Effect of nebulized ketamine versus betamethasone gel on postoperative pharyngo-laryngeal complications after proseal laryngeal mask insertion in day case surgery

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Background General anesthesia with laryngeal mask airway can lead to trauma of the airway mucosa resulting in postoperative pharyngo-laryngeal complications. We compared between the effects of betamethasone gel applied over proseal laryngeal mask and nebulized ketamine in reducing pharyngo-laryngeal complications such as sore throat, hoarseness of voice, dysphagia, and cough during the first, 12 postoperative hours after elective day case surgical procedures.

Patients and methods In all, 120 patients (aged 16–45 year) American Society of Anesthesiologists physical status I and II, scheduled for elective day case surgery with proseal laryngeal mask, were enrolled into this prospective, randomized, double-blinded study. The patients were randomly allocated into four groups of 30 participants each: group C received nebulized saline and lubricant gel over laryngeal mask; group B received nebulized saline and 0.05% betamethasone gel over laryngeal mask; group K received nebulized ketamine (1 mg/kg) and lubricant gel over laryngeal mask; group KB received nebulized ketamine (1 mg/kg) and 0.05% betamethasone gel over laryngeal mask. The incidence and the severity of postoperative sore throat, hoarseness of voice, dysphagia, and cough were graded at 30 min, 2, 4, 8, and 12 h.

Results The incidence and severity of postoperative sore throat, hoarseness of voice, dysphagia, and cough were significantly lower in groups KB, K, and B, compared with control group ($P<0.05$). The incidence and severity of postoperative sore throat, hoarseness of voice, dysphagia, and cough were lower in group KB compared with groups K and B at all times after removal of laryngeal mask up to 12 h without significant difference.

Conclusion The prophylactic use of betamethasone gel or nebulized ketamine significantly reduced the incidence and severity of postoperative pharyngo-laryngeal complication. Betamethasone gel and nebulized ketamine were significantly more effective than using each of these drugs alone.

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Introduction

Postoperative sore throat is an unpleasant side effect of general anesthesia (GA) especially if combined with hoarseness, dysphagia, and cough. Postoperative pharyngo-laryngeal complications occur as a result of irritation and inflammation of the airway from the trauma occurring to the airway mucosa [1,2]. Pharyngo-laryngeal complications are the common complications after surgery using the laryngeal mask airway and is considered as one of the major problems of patients after surgery. The incidence of pharyngo-laryngeal complications during the placement (insertion) of the laryngeal mask airway is reported to be 34–58%. Its incidence is related to various factors including age, sex, cuff size, duration of use, rate of manipulation during insertion, and number of attempts of insertion [3–5]. It may leave the patient with an unpleasant memory of the operation after discharge from the hospital and may negatively affect patient comfort and lead to postoperative morbidity [6].

The nonpharmacological methods of reducing pharyngo-laryngeal complication after surgery include: the use of a laryngeal mask of smaller size, treating the laryngeal mask with water-soluble lubricating gel, careful airway instrumentation, the insertion of laryngeal mask after obtaining complete muscular relaxation, minimizing intracuff pressure, and gentle suction of the patient's pharynx [7]. The pharmacological methods include using azulene sulfonate [8,9], ketamine gargle [10], steroid gels [11], and steroid injection [12–14].

There is an increasing amount of experimental data showing that N-methyl-D-aspartate (NMDA) receptors are not found only in the central nervous system, but also in the peripheral nerves. Moreover, experimental studies point out that peripheral administered of NMDA receptor antagonists are

involved with antinociception [15] and anti-inflammatory cascade [16].

Ketamine is an NMDA receptor antagonist and has been used as a gargle for reducing the incidence and severity of pharyngo-laryngeal complications due to its antinociceptive and anti-inflammatory effects [8,16]. Ketamine nebulization has advantages over gargle: it spares the patient from the bitter taste of ketamine and a much smaller volume is required as opposed to larger volumes required for gargle with risk of aspiration if accidentally swallowed [17].

Betamethasone gel applied over the laryngeal mask might reduce the incidence of postoperative sore throat, cough, dysphagia, and hoarseness of voice due to its anti-inflammatory modulating effects of tissue edema and pain [18].

The aim of this study is to compare the role of application of betamethasone gel on the proseal laryngeal mask cuff and nebulized ketamine for reducing the incidence and severity of pharyngo-laryngeal complications.

