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Effects of intravenous lidocaine prior to intubation on postoperative airway symptoms

Kimiko Takekawa, Seiichi Yoshimi, and Yasushi Kinoshita

Department of Anesthesia, Kochi Red Cross Hospital, 2-13-51 Shinhonmachi, Kochi 780-8562, Japan

Abstract
We investigated whether intravenous lidocaine prior to endotracheal intubation influences the postoperative airway symptoms of sore throat, cough, and sputum. After ethics committee approval, 80 patients undergoing elective operations were studied. A total of 20 patients were given lidocaine 1.0 mg·kg^{-1} (group L1), 20 patients were given lidocaine 1.5 mg·kg^{-1} (group L2), and 40 patients received normal saline (group C). The sore throat incidence was 20% in group L1, 0 in group L2, and 40% in group C. Cough incidence was 0 in group L1, 20% in group L2, and 40% in group C. Sputum incidence was 35% in group L1, 25% in group L2, and 47.5% in group C. There were significant differences in the incidences ($P < 0.01$) and severity ($P < 0.01$) of sore throat and cough in groups C and L (groups L1 + L2). There were no significant differences between groups in terms of the incidence or severity of sputum. In conclusion, intravenous lidocaine prior to endotracheal intubation decreased the incidence of postoperative sore throat and cough.

Key words Lidocaine · Postoperative complication · Cough

Introduction

Postoperative airway complications such as sore throat, cough, and sputum are common complaints. Sore throat was investigated in many reports concerning mechanical stimulation such as the pressure or design of the endotracheal tube cuff, endotracheal tube size, intubation procedure, and so on [1]. Women were reported to be more prone to sore throat than men [2]. Fuller showed that intravenous lidocaine reduced postoperative sore throat significantly across a variety of conditions, such as sex, blade shape, bucking, and smoking [3].

Coughing exacerbates the pain of a body wound and increases intracranial or intraocular pressure of patients with brain disease or glaucoma. Intracuff lidocaine is reported to decrease postoperative cough [4].

Postoperative excessive airway secretion leads to atelectasis and infectious pneumonia. Atropine has been used to control airway secretions. Lidocaine also affects airway secretions. It decreases goblet cell secretion by suppressing neural control, although water reabsorption in the airway is reduced by lidocaine based on ion transport [5,6].

The method of lidocaine application seems to influence the results. Soltani and Aghadavoudi showed that intracuff lidocaine best prevented cough and sore throat, whereas jelly lubrication increased cough and sore throat postoperatively among some application methods following intravenous lidocaine prior to endotracheal intubation [7]. It was reported that lidocaine spray suppresses cardiovascular responses and increases intracranial pressure less than intravenous lidocaine [8].

We investigated whether intravenous lidocaine before endotracheal intubation affects the postoperative airway complications of sore throat, cough, and sputum with various clinically used dosages.

Materials and methods

The study was approved by the ethics committee of Kochi Red Cross Hospital. Written informed consent was obtained preoperatively. A total of 80 adult American Society of Anesthesiologists (ASA) physical status I-II patients without airway symptoms were studied prospectively. Smokers were excluded. Operations included abdominal, gynecological, urological, and orthopedic surgery with expected extubation immediately after the operation. The patients were premedicated with 0.5 mg atropine and 25 mg hydroxyzine intramuscularly 30 min before the operation. Endotracheal intubation was completed smoothly following induction

Address correspondence to: K. Takekawa
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with fentanyl 2.5–3.0 μg·kg^{-1}, propofol 1 mg·kg^{-1}, and vecuronium 0.1 mg·kg^{-1} 5 min after intravenous lidocaine or normal saline. Altogether, 20 patients were given lidocaine 1 mg·kg^{-1} (group L1), and 20 patients were given lidocaine 1.5 mg·kg^{-1} (group L2) to ensure differences between clinically used dosages. Another 40 patients received normal saline (group C). All groups were randomly selected. Endotracheal tubes of 7.5 mm internal diameter for men and 7.0 mm internal diameter for women were used (Portex Profile cuff endotracheal tube; SIMS Portex, Hythe, Kent, UK). The cuff balloon was inflated manually with minimum pressure to diminish leak; it was not touched during the operation. Heat-moist exchangers were attached in all cases (Mallinckrodt DAR Hygrobac "S"). Anesthesia was inhalation or intravenous anesthesia with oxygen and air. Nitrous oxide was not used.

