Original Article

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A Comparative Study of Inflation of Endotracheal Tube Cuff with Buffered Lidocaine, Saline and Air for Smooth Periextubation Period in Patient with Hyperactive Airway

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Abstract

Background: Increased cough and restlessness during emergence from general anaesthesia in patients with hyperactive airway undergoing surgical procedures might result in adverse effects like hypertension, tachycardia or tachy arrhythmias, myocardial ischaemia, bronchospasm, and increased bleeding at the surgical site. Hence, in such patients, we sought to determine the benefits of filling the endotracheal tube cuff with either buffered lidocaine, saline or air, so as to prevent endotracheal tube-induced coughing during emergence from general anaesthesia.

Aim and Objectives: To compare effects of ETT cuff inflation with buffered lidocaine 2%, saline and air for peri extubation period in patients with hyperactive airway for Initial & final ETT cuff pressure difference, Occurrence of cough in periextubation period & Incidence of sore throat post operatively.

Method: 240 patients of ASA grade 1 & 2, of 15 to 60 years old, either with a history of chronic smoking or recently treated upper respiratory tract infections were randomly assigned into three groups (n = 80), based on the type of endotracheal tube cuff inflation, as follows: Group A (air), Group B (normal saline) and Group C (Buffered lidocaine). Cough in periextubation period was graded at extubation as: Grade 0 (no cough), Grade 1 (cough < 15s) and Grade 2 (cough > 15s).

Result: Extubation was smooth in Group C compared with Groups B and A ($p < 0.0001$). Further, the incidence of sore throat was found to be lower in both liquid groups, B and C, compared with Group A at 1 h ($p < 0.0001$) and 24 h ($p < 0.01$) postoperatively.

Keywords: Buffered Lignocaine; Hyperactive Airway; Periextubation Period; Endotracheal Tube Cuff.

Introduction

Cuffed endotracheal tube provide secured airway for controlled or spontaneous ventilation and protection against aspiration. Amongst the sequelae inherent to the usage of cuffed endotracheal tube are local irritation and inflammation of the airway caused by prolonged inflation of the cuff which results in post intubation morbidities like sore throat, hoarseness of voice and cough [1].

Airway becomes hyperactive in chronic smokers and in patients those recently treated for upper respiratory tract infections (URTIs). In these patients the receptors meant for cough reflex, the rapidly adapting stretch receptors (RARs), are in a hypersensitised stage [2-8]. Hence, these patients tend to cough more frequently and violently during extubation and in postextubation period. Restlessness and coughing during emergence from General Anaesthesia can result in hypertension, tachycardia or tacharrhythmias, myocardial ischaemia, increased intraocular and intracranial pressures, myocardial ischemia, broncho spasm and increased bleeding at the surgical site [9,10].

So careful periextubation period is of utmost need for the patients of hyperactive airway to reduce postoperative morbidities. Lignocaine instilled in an endotracheal tube cuff diffuses slowly across the cuff membrane. The cuff would act as a potential reservoir for the local anaesthetic, allowing diffusion and subsequent anaesthesia of the underlying tracheal mucosa [17].

This comparative study was conducted to study the effect of low dose of alkanized Lignocaine, saline and air in the endotracheal tube cuff on cuff pressure changes, occurrence of cough and post-operative sore throat.

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Method

The study was conducted in the Department of Anesthesiology, S.M.S. hospital and attached group of hospitals, Jaipur with due permission from the institutional ethical committee and a written informed consent.

Hospital based, Prospective, Comparative, Randomized, Clinical trial.

This Study was conducted between May 2015 to May 2016.

The study recruited patients between the age of 15 to 60 years, of ASA grade I and II, with hyperactive airway (history of smoking for at least 2 yrs or recently treated URTI) presenting for elective or emergency surgery lasting more than 90 minutes duration.

Sample Size

The sample size was calculated 76 subjects in each 3 groups at α error 0.05 and power 80% assuming proportion of patients developing sore throat at 24 hrs in group-A, B or C to be 0.63, 0.40 & 0.28 respectively. Hence for study purpose, 80 patients were taken in each of three groups.

Patients listed for surgery were enrolled and assessed for eligibility. Those not meeting the inclusion criteria or those refusing to participate were excluded. Patients were then randomly allocated to one of the three groups (80 patients in each group)

Group A (n=80): Patients in whom endotracheal tube cuff were inflated with 6-8 ml of air.

Group B (n=80): Patients in whom endotracheal tube cuff were inflated with 6-8 ml normal saline.