Patients and methods

The study is a double-blinded, randomized clinical trial conducted on 120 patients after obtaining approval from Institutional Ethics Committee of our hospital and individual written informed consent. The age of the patient ranged between 16 and 45 years, of either sex with American Society of Anesthesiologists (ASA) physical status I–II who were scheduled for elective surgery under GA with proseal laryngeal mask airway. This study was held at Samir Abbas Medical Centre, Khobar, KSA during the period between January 2014 and May 2015. Patients with a history of preoperative sore throat or hoarseness, congenital and acquired laryngeal and pharyngeal deformities, oral surgeries, active respiratory tract infection, asthma, chronic obstructive pulmonary disease, gastroesophageal reflux, head and neck surgeries, Mallampati grade more than 3, BMI more than 30, known allergies to the study drug, the use of laryngeal mask with a duration greater than 1.5 h, cases of difficult insertion, those who required more than one attempt of proseal laryngeal mask insertion, and traumatization of pharynx and larynx during insertion of mask were excluded from the study.

After exclusion, the patients were randomly allocated to one of the four groups using a computer-generated randomization list (n=30 for each group).

(1) Group saline (C): received nebulized saline 5.0 ml and a lubricant gel all over the cuff of the proseal laryngeal mask.
(2) Group betamethasone (B): received nebulized saline 5.0 ml and 0.05% betamethasone gel all over the cuff of the proseal laryngeal mask.
(3) Group ketamine (K): received nebulized ketamine 1 mg/kg in 5 ml saline and lubricant gel all over the cuff of the proseal laryngeal mask.
(4) Group ketamine plus betamethasone (KB): received nebulized ketamine 1 mg/kg in 5 ml saline and 0.05% betamethasone gel all over the cuff of the proseal laryngeal mask.

The patients were randomized and double blinded into the four groups with the help of a computer-generated table of random numbers in opaque, sealed envelopes prepared by an anesthesiologist who is not part of the study. The envelopes were opened by the staff nurse; the solutions were prepared by the researcher, and then the anesthetic nurse gave them without any information about the solution type. The patients received the study drug (ketamine or normal saline) via nebulization masks connected to a wall-mounted oxygen-driven source (8 l, 50 psi) for 15 min and cuff of proseal laryngeal mask lubricated by betamethasone gel or lubricant gel according to the group before induction of anesthesia. The anesthesia nurse later did not participate in the subsequent assessment of these patients.

GA was induced 10 min after completion of nebulization and lubricating proseal laryngeal mask by betamethasone gel or lubricant gel according to the group. The intraoperative monitoring included continuous electrocardiography, noninvasive blood pressure, pulse oximetry (SpO_2), and end-tidal carbon dioxide.

Preoxygenation was done by face mask for 3 min, then anesthesia was induced with intravenous propofol 2 mg/kg, fentanyl 1.5 μg/kg, and atracurium 0.5 mg/kg. Laryngeal mask insertion was performed by an experienced anesthesiologist after ensuring maximum neuromuscular blocking effect as assessed by train of four count less than 2. The laryngeal mask airway (LMA) cuff was fully deflated and then lubricated with betamethasone gel or lubricant gel according to each group. The LMA size was chosen according to the sex and weight of the patient: size 3 (<50 kg) or size 4 (≥50 kg) for women and size 4 (<70 kg) or size 5 (≥70 kg) for men [19]. LMA was inserted using the index finger insertion technique by the same experienced anesthesiologist in all patients. LMA

cuff pressure was adjusted to less than 40 mmHg by using a handheld pressure gauge in which the transducer was connected to the pilot balloon of the laryngeal mask to provide digital display of the intracuff pressure on the screen of the monitor (Endotest; Rüsch, Kernen, Germany) [20]. LMA insertion success was confirmed with chest expansion, capnography, and airway pressure traces. Anesthesia was maintained with sevoflurane in a concentration of 2% with a 50% oxygen–nitrous oxide mixture. After laryngeal mask was inserted, mechanical ventilation with an initial tidal volume of 8 ml/kg, and respiratory frequency of 12 breath/min were used to maintain normocapnia. If the first attempt of laryngeal mask failed, the patient was excluded from the study. At the end of the surgery, oxygen (100%) was administered and residual neuromuscular block was antagonized with by a combination of neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. The laryngeal mask was removed at a T4/T1 ratio of more than 90% and the patient was fully conscious.

Information of the patients including age, sex, weight (kg), ASA status, type of surgery, duration of surgery, and position of patients was recorded.

Postoperative sore throat, hoarseness, dysphagia, and cough were evaluated when the patient's Ramsay Sedation Score [21] was 2 (cooperative, oriented, and tranquil) by asking the patients if they were having any difficulty when eating and swallowing, whether they had a dry harsh voice and whether they had any throat pain or cough. These problems were evaluated 30 min after extubation in the recovery room and then at 2, 4, 8, and 12 after surgery by a nurse blinded to the study. Sore throat, dysphagia, hoarseness, and cough were graded on a four-point scale [10,22] (Table 1).

The outcome of the study was to assess the incidence and severity of postoperative sore throat, hoarseness of voice, dysphagia, and cough at recovery, and postoperatively in day case adult patients undergoing surgery under GA with proseal laryngeal mask.

