EFFECT OF INTRACUFF MEDIA-ALKALINISED LIGNOCAINE, SALINE, AND AIR ON ENDOTRACHEAL TUBE INDUCED EMERGENCE PHENOMENA: A RANDOMIZED CONTROLLED STUDY

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ABSTRACT

CONTEXT
Emergence from general anaesthesia is associated with post extubation cough, hoarseness, sore throat, and dysphagia, which may affect the smoothness of extubation. Prophylactic interventions have been studied to reduce these tracheal morbidities with varying results.

AIMS
To compare the efficacy of air, alkalinised lignocaine and saline in maintaining intracuff pressure and reducing postoperative cough (PEC) and sore throat (POST).

SETTINGS AND DESIGN
A randomised controlled study conducted in a teaching hospital.

METHODS AND MATERIALS
105 patients scheduled for elective surgeries were randomly allocated into groups of 35 each. The endotracheal tube (ETT) cuffs were inflated with air, alkalinised lignocaine, or saline. The intracuff pressure (ICP) was initially set to 25-30 cm of H_2O; measured every 30 minutes and before extubation; the minimum volume for occlusion (MOV) noted. The incidence PEC and POST were monitored.

STATISTICAL ANALYSIS
Data analysed using Chi-square test, Fisher's exact test; Bonferroni method allowed multiple comparisons. A p value <0.05 was considered significant.

RESULTS
Pre-lubricated ETT cuff inflation with liquid media maintained an acceptable ICP. Saline and alkalinised lignocaine were effective in reducing PEC and POST. Alkalinised lignocaine provided smoother extubation and fared better in the early postoperative period.

CONCLUSIONS
Pre-lubricated ETT cuffs with liquid media reduced PEC and POST. Alkalinised lignocaine showed better profile than saline. Optimum ICP reduces tracheal morbidity.

KEYWORDS
Alkalinised lignocaine, saline, intracuff pressure, extubation cough, sore throat.

KEYMESSAGES
Monitoring and maintenance of optimum intracuff pressure is desirable following intubation. Intracuff media has a bearing on emergence phenomena.

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INTRODUCTION: Reported incidence of PEC and POST is 38-96%.[1] Non-lubricated ETT, non-humidified gases, N_2O diffusion, or multiple intubation attempts are probable causes. Standard techniques or media are not suggested for cuff inflation and maintenance. Recommended ICP is 20-30 cm H_2O in the ICU.[2] Overinflation causes impairment of tracheal mucosal perfusion, underinflation predisposes to aspiration; therefore, ICP monitoring is indicated.[3]

Usual cuff inflations are with air and monitoring is not routinely practiced. Saline and varying doses of $NaHCO_3$ with lignocaine have been tried for cuff inflation. In this study, 7.5% $NaHCO_3$ in high dilutions with lignocaine and saline were compared with air.

MATERIALS AND METHODS: After obtaining institutional ethical committee approval and written informed consent, 105 patients of either sex scheduled for elective surgery were randomly allocated into 3 groups of 35 each. They belonged to ASA PS I or II were aged 20 to 50 years and weighing 50 to 70 Kg. No additional risk or financial constraints were placed on them. Patients with difficult airway, hyper reactive airway, surgery of airway, those who needed nasogastric tube insertion, or more than one attempt at intubation were excluded. After adequate fasting, patients were premedicated with inj. morphine 0.1 mg/kg, inj. ondansetron 0.01 mg/kg, and inj. midazolam 0.2 mg/kg. Monitoring included ECG, pulse oximetry, capnography, and blood pressure. Patients were induced with inj. thiopentone sodium 3-6 mg/kg followed by inj. vecuronium bromide 0.12 mg/kg, and inj. lignocaine 1.5 mg/kg before intubation.

ETT of sizes 7/7.5 mm ID for females, 8/8.5 mm ID for males, prelubricated with water soluble jelly were used. Minimum Occlusion Volume (MOV), which is the volume of air or liquid injected into the cuff that eliminates an audible inspiratory leak with positive pressure ventilation was determined.

Group A received air in their cuffs, group B alkalinised lignocaine, and group C 0.9% saline. Lignocaine 2% was alkalinised using 7.5% $NaHCO_3$ in the ratio 9:1 so as to make 10 mL of solution with a pH around 8. Initial ICP was ensured to be 25-30 cm of H_2O using cuff pressure manometer. Ventilation was maintained with closed circuit to ensure normocarbia. N_2O:O_2 in 70%-30% ratio, 0.4-1% isoflurane, and vecuronium were used for maintenance. ICP was measured every 30 minutes and if found high (>40 cm H_2O), was brought back to the normal range. At the end of surgery, neuromuscular blockade was reversed and ventilation assisted manually till extubation before which the final ICP was measured.