Group C (n=80): Patients in whom endotracheal tube cuff were inflated with 6-8 ml buffered

Lignocaine (6 ml 2% lignocaine + 0.5 ml of 7.5% sodium bi carbonate).

Selection of study participants-

Inclusion Criteria

- Written Informed consent.
- Age between 15-60 years.
- Patient with ASA class I or II.
- Patient with a history of smoking for 2 years or more.
- Those that recently treated for URTI .

Exclusion Criteria

- Patients in whom general anaesthesia is contraindicated
- Patient in whom intubation failed in first attempt
- Patient with difficult airway who need Comparatively smaller size of endotracheal tube
- Patient who on ACE inhibitors
- Atrio-ventricular block
- Patient allergic to lignocaine
- Patients fitting in the criteria of difficult intubation (mallampati grade 3 & 4)
- Patients in whom total duration of laryngoscopy and intubation was more than 90 seconds.
- Patients unwilling to give consent for proposed study.

Pre-Anesthetic Check up

All patients were visited on the day prior to surgery and explained about the anesthetic technique and perioperative course. Each patient had pre-anesthetic checkups which include:

- Any significant present/past medical/surgical history
- Physical examination
- Vital parameters like B.P./Pulse/Temperature/ Respiratory rate
- Routine investigation – Hb, TLC, DLC, Bleeding time, Clotting time, Prothrombin time, Fasting blood sugar, Serum Urea and Creatinine, SGOT, SGPT, Alkaline Phosphatase, serum electrolytes, ECG, Chest X-ray, Echocardiography(if available).

Written and informed consent obtained for performance of anesthesia after complete explanation about the study protocol and the procedure.

Anesthetic Procedure

Patients was premedicated with inj ranitidine -1mg/kg +metoclopramide-0.2 mg/kg, then inj midazolam-0.02mg/kg +inj tramadol-2mg/kg +inj glycopyrolate-4mcg /kg.

Induction done with IV propofol- 1.5 to 2 mg/kg & the drug was administered in small doses over a period of 60-90 seconds, until there was loss of eyelash reflex and lack of response to vigorous voice commands and tactile stimuli. Muscle relaxation for intubation was facilitated with inj-vecuronium-0.1 mg/kg body wt. Positive pressure ventilation was

done with 100% oxygen for a period of three minutes. Patient was intubated with aid of macintosh laryngoscope with appropropiate size endotracheal tube with prechecked cuff for any leak.

Intubated patients was subsequently randomly divided into three groups based on the endotracheal tube cuff filling as:

Group A (n=80): Patients in whom endotracheal tube cuff were inflated with 6-8 ml of air.

Group B (n=80): Patients in whom endotracheal tube cuff were inflated with 6-8 ml normal saline.

Group C (n=80): Patients in whom endotracheal tube cuff were inflated with 6-8 ml buffered.

Lignocaine (6 ml 2% lignocaine + 0.5 ml of 7.5% sodium bi carbonate).

In all the patients the endotracheal tube cuff was filled depending upon the minimal occlusion volume (volume at which no palpable leak was felt over the trachea) of each patient & initial endotracheal tube cuff pressure was noted. Care was taken to ensure that the starting cuff pressure should be approximately 20 to 25 cm H_2O, measured using a high volume, low-pressure endotracheal tube cuff manometer. Anaesthesia was maintained with N_2O/ O_2 (60/40%) and 0.6% isoflurane. Further neuromuscular block was maintained with loading dose intermittent boluses of vecuronium (one-quarter of the intubating dose at 15 min interval). After surgery, residual neuromuscular block was reversed with inj neostigmine (0.05 mg/kg) and glycopyrrolate (0.01 mg/kg). Mechanical ventilation was maintained until swallowing or spontaneous ventilation resumed, and then assisted manual ventilation was done. Final endotracheal tube cuff pressure was recorded before extubation. The patient was extubated when the following criteria was met: (1) regular spontaneous ventilation; (2) ability to follow verbal commands (eye opening or hand grip) and (3) ability to demonstrate purposeful movements.

Following Recordings were done

- The endotracheal tube cuff pressure at intubation and at extubation were recorded with help of aneroid endotracheal tube cuff manometer.
- Cough reflex were checked just before extubation and after extubation. Grading of cough were done as following-

  Grade 0 – No cough; Grade 1 – Cough lasting for < 15 sec and Grade 2 – Cough lasting for > 15 sec.
- Sore throat was assessed in the recovery room with a visual analog scale (VAS : 0 –10 cm) after extubation at 1hr and 24 hr. Grading of sore throat were done as following-

  Score 0 – No pain; Score 1 –Tolerable (mild – moderate) and Score 2 – Intolerable pain (severe).