Statistical analysis

Sample size based on previous studies on the assumption that the incidence of postoperative sore throat is 60% and to show a 50% reduction in the incidence at α=0.05, confidence interval of 95%, and a power 85% we required a sample size of 30 patients per group, using the computer software G*Power, version 3.1.9.2.2, Erdfelder, Faul and Buchuner (German).

Collected data were organized, tabulated, and statistically analyzed using the statistical package for social sciences, version 16 (SPSS Inc., IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp, USA), running on IBM compatible computer. Numerical data were represented as mean and SD, while categorical data represented as frequencies (*n*) and percentages (%). For parametric data, one-way analysis of variance was used to compare between the four groups. For nonparametric data, Kruskal–Wallis test was used to compare between the four groups. Mann–Whitney *U* test was used for pairwise comparisons when Kruskal–Wallis test is significant. For data collected as proportions a χ^2 test was performed. *P* value less than 0.05 was considered statistically significant.

Results

Demographic data for the 120 patients are shown in Table 2. There were no significant differences among the four groups with respect to age, sex, weight, ASA status, type of surgery, duration of anesthesia, position of patients during surgery, and recovery time ($P>0.05$).

The incidence of postoperative sore throat was significant in groups B, K, and KB than the control group up to 12 h postoperatively ($P<0.05$) as seen in Fig 1.

The incidence of postoperative dysphagia was significant in groups B, K, and KB than the control

Table 1 Scoring system for sore throat, dysphagia, hoarseness, and cough [10,22]

	Score
Sore throat	0=no sore throat
	1=mild sore throat (complains of sore throat only on asking)
	2=moderate sore throat (complains of sore throat on his/her own)
	3=severe sore throat (change of voice or hoarseness, associated with throat pain)
Dysphagia	0=no dysphagia
	1=minimal
	2=moderate
	3=severe
Hoarseness	0=no hoarseness
	1=slight hoarseness
	2=severe hoarseness
	3=cannot speak because of hoarseness
Cough	0=no cough occurring at any time
	1=minimal cough, less than noted with a cold
	2=moderate cough, as would be noted with a cold
	3=severe cough, greater than would be noted with a cold

group up to 12 h postoperatively ($P<0.05$) as shown in Fig 2.

The incidence of postoperative hoarseness was significant in groups B, K, and KB than the control group of up to 12 h postoperatively ($P<0.05$) as shown in Fig 3.

The incidence of postoperative cough was significant in groups B, K, and KB than the control group of up to 12 h postoperatively ($P<0.05$) as shown in Fig 4.

The incidence of postoperative sore throat, dysphagia, hoarseness, and cough were better but not significant in group KB than groups B and K up to 12 h postoperatively as shown in Figs 1–4, so betamethasone plus ketamine was better than using each drug alone.

The severity of postoperative sore throat, dysphagia, and cough were significant in groups B, K, and KB than the control group up to 12 h postoperatively and hoarseness was significant in groups B, K, and KB than the control group up to 4 h postoperatively ($P<0.05$) as shown in Table 3.

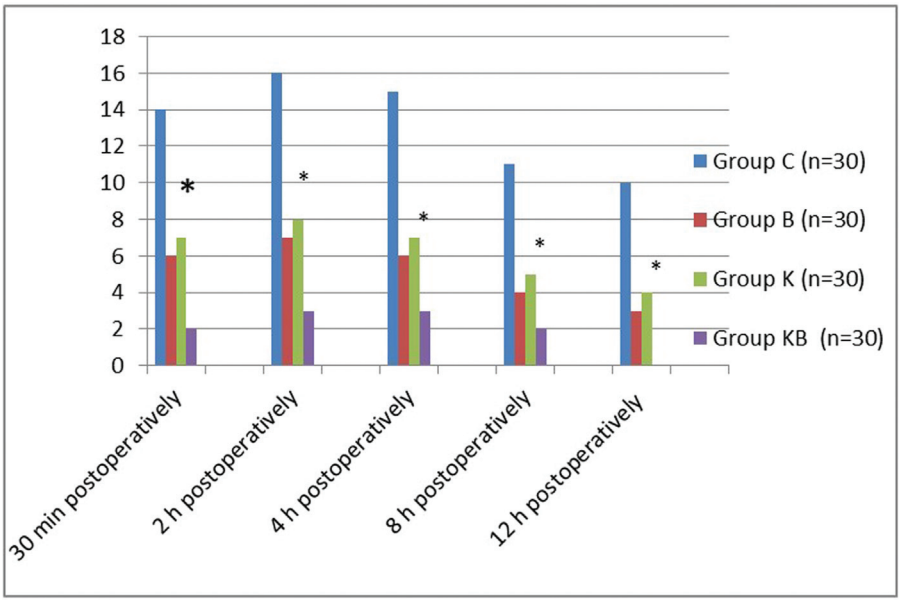
The severity of postoperative sore throat, dysphagia, hoarseness, and cough were better but not significant in

