Topical airway anesthesia for awake fiberoptic intubation: Comparison between airway nerve blocks and nebulized lignocaine by ultrasonic nebulizer

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ABSTRACT

Overview: Awake fiberoptic bronchoscope (FOB) guided intubation is the gold standard of airway management in patients with cervical spine injury. It is essential to sufficiently anesthetize the upper airway before the performance of awake FOB guided intubation in order to ensure patient comfort and cooperation. This randomized controlled study was performed to compare two methods of airway anesthesia, namely ultrasonic nebulization of local anesthetic and performance of airway blocks. Materials and Methods: A total of 50 adult patients with cervical spine injury were randomly allocated into two groups. Group L received airway anesthesia through ultrasonic nebulization of 10 ml of 4% lignocaine and Group NB received airway blocks (bilateral superior laryngeal and transtracheal recurrent laryngeal) each with 2 ml of 2% lignocaine and viscous lignocaine gargles. FOB guided orotracheal intubation was then performed. Hemodynamic variables at baseline and during the procedure, patient recall, vocal cord visibility, ease of intubation, coughing/gagging episodes, and signs of lignocaine toxicity were noted. Results: The observations did not reveal any significant differences in demographics or hemodynamic parameters at any time during the study. However, the time taken for intubation was significantly lower in Group NB as compared with the Group L. Group L had an increased number of coughing/gagging episodes as compared with Group NB. Vocal cord visibility and ease of intubation were better in patients who received airway blocks and hence the amount of supplemental lignocaine used was less in this group. Overall patient comfort was better in Group NB with fewer incidences of unpleasant recalls as compared with Group L. Conclusion: Upper airway blocks provide better quality of anesthesia than lignocaine nebulization as assessed by patient recall of procedure, coughing/gagging episodes, ease of intubation, vocal cord visibility, and time taken to intubate.

Key words: Airway management, bronchoscopy, laryngeal nerves, lidocaine, nebulizers

INTRODUCTION

Securing the airway during general anesthesia in patients with difficult airway poses a risk to the patient and presents challenges for the anesthesiologists.[1,2] Awake fiberoptic bronchoscope (FOB) guided intubation is a safe approach to airway management in most cases of difficult airway, especially in patients with cervical spine injury. This technique reduces the risk of neurologic injury before the onset of surgical procedure.[3] It is essential to sufficiently anesthetize the upper airway and suppress the gag, swallow and cough reflexes prior to awake FOB guided intubation and thus ensure patient comfort.[1,2] This can be achieved in multiple ways, which can broadly be divided into two groups: (a) Topical administration of local anesthetic (LA), or (b) blockade of neural supply to oropharynx and larynx. Topical administration of LA in the form of sprays, gargles, lozenges, or impregnated swabs causes fewer trauma to the oropharyngeal and laryngeal tissues as compared to nerve blocks. The risk of inadvertent injection into a blood vessel is also avoided by using this technique. In contrast, nerve
block techniques typically require a smaller dose of LA as compared with topical administration of LA, possibly decreasing the risk of systemic toxicity.

Topical application of LA by nebulization technique is one of the techniques used to anesthetize the airway. Customary compressed air driven jet nebulizers atomize only highly concentrated anesthetics, so that the maximum dose of LA can be exceeded within a short period of time. Ultrasonic nebulizer has been designed to deliver liquid medication in the form of droplets with an average diameter of just 3.5 μm to the airway. Ultrasonic nebulizers are often used in the treatment of pulmonary hypertension. Due to the fine mist of vaporized anesthetics, a remarkably lower dose of lignocaine is required and hence the probability of toxicity due to overdose is avoided. It also anesthetizes the trachea beyond glottis.

This randomized controlled study was conducted to assess and compare the efficacy of ultrasonic nebulization with nerve block technique to achieve upper airway anesthesia for awake FOB guided intubation. The findings may influence clinical practice in the management of the difficult airway during anesthesia.

**MATERIALS AND METHODS**

After approval of the protocol by the Institutional Review Board, 50 adult patients with traumatic cervical spine injury undergoing cervical spine fixation surgery were recruited for the study over a period of 12 months. A written informed consent was obtained from each patient. Uncooperative patients, those allergic to LA, asthmatics, epileptics and those with deranged coagulation, hemodynamic instability, bradyarrhythmias, or infection at the local site were excluded from the study.