Data Processing and Analysis

Statistical analyses were done using computer software (SPSS trial version 20 and primer). The qualitative data were expressed in proportion and percentages and the quantitative data expressed as mean and standard deviations. The difference in proportion was analysed by using chi square test and the difference in means were analyzed by using student T Test and one way ANOVA and post Hoc Test. Tukey Test applying to find out the most significant groups among all the groups. Significance level for tests were determined as 95% ($P< 0.05$).

Results

Data was recorded in terms of initial and final endotracheal tube cuff pressure, occurrence of cough in periextubation period and sore throat at 1hr & 24 hr. The final conclusions carried out are as follows –

The demographic profile of the patients in terms of age, sex ratio, ASA grade, smoking status, treated URTI and total surgical duration was comparable in both the groups.(Table-A)

The mean variables (initial and final endotracheal tube cuff pressure, occurrence of cough at periextubation period and sore throat at 1hr & 24 hr) were comparable in both the groups so desired study and control population was achieved with appropriate randomization.

No Significant difference was observed in mean initial cuff pressure among the groups. In group A mean was 22.71±11.16 cmH20; (with range 19 to 25), in group B mean was 22.55 ±11.135; (with range 20 to 24 cmH2O) and in group C mean was 22.44±1.22; (with range 20 to 25 cmH20) (P=0.33NS) (Table B).

Significant difference was observed in final cuff pressure among the groups. On applying post HOC test TUKEY test, group A was significantly have higher mean (55.49 ±5.59) as compared to group B(23.91±1.058) and group C(23.33 ±1.29). (<0.001S) There was no statistical significant increase in final endotracheal tube cuff pressure compared with initial cuff pressure in both the liquid groups, B and C (Table B).

Proportion of the cases with cough more than 15 second was maximum in group A (56.25%) as compared to group B (30%) and least was in group C (10%). Proportion of cases who did not have cough in periextubation period were maximum in group C (70%) as compared to group B (20%) followed by group A. (13.75). Proportion of the cases with cough less than 15 second were maximum in group B(50%), followed by group A (30%) and least in group C (20%). (P<0.001S) (Table C).

Proportion of the cases with Sore throat at 1 hr with Severe type were maximum in group A (20%) as compared to group B and group C (0%) while mild to moderate type of sore throat were maximum in group A(56.25%), followed by group B (25%) and least in group C (15%). There were no Sore throat at 1 hr maximum in group C (85%) as compared to group B (75%) followed by group A.(23.75%). (P<0.001S). (TableD). Proportion of the cases with Sore throat at 24 hr with Mild-to-Mod type were maximum in group A (43.75%) as compared to group B (15%) and least were in group C (12.5%) while no Sore throat at 24 hr were maximum in group C(87.5%) as compared to group B (85%) followed by group A.(56.25%) (P<0.001S) (Table E).

Table 1: Demographic data

	Groups		
	A	**B**	**C**
Age(years)	38.34 ±11.807	37.00±11.46	37.00±11.46
Sex(M/F)	19/16	23/57	24/56
Number of smoker	58	58	56
Treated URTI	19	21	24
Duration of surgery	140.66±25.078	136.25±16.114	136.25±16.114
ASA grade(I/II)	22/58	22/58	24/56

Table 2: ETT cuff pressures measured at the start and at the end of the surgery

Parameter	A	B	C
Initial cuff pressure(cm.H_2O)	22.71 ±1.160	22.55 ±1.135	22.44 ±1.221
Initial cuff pressure(cm.H_2O)	55.49 ±5.594	23.91 ±1.058	23.33 ±1.290