Table 2 Demographic data and data related to the surgery

	Group C (*N*=30)	Group B (*N*=30)	Group K (*N*=30)	Group KB (*N*=30)	*P* value
Age (year)	29.7±12.3	31.1±13.6	33.5±13.2	34.5±13.4	0.38
Weight (kg)	69.3±9.6	8 69.9±7.6	71.2±8.8	71.5±6.1	0.62
Sex (male/female)	6/24	8/24	5/25	6/24	0.35
ASA (I–II)	23/7	22/8	24/6	22/8	0.54
Duration of anesthesia (min)	45.3±13.92	43.6±13.85	47.6±11.54	46.6±12.65	0.28
Recovery time (min)	28.6±2.3	29.1±2.3	28.5±2.1	27.7±2.8	0.18
Type of surgery					
Ovum pickup	8 (26.7)	7 (33.3)	9 (30.0)	8 (26.7)	0.26
Hysteroscope	6 (20.0)	5 (16.7)	4 (13.3)	5 (16.7)	
Ovarian cystectomy	5 (16.7)	7 (33.3)	6 (20.0)	6 (20.0)	
TESE	7 (33.3)	6 (20.0)	8 (26.7)	6 (20.0)	
Varicocelectomy	4 (13.3)	5 (16.7)	3 (10.0)	5 (16.6)	
Position of patients					
Lithotomy	14 (46.7)	12 (40.0)	13 (43.3)	13 (43.3)	0.32
Supine	16 (53.3)	18 (60.0)	17 (56.7)	17 (56.7)	

Data were expressed as mean±SD or *n* (%). ASA, American Society of Anesthesiologists; TESE, testicular sperm extraction.

Figure 1



Incidence of sore throat in patients. Data were expressed as *n* (%). *Statistically significant ($P<0.05$).

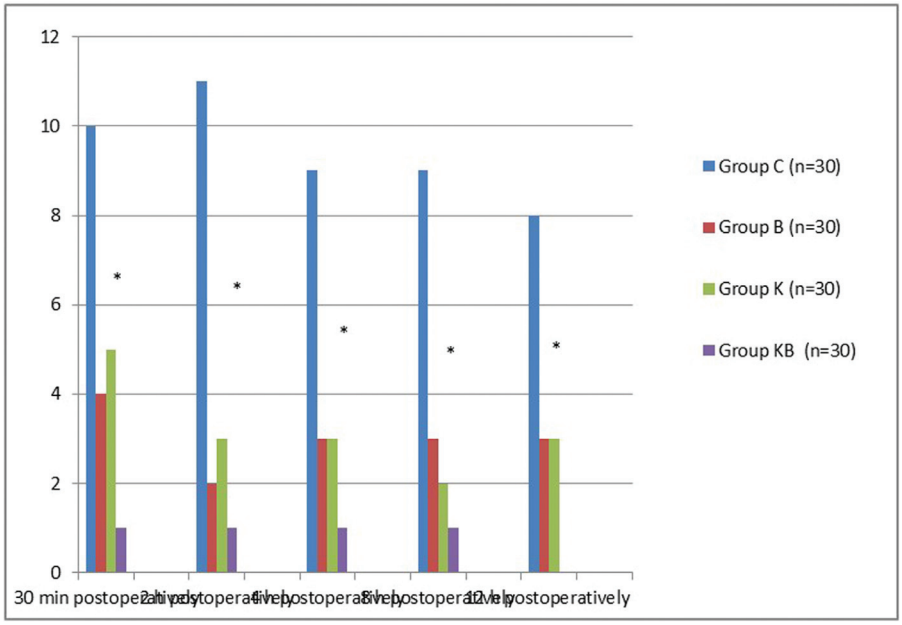
group KB than in groups B and K up to 12 h postoperatively as shown in Table 3, so a combination of betamethasone plus ketamine was better than using each drug alone in decreasing the severity of these parameters. No local or systemic side effects were observed in the tested groups.

Discussion

The results of this study demonstrated that the incidence and severity of postoperative sore throat, dysphagia, hoarseness, and cough were significantly decreased in groups KB, K, and B compared with group C at all times during 12 h after removal of the laryngeal mask except that the severity of hoarseness was significantly decreased in groups KB, K, and B compared with group C at all times during 4 h and nonsignificant at 8 and 12 h.