A thorough preoperative evaluation including a complete airway evaluation (mouth opening, mallampati grading, thyromental distance, and evaluation of dentition) was performed. Standard fasting guidelines and anti-aspiration prophylaxis with tablet ranitidine 150 mg were prescribed. The patients were explained about the awake FOB guided intubation during preoperative assessment. Injection glycopyrrolate 5 μg/kg was given intramuscularly half an hour before shifting the patient to the operating room (OR). Inside the OR, standard monitoring, including electrocardiography (ECG), noninvasive blood pressure (BP), and pulse oximetry (SpO₂) were applied in all patients. An intravenous (IV) line was secured and ringer lactate was started. An arterial line was established under local anesthesia. After recording the baseline heart rate (HR), BP and SpO₂, injection midazolam 20 μg/kg and injection fentanyl 1 μg/kg were given IV.

The patients were randomly allocated into two groups. Randomization was done using computer generated tables of random numbers. Group L (n = 25) received 10 ml of 4% lignocaine by ultrasonic nebulizer (LD 10185, Honsun, Shanghai, China) for 15 min, and Group NB (n = 25) received bilateral superior laryngeal nerve and transtracheal instillation of 2 ml of 2% lignocaine, along with viscous xylocaine gargles twice. Adequate effect of local anesthesia was confirmed by heaviness of tongue in Group L patients and by hoarseness of voice in Group NB patients.

While giving supplemental oxygen through nasal prongs, FOB guided intubation was performed. Size 8.0 mm internal diameter endotracheal tube was used for male patients and 7.5 mm for female patients. Vital parameters (HR, BP, and SpO₂) were also recorded during intubation and at 1 min and 3 min postintubation. Supplemental LA was given as 1 ml aliquots of 2% lignocaine through the working channel of FOB (next aliquot given only after waiting for 30-60 s). Other parameters such as gag/cough reflex, cord visibility (relaxed, partially relaxed or adducted on endoscopic view), and ease of intubation [Table 1] were also recorded. Any signs of lignocaine toxicity such as ECG changes, seizures, and bronchoconstriction were also noted. After the airway was secured, general anesthesia was administered with propofol 2 mg/kg, and rocuronium 0.6 mg/kg. Postoperatively, patient comfort was assessed for complete amnesia, partial recall, and unpleasant memories during awake FOB guided intubation.

All data were tabulated and analyzed statistically. Parametric values were reported as mean ± standard deviation. Hemodynamic variables were compared using the unpaired Student’s t-test. Intubation grades and patient comfort scores were compared using the Mann—Whitney U test. Statistical significant value was considered if \( P < 0.05 \).

**RESULTS**

The demographic data [Table 2] showed no significant differences between the two groups. There was no statistically significant difference between both groups at any interval for HR or BP [Figure 1]. Patients in both

| Table 1: Grades of intubating condition |
|----------------------------------------|
| Grade of intubating conditions | Description |
|----------------------------------|-------------|
| Optimal                          | No collision (hold-up) encountered |
| Suboptimal                       | Hold-up, relieved by rotation of the tube once |
| Difficult                        | Hold-up, requiring more than one rotation of the tube or alteration in the patient's head or neck position |
| Failure                          | Failure of the attempt at FOB guided tracheal intubation |

FOB: Fiberoptic bronchoscope
groups exhibited a slight decrease in SpO₂ during the procedure, but the lowest SpO₂ recorded was 92%. All the patients remained sufficiently awake to cooperate with the procedure and none of the patients showed any evidence of lignocaine toxicity.

Awake FOB guided intubation was accomplished in all patients in both groups and in no patient was the procedure abandoned due to discomfort. The time taken to perform FOB guided intubation was less in Group NB (123.0 ± 46.7 s) as compared with Group L (200.4 ± 72.4 s) and this was statistically significant [Table 2]. Significantly more number of patients experienced gag and coughing during the procedure in Group L as compared with Group NB [Figure 2]. It was due to this reason that supplemental lignocaine had to be used in significantly more number of patients in Group L as compared with Group NB (n = 16 in Group L as compared to n = 5 in Group NB, P = 0.009). The mean supplemental lignocaine volume used was 1.06 ± 0.87 ml and 0.6 ± 0.64 ml in Group L and Group NB, respectively. This difference was statistically significant (P = 0.004). The highest quantity of supplemental lignocaine used in a single patient was 4 ml in Group L (n = 1) and 2 ml in Group NB (n = 3).