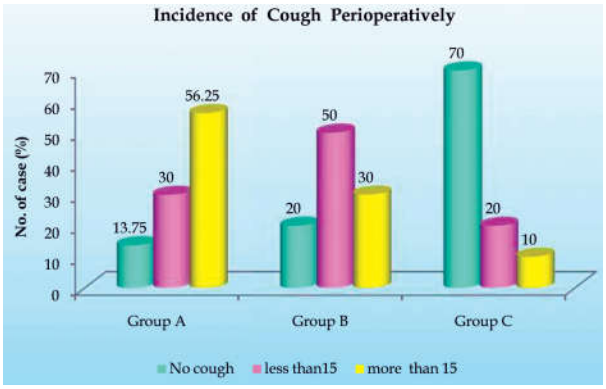

Fig. 1: Incidence of cough perioperatively

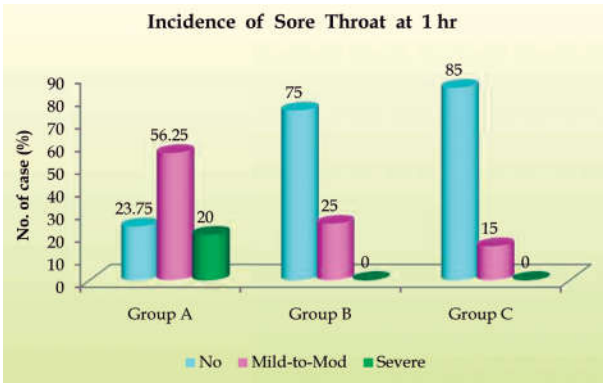

Fig. 2: Incidence of sore throat at 1 hour

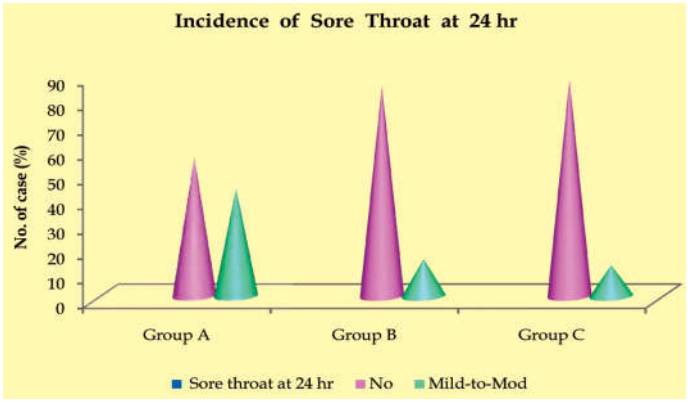

Fig. 3: Incidence of sore throat at 24 hours

Table 3: Incidence of cough perioperatively

	Group A		Group B		Group C	
Cough (seconds)	**No**	**%**	**No**	**%**	**No**	**%**
No cough	11	13.75	16	20	56	70
less than15	24	30	40	50	16	20
more than 15	45	56.25	24	30	8	10
Total	69	86.25	64	80	24	30

Table 4: Incidence of sore throat at 1 hour

	Group A		Group B		Group C	
Sore throat at 1 hr	**No**	**%**	**No**	**%**	**No**	**%**
No	19	23.75	60	75	68	85
Mild-to-Mod	45	56.25	20	25	12	15
Severe	16	20	0	0	0	0
Total	61	76.25	20	25	12	15

Table 5: Incidence of sore throat at 24 hours

	Group A		Group B		Group C	
Sore throat at 24 hr	**No**	**%**	**No**	**%**	**No**	**%**
No	45	56.25	68	85	70	87.5
Mild-to-Mod	35	43.75	12	15	10	12.5
Total	80	100	80	100	80	100

Discussion

Rapidly adapting stretch receptors in the tracheal mucosa are believed to be the irritant receptors meant for cough [3-5]. These receptors are highly sensitive to mechanical stimuli like touch, displacement and stretch. Tracheal intubation with endotracheal tube, cuff inflation and the resulting hyperinflation in turn stimulate these receptors, thus producing cough in normal patients during extubation (endotracheal tube-induced cough). In chronic smokers and those with recently treated URTI, the threshold stimulation for cough receptors is reduced [2-6].

Long-term smoking causes neutrophilic infiltrates in vulnerable smokers that sensitise the cough-sensitive nerves by the release of sensory neuropeptides and direct stimulation of the nerves/ receptors [7,8].

Empey et al report cough threshold values to be significantly low for up to two weeks following URTIs. Stimulation of these receptors also results in the release of substance P (which causes mucosal vasodilatation, plasma exudation and airway mucus secretion), calcitonin gene-related peptide (causes mucosal vasodilatation) and neurokinin A (causes bronchoconstriction) [5]. Hence smokers tend to cough more frequently and violently during emergence from general anaesthesia.

Cough and sore throat during emergence in a lighter plane of anaesthesia can result in hypertension, tachycardia, and myocardial ischemia, raised intraocular and intracranial pressures. These features are particularly undesirable in patients undergoing neurosurgical or ophthalmic procedures or those who are at an increased risk of adverse cardiovascular events [9-10].