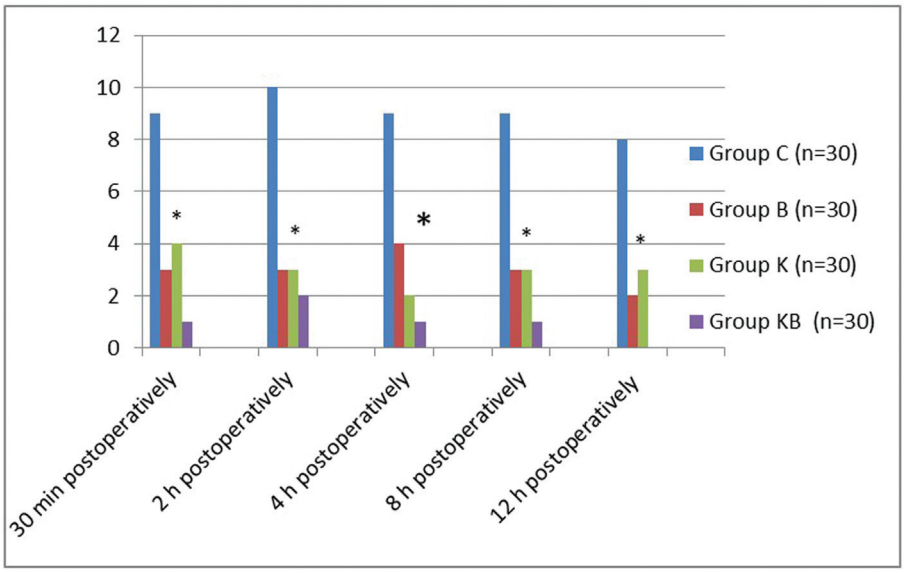
Nebulized ketamine 1 mg/kg and betamethasone gel (group KB) before the induction of GA decreased the incidence and severity of postoperative sore throat,

Figure 2



Incidence of dysphagia in patients. Data were expressed as *n* (%). *Statistically significant ($P<0.05$).

Figure 3

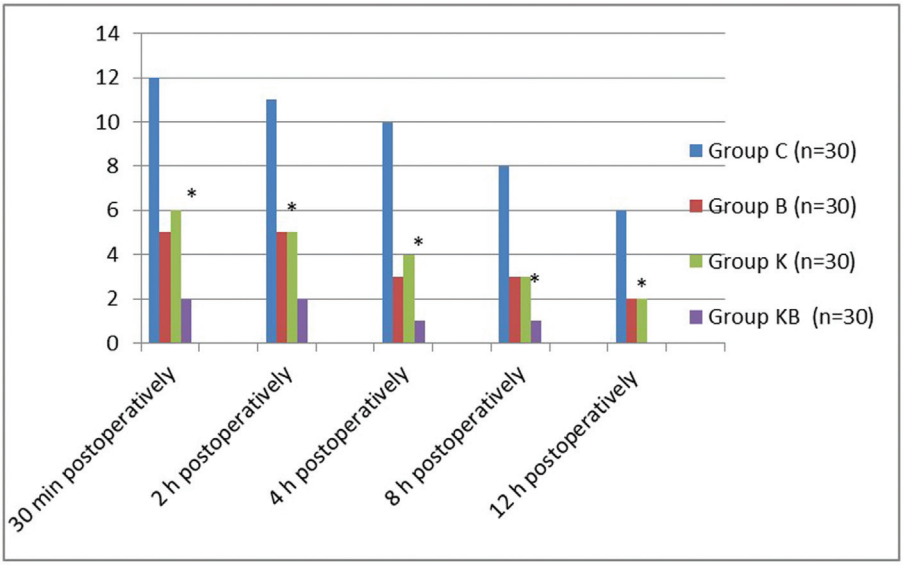


Incidence of hoarseness of voice in patients. Data were expressed as *n* (%). *Statistically significant ($P<0.05$).

dysphagia, hoarseness, and cough compared with other groups at all times during 12 h after tracheal extubation. So nebulized ketamine combined with betamethasone gel was more effective than using each drug alone for reducing sore throat, dysphagia, hoarseness, and cough at all times after removal of the laryngeal mask up to 12 h.

Ketamine is an NMDA receptor antagonist with the primary site of action in the central nervous system and parts of the limbic system while its use via nasal route, gargle, and rectal route suggests its peripheral effect. The mechanism of the topical effect of ketamine nebulization attenuated the local inflammation and also to the peripheral analgesic effect of ketamine [10].

Figure 4



Incidence of cough in patients. *significant.