The extubation was graded based on the duration of PEC as: grade 0=no cough; grade 1=cough lasting <15 seconds; grade 2=cough lasting >15 seconds. The incidence of POST at 1 hr, 2 hr, and at 24 hr were observed and graded as follows: grade 0=No sore throat; grade 1=Tolerable pain; grade 2=Intolerable pain. Complications like laryngospasm, bucking on tube, restlessness were noted and treated. The observed data was analysed by SPSS version 18 and the variables compared using Pearson's Chi-square test, or Fisher's exact test as indicated. Bonferroni method allowed multiple comparisons and a p value <0.05 considered statistically significant.

RESULTS:

Intracuff media	Air	*Alk. Lignocaine	Saline
Age (Y)	43.63±13.66	43.03± 12.57	46.55 ±13.68
Height (cm)	160.50±7.61	160.85±7.48	161.70±7.96
Weight (Kg)	58.52±9.47	60.88±9.20	61.27±9.89
ETT size (mm)	7.48±0.53	7.51±0.54	7.4±0.50
Surgery Duration (min)	126.77±30.04	124.21±27.40	125.67±28.06

Table 1: Demographic Profile

Patient parameters comparable:* Alk-Alkalinise

All patients were comparable with respect to age, weight, sex, ETT size, and duration of surgery [Table 1].

Group	Number	MOV-male	MOV-female	Mean	S.D
Air	30	7.27 mL	3.55 mL	4.54 mL	±1.85
Alk. lignocaine	33	6.85 mL	3.90 mL	4.71 mL	±1.61
Saline	33	7.45 mL	3.99 mL	4.83 mL	±1.84

Table 2: Comparison of Minimum Occlusion Volume (MOV)

MOV was higher in males.

Five in group A, 2 each in groups B and C were excluded as they needed nasogastric tube insertion, intravenous lignocaine for treating stress response, or multiple attempts at intubation. The MOV were comparable in all the groups with liquids requiring a slightly higher volume, which was not statistically significant [Table 2]. The occlusion volume in males (mean 7.2 mL) was higher when compared to females (mean 3.8 mL) [Table 2].

The initial ICP was 25-30 cm H_2O. ICP steadily increased with time, the air group showing significantly higher values (46.5 cm±3.54 H_2O). For alkalinised lignocaine, it was 33.17±4.21 cm H_2O and for saline, 33±3.83 cm H_2O. The rate of rise ICP and its magnitude was greatest in the first 30 minutes; this was statistically significant the air group. The ICP gradually increased with the duration of surgery in all the groups.

Time in Minutes	No	Air (In cm H_2O)	No	Alkalinised Lignocaine (In cm H_2O)	No	Saline (In cm H_2O)
Start	30	24.43±1.65	33	24.70±1.43	33	24.88±1.50
30 m	30	33.07±2.99	33	26.97±2.21	33	26.45±1.54
60 m	30	36.37±3.67	33	28.39±2.81	33	27.82±2.22
90 m	30	38.93±3.97	33	29.48±2.76	33	28.94±2.63
120 m	15	42.33±4.03	15	30.93±3.53	16	31.12±2.82
150 m	10	45.70±3.86	6	33.17±4.21	9	32.44±2.70
180 m	2	46.50±3.54	2	31.00±7.07	4	33.00±3.83
Final	30	43.57±5.63	33	30.94±3.74	33	31.45±4.61

Table 3: Intracuff Pressure (ICP)

Steady increase in ICP; the air group showing significantly higher values. For the liquid group, there was a steady minimal rise in ICP; but was within acceptable range [Table 3]. Patients with no cough (PEC grade 0) or cough less than 15 seconds (PEC grade II) and were considered to have smooth extubation. The extubation was smooth in 18 out of 30(60%) for the air group, 29 out of 33(87.9%) for the lignocaine group, and 22 out of 33(60.7%) for the saline group.