Numerous methods of attenuating cough reflex during tracheal extubation have been advocated such as use of narcotics, extubation in a deeper plane of anaesthesia, use of topical lignocaine gelly, use of topical lignocaine spray and use of IV alkalinized lignocaine.

Intravenous and prior topical administration of lignocaine has been used to help in reducing cough during emergence from general anaesthesia. Intravenous lignocaine (IVL) is known to suppress cough through its central nervous system depressant effect (cough centre in the medulla) and hence it requires a minimal serum concentration (> 3 μg/ml) to be effective. In addition, IVL produces delayed emergence from anaesthesia. Moreover, the efficacy of IVL in suppressing cough is of short duration (5–20 min) [18].

Topical administration of lignocaine is known to produce its irritant effect long before its cough suppressant effect appears [9]. Other disadvantages encountered with this technique are that it requires a specially designed instrument for its application and the tracheal mucosa in direct contact with the endotracheal tube cuff wall is effectively shielded from exposure to lignocaine applied by this technique.

Klemola UM [19] studied the effect of laryngeal spray with alkalinized lignocaine and alkalinized

lignocaine jelly application on 95 patients. The incidence of sore throat when both the techniques used was 95%, when alkalinized lignocaine jelly alone used was 85% and in the control group it was 62%. Thus, stating that the use of alkalinized lignocaine jelly was associated with a high incidence of post extubation sore throat and hoarseness.

Injecting lignocaine alone into the endotracheal tube cuff causes a low diffusion rate across the cuff (1% released during a 6 h period) [19,32]. Higher doses of lignocaine (200–500 mg) are required to produce a clinical effect. Hence this had no advantages over saline, and could be dangerous if the cuff ruptures [16].

By filling the endotracheal tube cuff with buffered lignocaine, diffusion of the uncharged base form of the drug occurred across the hydrophobic PVC walls of the endotracheal tube cuff [1,10]. Lignocaine, as a weak basic and lipophilic drug, binds avidly to the respiratory mucosa. The absorption characteristics of the mucosa, epithelial thickness, number of membrane pores and tissue pH also serve to delay absorption. Thus the tracheal mucosa in direct contact with the endotracheal tube cuff wall can be anaesthetized locally with a longer than expected effect of lignocaine and with intact supraglottic reflexes, preventing aspiration in these patients [1,18].

Buffering not only helped in increasing the diffusion of the drug in our study but also allowed us to use lower doses of lignocaine (without exceeding the toxic limits). The toxicity of local anesthetics must be considered regardless of the route of the administration. In this regard, our concerns were twofold, the risks of systemic absorption and the consequences of cuff damage with subsequent leakage of 2% lignocaine or saline into the bronchial tree. Although 20 mg/mL lignocaine (2%) was used, the mean volume used per endotracheal tube was 6 to 8 mL . This is considerably less than the amount of lignocaine used in a study by Sutherland and colleagues [20], in which a fixed dose of 370 mg of lignocaine was used in 21 adult patients to topically anaesthetize the airway for fiberoptic bronchoscopy and no incidence of toxic plasma concentrations of lignocaine was recorded.

Another study by Efthimiou [21] with 41 patients undergoing fiberoptic bronchoscopy, using average doses of 9.3 mg/kg of lignocaine, recorded only two patients in which plasma levels exceeded the toxic levels (5.0μg/ml) and no complications were observed.

In this study, all patients were extubated without any complications, and no evidence of cuff damage was observed.

Previously done studies by Carl Fagan and colleague [1] have compared the incidence of sore throat and hemodynamic changes between intracuff alkalinized lignocaine, intracuff saline and intracuff air and concluded that incidence of sore throat is significantly lower in intracuff alkalinized lignocaine group .

In one study done by Soltani and colleagues [22] compared the incidence of sore throat after general anaesthesia in six different groups which included spraying of the distal end of endotracheal tube cuff with 10% alkalinized lignocaine, spraying of 10% to laryngopharyngeal structures, application of 2% alkalinized lignocaine jelly to cuff of the tube, intravenous alkalinized lignocaine at the end of surgery, Intracuff alkalinized lignocaine and application of normal saline to the cuff end of the tube. They concluded that IV lignocaine, intracuff alkalinized lignocaine considerably decreases the incidence of sore throat post extubation. The results of these studies favour our study results.