The vocal cord visibility [Figure 3] was better in Group NB as compared to Group L (P = 0.006). Only three patients in Group L had completely relaxed vocal cords as opposed to 12 patients in Group NB. Partially relaxed vocal cords were observed in seven patients in Group L and 11 patients in Group NB. Completely adducted vocal cords were seen in 12 patients in Group L. However, this did not have much impact on the ease of intubation [Figure 4], probably because of supplemental LA instillation. There

| Table 2: Demographic data and time taken for FOB guided intubation |
|----------------------|------------------|-----------|
| Age (years)          | 39.9±10.4        | 39.8±8.0  |
| Sex (male/female)    | 23/1             | 21/4      |
| Weight (kg)          | 61.4±3.8         | 57.0±10.0 |
| Time for FOB (s)     | 200.4±72.4       | 123.0±46.7|

FOB: Fiberoptic bronchoscope

![Figure 1: Comparison of hemodynamic variables between the two groups at baseline, 1 min and 3 min after intubation](image1)

![Figure 2: Comparison between the number of patients experiencing coughing/gagging in each group](image2)

![Figure 3: Comparison of vocal cord visibility between the two groups](image3)

![Figure 4: Comparison of the intubating conditions between the two groups (no failure was encountered)](image4)
was no statistical difference in between the two groups regarding the intubating conditions ($P = 0.315$). Patient comfort was also significantly different between the two groups [Figure 5]. Only six patients in Group L reported complete amnesia as compared to 13 patients in Group NB. No patient in Group NB reported recall of unpleasant memories as compared with six patients in Group L ($P = 0.007$).

**DISCUSSION**

Awake tracheal intubation with the aid of a fiberoptic device was first described by Murphy in 1967,\(^5\) who used a choledochoscope to facilitate nasotracheal intubation in patients with difficult airway. Since then, numerous subsequent authors have described the anesthetic techniques and experiences with awake FOB guided intubation. It offers several advantages over use of FOB after induction of general anesthesia in patients with cervical spine instability:

- Patient remains in a neutral position, minimizing the risk of neurological deterioration;
- patient’s neurological status can be assessed after intubation, and
- spontaneous ventilation is preserved.\(^5\)

There are multiple ways of anesthetizing the airway to facilitate the performance of awake FOB guided intubation. Among them, topical anesthesia with nebulized LA, gargles, lozenges, sprays, airway blocks and LA through the working channel of FOB is commonly used. Although the above-mentioned techniques can be combined in various ways, we chose two mutually exclusive techniques to compare their efficacy and patient comfort. There is a paucity of literature comparing the efficacy and safety for such methods in a population with cervical spine fixation surgery.

Administration of lignocaine through nebulization for anesthesia of upper airway and larynx has also been previously studied. In their study Cullen et al,\(^6\) found that lignocaine nebulization decreased the discomfort of nasogastric tube insertion. In 2007, Techanivate et al,\(^7\) found adequate upper airway anesthesia with 2% lignocaine nebulization and topical cocaine application to the nose for fiberoptic nasotracheal application.

In our study, the time taken to perform FOB guided intubation was significantly more in the nebulization group as compared to the nerve blocks group. Our results are contradictory to the randomized double-blinded study conducted in 1995 by Reasoner et al,\(^1\) which compared nebulized lignocaine with airway blocks to aid in FOB guided intubation in patients with cervical spine instability. The topical anesthesia group received 20 ml of 4% lignocaine via nebulization followed by a 3 ml transtracheal injection. On the other hand, the nerve block group received bilateral glossopharyngeal and superior laryngeal nerve blocks along with the transtracheal injection. They found no significant difference in the time taken to intubate between the groups. This was probably because nebulization was supplemented by transtracheal injection of 3 ml lignocaine, which further improved the quality of anesthesia.