Interviews concerning airway symptoms that occurred 24 h after the operation were completed the day after surgery in the ward. All intubations and interviews were performed by the teaching staff using the triple-blind method. The interviewer checked the grade of symptoms using a checklist. Symptoms were graded as follows: 1, no symptoms; 2, mild; 3, moderate; and 4, severe (Table 1). Grades 2, 3, and 4 were counted as symptom-positive.

Data concerning the number and incidence were expressed as means ± SD, as a percentage, or as a real number. These levels were analyzed with Student's *t*-test and Fisher's exact probability test. Data on the severity of the symptoms were analyzed using the Mann-Whitney test. $P < 0.05$ was considered to indicate a significant difference. Sample sizes of 40 with the expected power between 0.8 and 0.9 had a smaller proportion of 0.1, a difference of 0.3, and a type I error of 0.05. The sample size needed was estimated from a pilot test.

Table 1. Grading scale to evaluate sore throat, cough, and sputum

Grade	Criteria
1	No symptoms
2	Mild: less severe than with a cold
3	Moderate: similar to that noted with a cold
4	Severe: more severe than with a cold

Results

The mean age was 53 ± 15 years in group L1, 53 ± 10 years in group L2, and 54 ± 16 years in group C. The average duration of surgery was 193 ± 127 min in group L1, 156 ± 64 min in group L2, and 174 ± 101 min in group C. Group L1 consisted of 7 men and 13 women, group L2 of 3 men and 17 women, and group C of 12 men and 28 women. The average weight was 55.8 ± 9.0 kg in group L1, 59.3 ± 12.0 kg in group L2, and 56.0 ± 11.6 kg in group C. The prevalence of patients requiring a nasogastric tube was 30% in group L1, 25% in group L2, and 18% in group C. The proportion of inhalation and intravenous anesthesia was 27 vs. 13 in group C, 19 vs. 1 in group L1, and 15 vs. 5 in group L2. There were no significant differences between groups regarding these variables. No convulsions occurred during induction.

The incidence and severity of positive airway symptoms are summarized in Table 2. There were significant differences in the incidence of sore throat between groups L2 and C ($P < 0.01$) and of cough between groups L1 and C ($P < 0.01$). There were no significant differences in the incidence of sputum among all groups. Altogether, 11 patients in group C had no symptoms, 7 patients in group L1, and 9 patients in group L2. Ten patients had all three symptoms in group C, whereas no patients in groups L1 and L2 had all three. Because there were no significant differences between all three symptoms in groups L1 and L2, statistically significant differences were examined between group C and group L (groups L1 + L2). Group C differed significantly from group L in the incidence of sore throat and cough ($P < 0.01$ for both).

The severity of the sore throat differed significantly between groups L2 and C ($P < 0.01$) and between groups L and C ($P < 0.01$). Cough severity was signifi-

Table 2. Postoperative airway symptoms

	Percent of patients in each group: total (mild/moderate/severe)		
Group	Sore throat	Cough	Sputum
L[a] ($n = 40$)	10* (2.5/7.5/0)**	10* (7.5/2.5/0)**	30 (27.5/2.5/0)
L1 ($n = 20$)	20 (5/15/0)	0* (0/0/0)**	35 (30/5/0)
L2 ($n = 20$)	0* (0/0/0)**	20 (15/5/0)	25 (25/0/0)
C ($n = 40$)	40 (5/35/0)	40 (35/2.5/2.5)	47.5 (35/7.5/5)

[a] Group L consists of groups L1 and L2
* Significantly different from group C in terms of incidence ($P < 0.01$)
** Significantly different from group C in terms of severity ($P < 0.01$)

cantly worse in group C than in group L1 ($P < 0.01$) and in group L ($P < 0.01$). There was no significant difference in sputum severity among all groups.