From the previous in vitro study by Jaichandran VV et al (2008) using high performance liquid chromatography, they found that by filling the endotracheal tube cuff with a mixture of 6 ml 2% lignocaine HCl + 0.5 ml NaHCO3 the minimum concentration of lignocaine (Cm = 155 μg/ml) that is required for blocking the cough receptors [12] was obtained at the end of 90 min across the cuff walls. Hence in our study, we used the above lignocaine buffered mixture for filling the endotracheal tube cuff in patients undergoing surgery with a minimum duration of 90 min [17]. The mean duration of anaesthesia in the group A was 140.66±25.078, in group B was 136.25±16.114 and in group C was 136.25±16.114 which were comparable and an insignificant 'p' value (0.26) in our study.

During anaesthesia with N_2O the cuff pressure increases with time as N_2O diffuses into it more rapidly than it diffuses out, because of the partial pressure gradient across the PVC membrane [10,11]. These findings are similar with our study. When the cuff pressure exceeds the capillary perfusion pressure (30–40 mmHg) tracheal mucosal erosion occurs, resulting in sore throat postoperatively, as evidenced in our study. Our data confirmed the increased cuff pressure and cuff volume after air inflation with N_2O and oxygen anaesthesia.

By replacing air with liquid (saline / buffered lignocaine), cuff hyperinflation problems can be avoided [10]. The lack of hyper pressure is probably

one advantage of liquid filling of endotracheal tube cuffs. In our study we monitored the endotracheal cuff pressure keeping the endotracheal cuff pressure at around 20-25 cm H_20 in all the groups after intubation. In our study, no significant difference was observed in mean initial cuff pressure among the groups. In group A mean was 22.71±11.16 cm H_20; (with range 19 to 25), in group B mean was 22.55 ±11.135; (with range 20 to 24 cm H_2O) and in group C mean was 22.44±1.22 ; (with range 20 to 25 cm H_20) (P=0.33=NS). But a Significant difference was observed in final cuff pressure among the groups . On applying post HOC test TUKEY test, group A was significantly have higher mean (55.49 ±5.59) as compared to group B(23.91±1.058) and group C(23.33 ±1.29). (P<0.001=S). There was no statistical significant increase in final endotracheal tube cuff pressure compaired with initial cuff pressure in both the liquid groups, B and C . The groups were incomparable and had a significant 'p' value (<0.001). Thus, confirming the data with previous studies.

In the study done by Estebe JP and others [16] on 60 patient intracuff alkalinized lignocaine was compared with intracuff saline and intracuff air. The results stated that there was a trend of reduced incidence of post operative sore throat in alkalinized lignocaine group. Jean Pierre Estebe et al., demonstrated that alkalinisation of intracuff lignocaine improves endotracheal tube induced emergence phenomenon. There was a decreased incidence of cough and other parameters like restlessness, Postoperative nausea and vomiting (PONV), dysphonia, hoarseness in the post extubation period.

Huang CJ et al., demonstrated that emergence coughing and the incidence of sore throat was significantly less than the control group when lignocaine 4% and alkalinized lignocaine were used. They suggested using alkalinized and warmed lignocaine prestored in the endotracheal tube cuff for smoother emergence from general anaesthesia [9].

In our study we found that the incidence of coughing at extubation was higher in the air and saline groups as compared to lignocaine. Proportion of the cases with cough more than 15 second were maximum in group A (56.25%) as compared to group B (30%) and least were in group C(10%). Proportion of cases who did not have cough in periextubation period were maximum in group C (70%) as compared to group B (20%) followed by group A.(13.75). Proportion of the cases with cough less than 15 second were maximum in group B(50%), followed by group A (30%) and least in group C (20%). (P<0.001S). These data was comparable with the results of previous studies.

In our study the incidence of sore throat was recorded at two different intervals. It was recorded as the severity or grade of sore throat. Proportion of the cases with Sore throat at 1 hr with Severe type were maximum in group A (20%) as compared to group B and group C (0%) while mild to moderate type of sore throat were maximum in group A (56.25%), followed by group B (25%) and least in group C (15%). There were no Sore throat at 1 hr maximum in group C (85%) as compared to group B (75%) followed by group A (23.75%). (P<0.001S). Proportion of the cases with Sore throat at 24 hr with Mild-to-Mod type were maximum in group A (43.75%) as compared to group B (15%) and least were in group C (12.5%) while no Sore throat at 24 hr were maximum in group C(87.5%) as compared to group B (85%) followed by group A.(56.25%)(P<0.001S). These data for incidence of sore throat was comparable with the results of previous studies.

Conclusions

Injecting buffered lidocaine into the Endotracheal tube cuff not only reduces the incidence of sore throat but also enables improved Endotracheal tube tolerance and helps in producing smooth Periextubation period in patients with hyperactive airways.

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