Kundra et al,\(^8\) also compared two methods of anesthetizing the airway for awake fiberoptic nasotracheal intubation. One of the groups received 4 ml of 4% lignocaine through nebulization and the other received airway blocks (translaryngeal, bilateral laryngeal and lignocaine soaked cotton swabs in the nose). Although the time taken to intubate was similar in both groups, patients who received lignocaine nebulization for airway anesthesia had to undergo significantly higher stress during the insertion of endotracheal tube through the glottis. The grimace scores as well as the mean HR and BP in the nebulization group were significantly higher during endotracheal tube insertion.

Patient comfort was better in the nerve blocks group as compared with the nebulization group in our study, as deduced by the coughing/gagging episodes as well as the patient assessment of procedure recall. These findings are similar to those reported by Graham et al,\(^9\) in 1992. They compared three different methods to provide airway anesthesia during FOB. All patients received benzocaine lozenges, lignocaine sprays for posterior pharynx and lignocaine jelly for nasal passages along with either 4 ml of 2.5% cocaine injection through FOB working channel, transtracheal injection of the same amount of cocaine or nebulized 4 ml of 4% lignocaine. They reported that the transtracheal injection of cocaine provided significantly superior patient comfort and less coughing episodes as compared with the rest of the techniques. The findings...
reported by Reasoner et al\textsuperscript{[9]} were also similar. Although, there was no difference in the number of coughing/gagging episodes between the two study groups, patient recall of the procedure was more in the nebulization group. Kundra et al\textsuperscript{[10]} also reported higher grimace scores, mean HR and BP during insertion of endotracheal tube in patients who received lignocaine via nebulization as compared to nerve blocks. However, the patient comfort and recall of the procedure were comparable between the two groups.

In our study, vocal cord visibility and ease of intubation as assessed by the bronchoscopist were better in the nerve block group as compared with the nebulization group. This finding is similar to that observed by Graham et al\textsuperscript{[8]}\textsuperscript{,} They reported that the bronchoscopist preferred transtracheal instillation of LA as compared to LA nebulization or LA instillation through the working port of FOB. However, Reasoner et al\textsuperscript{[9]} did not find any difference in the quality of airway anesthesia between nebulized LA and nerve blocks as assessed by a blind observer/bronchoscopist.

Gal\textsuperscript{[10]} reported that lignocaine mist produced as an aerosol during ultrasonic nebulization causes airway irritation in subjects as evidenced by coughing. Later however, it results in bronchodilatation due to its membrane stabilizing action. No such adverse effects caused by lignocaine mist were noted in our study.

The maximum total dose of lignocaine used in our study was 400 mg through nebulization. Such a dose of lignocaine has been safely used and reported for FOB in many previous studies. In 1997, Parkes et al\textsuperscript{[11]} used 6 mg/kg of 10% lignocaine solution through nebulization mask for fiberoptic intubation. The serum lignocaine levels measured remained below the accepted threshold of 5 mg/l at all times (highest levels obtained were 0.45 mg/l). Similarly, Langmack et al\textsuperscript{[12]} measured the serum lignocaine levels in 51 asthmatic volunteers undergoing FOB with topical lignocaine. The average total dose used was 600 mg (8.2 mg/kg), which was found to be safe in all patients as assessed by serum lignocaine concentrations. However, in 1993, Wu et al\textsuperscript{[13]} have reported seizures in a patient after administration of a total dose of 300 mg of topical lignocaine during FOB. The serum lignocaine concentrations were found to be well above the acceptable toxic limits. Hence, a constant lookout for signs and symptoms of lignocaine toxicity is mandatory while using large doses.

The limitations of our study are that it is an unblinded study allowing some amount of bias. Furthermore, serum lignocaine levels were not measured due to nonavailability of this facility at our center.

Given the results of the study and the above discussion, the following conclusions may be drawn. The performance of bilateral superior laryngeal and transtracheal recurrent laryngeal nerve blocks provides adequate airway anesthesia to aid in awake FOB guided intubation. Furthermore, 10 ml of 4% lignocaine through ultrasonic nebulizer may not provide acceptable conditions for bronchoscopy, but a higher dose might be able to adequately anesthetize the airway. However, a lower dose of lignocaine through nebulization along with supplemental lignocaine instillation through the working channel of FOB might provide adequate airway anesthesia. More studies need to be performed to determine the amount of lignocaine, which can be used for nebulization with serum lignocaine levels.

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