Discussion

We investigated the effects of clinical use dosages of lidocaine because massive dosages of lidocaine have been reported to cause irreversible neuralgic impairment. The effects of lidocaine on postoperative airway symptoms did not differ significantly within this range. The evaluation to compare their symptoms with the cold was considered valid for assessing symptoms within 24 h after surgery [1].

The most important finding from this study is that intravenous lidocaine prior to intubation decreases the incidence and severity of sore throat and cough postoperatively. The precise mechanism and relation between the suppression of cough and sore throat by intravenous lidocaine remains unknown. Application methods (spray or lubrication) have been reported to increase the incidence of sore throat [2]. No stimulation of the laryngeal or tracheal mucosa by intravenous lidocaine might be one reason for the good effects of intravenous lidocaine on postoperative airway symptoms.

Another plausible explanation of the lidocaine effects is that it suppresses the excitation of airway sensory C fibers, which reduces the amount of neuropeptide released followed by neuroplasticity in the airway and brainstem. Sensory C fibers in the airway have a high threshold to mechanoreceptors but a low threshold to capsaicin. In addition to this fiber, Aδ afferent fibers control cough and the breathing pattern with rapidly adapting irritant receptors and slowly adapting pulmonary stretch receptors, respectively. Those nociceptive-like C fibers, which store neuropeptides such as calcitonin gene-related peptide and tachykinins (substance P, neuropeptide A, and neuropeptide B), excite connecting nerve endings through the axon reflex, stimulating the release of neuropeptide from their terminals. At this point, afferent inputs from both are sent to the brainstem. Released neuropeptides that directly control bronchomotor tone, bronchovascular caliber, and respiratory secretion lead to neurogenic inflammation. They affect recruitment, adherence, and activation of granulocytes, which may further exacerbate neurogenic inflammation and hyperresponsiveness [9]. Substance P has a strong affinity for the NK-1 receptor, which is thought to play an important role in neurogenic inflammation. Neuropeptide A has an affinity for NK-2 receptor, the antagonist that has an antitussive effect [10]. The excitement of afferent C fiber itself works on the airway in a similar manner as the efferent nerves.

The characteristic feature of the sensory C fiber is its neuroplasticity in the airway and brainstem. It has been shown that irritation and inflammation of the airway is associated with induction of tachykinin synthesis in nonnociceptive airway afferent fibers that under normal conditions do not contain neuropeptide. More prominent central sensitization is estimated following peripheral neural excitation [11].

It is doubtful that remaining lidocaine, given prior to intubation, has efficacy postoperatively as the half-life of lidocaine is approximately 2 h [12]. Chang stated the possibility that the cough pathway is sensitized in a way similar to the pain situation. Pain can be present under no stimulation or occurs in a prolonged manner in response to a noxious stimulus when the sensitization process occurs as a consequence of activation of high-threshold receptors [13]. The strong stimulation of laryngoscopy or moving the tube may excite sensory C fibers and produce secondary neuroplasticity accompanied by postoperative sore throat and cough. Lidocaine may reduce released neuropeptides and secondary neural change. Direct central suppression can occur as well.

Sputum did not show a significant decrease, although lidocaine is expected to have the same effect on sore throat and cough through sensory C fibers [14]. Atropine is shown to block not only the cholinergic nerve but also part of the excitatory nonadrenergic/noncholinergic nerve component [15]. It is possible that reduction of sputum by lidocaine is masked by the premedication atropine. Water transportation might not be directly changed by less lidocaine in the blood after an operation.

In conclusion, intravenous lidocaine prior to intubation may decrease postoperative sore throat and cough.

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