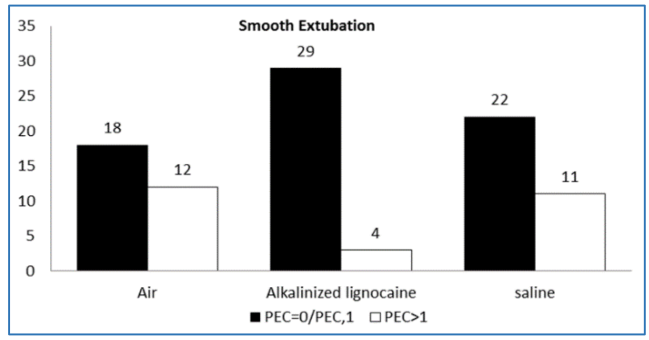

Fig. 1: PEC Grade 0 and Grade1 were Considered as Smooth Extubation (p Value 0.04)

Alkalinised lignocaine offered reduced incidence of cough and smoother extubation (p value 0.04) [Figure1].

Time	Total No.	Air	Alkalinised Lignocaine	Saline	P value
1 h	30	13(43.3%)	3(9.1%)	10(30.3%)	0.008
2 h	33	20(66.7%)	15(45.5%)	14(42.4%)	0.115
24 h	33	25(83.3%)	21(63.6%)	24(72.7%)	0.214

Table 4: Postoperative Sore Throat (POST)

POST least for alkalinised lignocaine (p value 0.008) at 1 hour. The incidence of POST in first hour was significantly lower for alkalinised lignocaine 9.1% (p value of 0.008) [Table 4]. In the second hour, 20 out of 30(66.7%) in air group, 15 out of 33(45.5%) in the lignocaine group, and 14 out of 33(42.4%) in the saline group had POST.

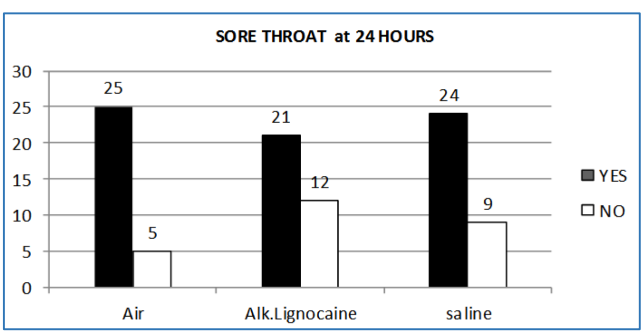

Fig. 1: Sore Throat in 24 Hours (P Value 0.214); Lignocaine Group with A Better Profile

At 24 h, 25 out of 30(83.3%) in the air group, 21 out of 33(63.6%) in lignocaine group, 24 out of 33(72.7%) patients in saline group had POST [Figure 2]. At two hours, alkalinised lignocaine and saline produced almost similar effects but fared better than air.

Amongst the 24 hour incidence of POST, the least was noted with the lignocaine group followed by saline and then air although statistically not significant.

DISCUSSION: In our study, we used either air, alkalinised lignocaine (1 mL 7.5% $NaHCO_3$: 9 mL 2% lignocaine) or 0.9% normal saline for endotracheal cuff inflation and compared their effects on ICP and the quality of extubation. Buffering lignocaine with 7.5% $NaHCO_3$ in this ratio produces a solution with a pH of about eight. This is likely to give an adequate concentration of unionized fraction of lignocaine for trans-cuff diffusion providing optimum clinical effects. The results obtained were in good correlation with studies done using lower concentrations of (1.4%) NaHCO3 to alkalinise 2% lignocaine.

At higher concentrations, NaHCO3 may precipitate and is likely to block the pilot balloon during cuff inflation. The duration of surgery in our study was around 120 to 130 minutes. The rise in ICP was high with air as media especially in the initial period (30 minutes), but was gradual and within acceptable limits when liquids were used for cuff inflation.

Each time, the ICP reached above 40 cm H_2O. It was brought back to the normal range. The volume needed for cuff inflation (MOV) was comparable in all the three groups and was on an average 4-6 mL.

This was higher for males. The maintenance of ICP was better in those with alkalinised lignocaine and saline in their cuffs. When compared with saline, alkalinised lignocaine had a better profile in the quality of extubation in maintaining the ICP and in reducing POST. This is in concordance with previous studies. Considering a remote possibility of cuff rupture, saline may have a theoretical advantage over alkalinised lignocaine. The main goal of anaesthesiologist is to provide smooth extubation. During emergence, patient may experience restlessness and cough, which may coexist with or precipitate bronchospasm, laryngospasm, or even negative pressure pulmonary oedema. This can also increase the intraocular, intragastric, intrathoracic, and intracranial pressures.[4]

An important factor maybe direct irritation and resultant inflammatory reaction within the tracheal mucosa caused by the ETT cuff. High ICP caused by large volumes of media used for cuff inflation along with N_2O diffusion can cause transient reversible ischemic changes in the adjacent tracheal mucosa.[5] However, newer low pressure-high volume cuffs tend to withstand the rise in cuff pressure due to N_2O influx to some extent. Topical anaesthetics and steroids have been tried to prevent PEC and POST.[6] ETT prelubricated with water soluble jelly and alkalinised lignocaine cuffs are claimed to reduce POST.[7] Ideal ICP is that which provides an airway seal that would allow positive pressure ventilation with minimal leak.