Table 3 Severity grades of sore throat, dysphagia, hoarseness of voice, and cough

	Group C (*N*=30)	Group B (*N*=30)	Group K (*N*=30)	Group KB (*N*=30)	*P* value
30 min postoperatively					
Sore throat (0/1/2/3)	16/9/4/1	24/5/1/0	23/6/1/0	28/2/0/0	0.02*
Dysphagia (0/1/2/3)	20/6/3/1	26/3/1/0	25/4/1/0	29/1/0/0	0.015*
Hoarseness (0/1/2/3)	21/7/1/1	27/2/1/0	26/3/1/0	29/1/0/0	0.023*
Cough (0/1/2/3)	18/8/2/2	25/4/1/0	24/5/1/0	28/2/0/0	0.01*
2 h postoperatively					
Sore throat (0/1/2/3)	14/12/2/2	23/6/1/0	22/7/1/0	27/3/0/0	0.04*
Dysphagia (0/1/2/3)	19/6/4/1	28/1/1/0	27/1/2/0	29/1/0/0	0.01*
Hoarseness (0/1/2/3)	20/6/3/1	27/2/1/0	27/1/2/0	28/2/0/0	0.013*
Cough (0/1/2/3)	19/7/2/2	25/4/1/0	25/4/1/0	28/2/0/0	0.02*
4 h postoperatively					
Sore throat (0/1/2/3)	15/10/3/2	24/5/1/0	23/6/1/0	27/3/0/0	0,02*
Dysphagia (0/1/2/3)	21/5/3/1	27/2/1/0	27/1/2/0	29/1/0/0	0.02*
Hoarseness (0/1/2/3)	21/5/3/1	26/3/1/0	28/1/1/0	29/1/0/0	0.036*
Cough (0/1/2/3)	20/7/2/1	27/2/1/0	26/3/1/0	29/1/0/0	0.01*
8 h postoperatively					
Sore throat (0/1/2/3)	19/8/2/1	26/4/0/0	25/5/0/0	28/2/0/0	0.013*
Dysphagia (0/1/2/3)	21/6/2/1	27/3/0/0	28/2/0/0	29/1/0/0	0.01*
Hoarseness (0/1/2/3)	24/6/2/1	27/3/0/0	27/3/0/0	29/1/0/0	0.190
Cough (0/1/2/3)	22/7/1/0	27/2/1/0	27/2/1/0	29/1/0/0	0.05*
12 h postoperatively					
Sore throat (0/1/2/3)	20/8/2/0	27/3/0/0	26/4/0/0	30/0/0/0	0.002*
Dysphagia (0/1/2/3)	22/6/2/0	27/3/0/0	27/3/0/0	30/0/0/0	0.012*
Hoarseness (0/1/2/3)	24/5/1/0	28/2/0/0	27/3/0/0	30/0/0/0	0.056
Cough (0/1/2/3)	24/5/1/0	28/2/0/0	28/2/0/0	30/0/0/0	0.04*

Data were expressed as *n*. *Statistically significant ($P<0.05$).

Experimental animal studies have shown a protective effect on airway inflammatory injury with ketamine nebulization [23]. In an earlier study, preoperative nebulization with 3.0 ml (225 mg) of isotonic magnesium sulfate, also an NMDA receptor antagonist showed a decrease in incidence and severity of pharyngo-laryngeal complications such as sore throat, dysphagia, hoarseness of voice, and cough at 0, 2, 4, and 24 h postoperatively [24].

Canbay *et al.* [10] found that ketamine gargle (40 mg ketamine in saline 30 ml; gargled for 30 s 5 min before induction) reduced the incidence and severity of postoperative sore throat in patients undergoing septorhinoplasty under GA with endotracheal intubation, potentially because of local anti-inflammatory and anti-hyperalgesic effects of ketamine (as a potent antagonist of the NMDA receptor).

Vanita *et al.* [17] concluded that the use of preoperative ketamine nebulization reduced the incidence and severity of sore throat during the early postoperative period up to 24 h in patients receiving GA with tracheal intubation.

Chan *et al.* [25] measured serum ketamine levels intraoperatively after gargling of ketamine and found low levels of serum ketamine; therefore systemic absorption of ketamine was unlikely to have a role in the attenuation of pharyngo-laryngeal complications and suggested a topical effect of ketamine.

In this study, the local administration of betamethasone on the cuff of the laryngeal mask was effective in reducing sore throat, hoarseness, dysphagia, and coughing in the betamethasone group at 30 min, 2, 4, 8, and 12 h after the removal of the laryngeal mask.

Most studies have dealt with the study of the effect of intravenous administration of dexamethasone on sore throat due to the endotracheal tube [26]. A few studies have focused on LMA complications and also on the effect of the local administration of glucocorticoids on sore throat, hoarseness of voice, dysphagia, and coughing after surgery [27].

Sumathi *et al.* [11] conducted a comparative study on the effect of the application of betamethasone gel and lidocaine gel in reducing sore throat, coughing, and hoarseness after surgery. The findings indicated that the application of betamethasone gel on the endotracheal tube leads to a reduction in the incidence and intensity of sore throat, coughing, dysphagia, and hoarseness.

Tabari *et al.* [28] compared the effect of the application of betamethasone gel on the endotracheal tube and the intravenous administration of dexamethasone on reducing sore throat after surgery. Their findings have shown that the application of betamethasone gel decreased the intensity of postoperative sore throat to a higher degree compared with the intravenous dexamethasone.

