Huang CJ, Tsai MC, Chen CT, Cheng CR, Wu KH, Wei TT, "In vitro diffusion of lidocaine across endotracheal tube cuffs," Can J Anesth 1999 ;46 : 82 – 6. 9. Fernandez R, Blanch L, Mancebo J, Bonsoms N, "Endotracheal tube cuff pressure assessment: pitfalls of finger estimation and need for objective measurement", Crit Care Med 1990; 18:1423-6. 10. Matias E. "Effect of NaHCO3 on the diffusion of lignocaine through the wall of endotracheal tube's cuff", Br J Anaesth 1995 ; 74 : A. 238. 11. Fagan C, Frizelle HP, Laffey J, Hannon V, Carey M, "The effects of intracuff lidocaine on endotracheal tube – induced emergence phenomena after general anesthesia", Anesth Analg 2000 ; 91 : 201 – 5. 12. Navarro, Rodrigo Moreira e Lima, Andressa Simoes Aguiar, Jose Reinaldo Cerqueira Braz, et al, "The effect of intracuff alkalized 2% lidocaine on emergence coughing, sore throat, and hoarseness in smokers", Rev Assoc Med Bras 2012; 58(2):248-253. 13. Take Kawa K, Yoshimi S, Kinoshita Y, "Effects of intravenous lidocaine prior to intubation on postoperative airway symptoms", J Anesth 2006 ; 20 : 44 – 7. 14. Soltani HA, Aghadavoudi O, "The effect of different lidocaine application methods on postoperative cough and sore throat", J Clin Anesth 2002 ; 14 : 15 – 8. 15. Diachun CA, Tunink BP, Brock – Utne JG, "Suppression of cough during emergence from general anesthesia : Laryngotracheal lidocaine through a modified endotracheal tube", J Clin Anesth 2001 ; 13 : 447 – 51.