Tracheal pressure >48 cm H_2O was seen to reduce capillary blood flow while pressures <18 cm H_2O increases the risk of aspiration. ICP of 25-40 cm H_2O protects from aspiration, avoids traumatizing trachea, and reduces PEC and POST.[8] Over inflation of cuff induced by N_2O intraoperatively can be reduced to some extent by substitution of air with saline resulting in maintaining sustained and optimal ICP.[9,10] Lignocaine (4%) spray was also found to be more effective than intracuff alkalinised lignocaine in reducing PEC in surgeries <2 hours.[11] Lignocaine (4%) instillation in ETT cuffs reduced incidence of cough better than intravenous lignocaine in neurosurgical patients.[12] PEC in smokers was found to be lesser with 2% alkalinised lidocaine filled ETT cuff.[13] Preoperative nebulization with ketamine was found to reduce the severity of sore throat in a recent study.[14]

In a systematic review, it was concluded that both topical and systemic lidocaine were effective in reducing POST.[15] A meta-analytical study confirmed that lignocaine both alkalinised and non-alkalinised instilled in endotracheal tube cuffs were effective in reducing PEC and POST.[16] Alkalinising lignocaine allowed better diffusion as the hydrophobic neutral base form of lignocaine was able to diffuse across the cuff membrane (65% of diffusion during 6 h) as against the commercially available charged hydrochloride form where only 1% of total diffuses to block the tracheal receptors. This necessitated a larger dose of lignocaine hydrochloride (200-500 mg) to exert a clinical effect. Adding 8.4% $NaHCO_3$ allows a smaller dose of lignocaine to be used (20-40 mg), so that only a very small concentration of lignocaine is attained (<0.08 µg/mL), which is lower than when lignocaine is used topically (0.43-1.5 µg/mL) or intravenously (2-3 µg/mL).[17] In one RCT, it was noted that alkalinised lignocaine instilled cuffs in longer duration surgeries produced better outcome as diffusion across membrane is a function of time.[18]

In our study, majority of surgeries were of more than 120 minutes duration, which might have contributed to the desired clinical effect. Increasing the pH through alkalinisation increases the unionized fraction available for diffusion. Effective suppression of cough receptors required more than 60 minutes.[19] But, at a higher pH, there is a tendency towards slower release of lignocaine and a chance of injuring the tracheal mucosa in case the cuff ruptures.[20] In another study, alkalinising lignocaine to a pH 7.4 to 7.6 was effective within 30 minutes, but peak action was seen in 300 minutes. Intracuff buffered lignocaine (6 mL lignocaine: 0.5 mL 7.5% NaHCO3) produces a concentration of 155 µg/mL on tracheal receptors in about 90 minutes producing clinical effects after trans-cuff diffusion.[21]

Lowering the concentration of $NaHCO_3$ to 1.4% for alkalinising 2% lignocaine was also effective in reducing the incidence of emergence phenomenon. In vitro studies confirm that even lower volumes of $NaHCO_3$ can produce greater release of lidocaine across low volume high pressure cuffs and variations in the volume and concentration of NaHCO3 had no effect on the diffusion of lignocaine.[22] A recent study using 2% lignocaine and 8.4% $NaHCO_3$ in the ratio 19:1 noted reduced cough, sore throat, and hoarseness in smokers.[23] Significant reduction in the sedation and analgesic requirement was noted in mechanically ventilated patients when alkalinised lignocaine was instilled in their ETT cuffs.[24] According to the review of evidence, there is need for routine ICP monitoring for every anaesthetic as well as in the ICU.[25]

CONCLUSION: Maintenance of ICP within acceptable range was better when liquids were used as inflating media. If alkalinised lignocaine is not available, the easy availability of saline makes it a better option than air. The average volume of cuff occlusion was 4 to 6 mL to maintain an ICP of 20-30 cm H_2O. Extubation was smoother and postoperative sore throat lesser with liquids especially alkalinised 2% lignocaine. As a routine saline or preferably alkalinised, 2% lignocaine need to be used for ETT cuff instillation. Intracuff pressure monitoring and maintenance of optimum ICP significantly reduces emergence phenomena and tracheal morbidity following endotracheal intubation.

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