Mohammad *et al.* [29] concluded that the local application of dexamethasone before surgery can decrease the incidence of complications in the laryngeal areas due to the placement of laryngeal mask airway such as sore throat, dysphagia, hoarseness, and coughing.

Ayoub *et al.* [30] and Selvaraj and Dhanpal [31] concluded that application of glucocorticoids to the cuff of the LMA induces a greater effect on reducing sore throat, hoarseness, and dysphagia caused by laryngeal mask. This is related to the direct contact of the drug with the posterior pharyngeal wall, vocal cords, and larynx.

Shaaban and Kamal [32] compared gargling with ketamine prior to intubation versus betamethasone gel when applied over the endotracheal tube and found that sore throat was reduced in both groups. In addition, using betamethasone gel decreased the incidence and severity of postoperative cough and hoarseness of voice more than gargling with ketamine.

Nebulized ketamine combined with betamethasone gel was more effective than using each drug alone for reducing sore throat, dysphagia, hoarseness, and coughing at all times after removal of the laryngeal mask up to 12 h. No other study compared the combination of nebulized ketamine and betamethasone gel.

Safavi *et al.* [33] concluded that a combination of ketamine gargle and intravenous dexamethasone was more effective than using each of these drugs alone in reducing the incidence and severity of postoperative sore throat, dysphagia, and hoarseness, perhaps due to their synergistic effects.

A drawback of our study was the absence of the measurements of plasma ketamine and betamethasone levels, and so we cannot rule out the contribution of the systemic effect of ketamine and betamethasone. Our doses were relatively low and we did not observe any central nervous system side effects.

Conclusion

For reducing the incidence and severity of postoperative sore throat, dysphagia, hoarseness, and cough, the administration of nebulized ketamine or betamethasone gel was effective. Nebulized ketamine combined with betamethasone gel was more effective than using each of these drugs alone at all times after removal of the proseal laryngeal mask.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Higgins PP, Chung F, Mezei G. Postoperative sore throat after ambulatory surgery. *Br J Anaesth* 2002; **88**:582–584.

2 Scuderi PE. More answers than questions. *Anesth Analg* 2010; **111**:891–892.

3 McHardy F, Chung F. Postoperative sore throat: cause, prevention and treatment. *Anaesthesia* 1999; **54**:444–453.

4 Bagchi D, Mandal MC, Das S, Sahoo T, Basu SR, Sarkar S. Efficacy of intravenous dexamethasone to reduce incidence of postoperative sore throat: a prospective randomized controlled trial. *J Anaesthesiol Clin Pharmacol* 2012; **28**:477–480.

5 Wakeling HG, Butler PJ, Baxter PJC. The laryngeal mask airway: a comparison between two insertion techniques. *Anesth Analg* 1997; **85**:687–690.

6 Ebneshahidi A, Mohseni M. Strepsils tablets reduce sore throat and hoarseness after tracheal intubation. *Anesth Analg* 2010; **111**:892–894.

7 Park SY, Kim SH, Lee AR, Cho SH, Chae WS, Jin HC, *et al.* Prophylactic effect of dexamethasone in reducing postoperative sore throat. *Korean J Anesthesiol* 2010; **58**:15–19.

8 Honarmand A, Safavi M. Beclomethasone inhaler versus intravenous lidocaine in the prevention of postoperative airway and throat complaints: a randomized, controlled trial. *Ann Saudi Med* 2008; **28**:11–16.

9 Ogata J, Minami K, Horishita T, Shiraishi M, Okamoto T, Terada T, *et al.* Gargling with sodium azulene sulfonate reduces the postoperative sore throat after intubation of the trachea. *Anesth Analg* 2005; **101**:290–293.

10 Canbay O, Celebi N, Sahin A, Celiker V, Ozgen S, Aypar U. Ketamine gargle for attenuating postoperative sore throat. *Br J Anaesth* 2008; **100**:490–493.

11 Sumathi PA, Shenoy T, Ambareesha M, Krishna HM. Controlled comparison between betamethasone gel and lidocaine jelly applied over tracheal tube to reduce postoperative sore throat, cough, and hoarseness of voice. *Br J Anaesth* 2008; **100**:215–218.

12 Park SH, Han SH, Do SH, Kim JW, Rhee KY, Kim JH. Prophylactic dexamethasone decreases the incidence of sore throat and hoarseness after tracheal extubation with a double-lumen endobronchial tube. *Anesth Analg* 2008; **107**:1814–1818.

13 Maruyama K, Sakai H, Miyazawa H, Toda N, Iinuma Y, Mochizuki N, *et al.* Sore throat and hoarseness after total intravenous anaesthesia. *Br J Anaesth* 2004; **92**:541–543.

14 Thomas S, Beevi S. Dexamethasone reduces the severity of postoperative sore throat. *Can J Anaesth* 2007; **54**:897–901.

15 Berrino L, Oliva P, Massimo F, Aurilio C, Maione S, Grella A, *et al.* Antinociceptive effect in mice of intraperitoneal N-methyl-D-aspartate receptor antagonists in the formalin test. *Eur J Pain* 2003; **7**:131–137.

16 Zhu MM, Zhou QH, Zhu MH, Rong HB, Xu YM, Qian YN, *et al.* Effects of nebulized ketamine on allergen-induced airway hyperresponsiveness and inflammation in actively sensitized Brown-Norway rats. *J Inflamm (Lond)* 2007; **4**:10.

17 Vanita A, Sukanya M, Rashi S. Nebulized ketamine decreases incidence and severity of post-operative sore throat. *Indian J Anaesth* 2015; **59**:37–42.

18 Stride PC. Postoperative sore throat: topical hydrocortisone. *Anaesthesia* 1990; **45**:968–971.

19 Jeon YS, Choi JW, Jung HS, Kim YS, Kim DW, Kim JH, *et al.* Effect of continuous cuff pressure regulator in general anaesthesia with laryngeal mask airway. *J Int Med Res* 2011; **39**:1900–1907.

20 Seet E, Yousaf F, Smita Gupta S, Subramanyam R, Wong DT, Chung F. Use of manometry for laryngeal mask airway reduces postoperative pharyngolaryngeal adverse events. *Anesthesiology* 2010; **112**:652–657.

21 Ramsay MA, Savege TM, Simpson BR, Goodwin R. Controlled sedation with alphaxalone-alphadolone. *Br Med J* 1974; **22**:656–659.

22 Harding CJ, McVey C. Interview method affects incidence postoperative sore throat. *Anaesthesia* 1987; **42**: 1104–1107.

23 Zhu MM, Qian YN, Zhu W, Xu YM, Rong HB, Ding ZN, *et al.* Protective effects of ketamine on allergen-induced airway inflammatory injure and high airway reactivity in asthma: experiment with rats. *Zhonghua Yi Xue Za Zhi* 2007; **87**:1308–1313.

24 Gupta SK, Tharwani S, Singh DK, Yadav G. Nebulized magnesium for prevention of postoperative sore throat. *Br J Anaesth* 2012; **108**:168–169.

25 Chan L, Lee ML, Lo YL. Postoperative sore throat and ketamine gargle. *Br J Anaesth* 2010; **105**:97.

26 De Oliveira GS Jr, Ahmad S, Fitzgerald PC, Marcus RJ, Altman CS, Panjwani AS, *et al.* Dose ranging study on the effect of preoperative dexa-methasone on postoperative quality of recovery and opioid consumption after ambulatory gynaecological surgery. *Br J Anaesth* 2011; **107**:362–371.

27 Rafiei MR, Arianpour N, Rezvani M, Ebrahimi A. Effects of intracuff dexa-methasone on post-extubation reactions. *J Res Med Sci* 2012; **17**:338–343.

28 Tabari M, Soltani G, Zirak N, Alipour M, Khazaeni K. Comparison of effectiveness of betamethasone gel applied to the tracheal tube and IV dexamethasone on postoperative sore throat: a randomized controlled trial. *Iran J Otorhinolaryngol* 2013; **25**:215–220.

29 Mohammad HJ, Banafshe F, Mohammad RM, Farshid R, Mohammad HD, Kazem B. Effect of local application of dexamethasone on reducing of post-surgical sore throat due to application of laryngeal mask airway. *J Biol Todays world* 2014; **3**:271–274.

30 Ayoub CM, Ghobashy A, Koch ME, McGrimley L, Pascale V, Qadir S, *et al.* Widespread application of topical steroids to decrease sore throat, hoarseness, and cough after tracheal intubation. *Anesth Analg* 1998; **87**:714–716.

31 Selvaraj T, Dhanpal R. Evaluation of the application of topical steroids on the endotracheal tube in decreasing post-operative sore throat. *J Anaesthesiol Clin Pharmacol* 2002; **18**:167–170.

32 Shaaban AR, Kamal SM. Comparison between betamethasone gel applied over endotracheal tube and ketamine gargle for attenuating postoperative sore throat, cough and hoarseness of voice. *Middle East J Anaesthesiol* 2012; **21**:513–519.

33 Safavi M, Honarmand A, Fariborzifar A, Attari M. Intravenous dexamethasone versus ketamine gargle versus intravenous dexamethasone combined with ketamine gargle for evaluation of post-operative sore throat and hoarseness: a randomized, placebo-controlled, double blind clinical trial. *Adv Biomed Res* 2014; **3**:212.