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COMPARISON OF THE EFFICACY OF ATOMIZED VERSUS NEBULIZED LOCAL ANESTHETIC FOR AWAKE NASAL FIBEROPTIC INTUBATION: A RANDOMIZED TRIAL.

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ABSTRACT

Background

Awake fiberoptic intubation (AFOI) is a critical technique for managing difficult airways requiring effective local anesthesia to ensure patient comfort and procedural success. Nebulization and atomization have been employed for the topicalization of the airway. This study compared the efficacy of atomized versus nebulized local anesthesia for awake fiberoptic intubations.

Methods

A random assignment was made to provide either atomized (n = 35) or nebulized (n = 35) local anesthetic to seventy adult patients who needed AFOI. Time to intubation and attempts for intubation were the primary outcomes while patient satisfaction, adverse hemodynamic changes, and complications were secondary outcomes. With $p < 0.05$ designated as the statistical significance level, the data were analyzed using SPSS version 21.0.

Results: The atomized group had a shorter intubation time (4.9 ± 1.1 vs. 7.0 ± 1.5 minutes, $p < 0.001$) and higher first-attempt success (85.7% vs. 62.9%, $p = 0.005$). Fewer required a second attempt (14.3% vs. 37.1%). The atomized group also had smaller increases in MAP (10.2 ± 2.1 vs. 12.5 ± 2.3 mmHg, $p = 0.03$) and HR (9.5 ± 1.9 vs. 12.3 ± 2.1 bpm, $p = 0.01$). Patient satisfaction was higher (9.0 ± 1.0 vs. 7.4 ± 1.3, $p = 0.002$), and complications like coughing, gagging, and desaturation were fewer but not statistically significant.

Conclusion

Atomized local anesthesia proved more effective than nebulized anesthesia for awake fiberoptic intubation, offering higher patient comfort, easier and quicker intubation, and greater satisfaction. Although complications were fewer with atomization, further research is needed. Thus, atomized anesthesia is recommended as the preferred method for AFOI.

Recommendations

Atomized local anesthesia is recommended for AFOI, particularly in patients with difficult airways, due to its higher efficacy and patient satisfaction. To validate these results and investigate long-term consequences, further extensive research is required.

Keywords: *Awake Fiberoptic Intubation, Atomized Anesthesia, Nebulized Anesthesia, Local Anesthesia, Airway Management, Patient Comfort.*
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INTRODUCTION

Awake fiberoptic intubation (AFOI) is a critical but safe procedure used for patients with anticipated difficult airways, where other methods of securing difficult airways (eg. SGA) are not feasible. The success of AFOI heavily depends on effective local anesthesia, which minimizes patient discomfort, prevents adverse hemodynamic changes, and facilitates the intubation process. Nebulization and atomization both have been widely used techniques for administering local anesthetics during AFOI. There is insufficient evidence to recommend one technique being superior to the others as there can be variable local anesthetic (LA) absorption based on the delivery device utilized, including but not limited to mucosal atomization, the spray-as-you-go (SAYGO) technique, transtracheal injection, and nebulization [1].

Nebulization delivers local anesthetic in the form of fine droplets through the patient's natural breathing process, making it a non-invasive and easy-to-administer technique.

Atomization, on the other hand, administers local anesthetic in a more targeted manner, often through high-pressure sprays that result in a fine mist of anesthetic. It produces LA particles finer than with nebulization.[2, 3] with minimal drug wastage and good intubation conditions.

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This study compares the efficacy of atomized versus nebulized local anesthesia for awake fiberoptic intubation in cases of anticipated difficult airway eg. Immobile cervical spine, faciomaxillary surgery, burn contracture & morbid obesity.

METHODOLOGY

Study Design

A prospective, randomized controlled study with an allocation ratio of 1:1. The participants were randomly assigned to either the atomized local anesthetic group (n = 35) or the nebulized local anesthetic group (n = 35).

Study Setting

The study took place at IQ City Medical College & Hospital, Durgapur over one year from August 2023 to August 2024.

Participants

A total of 70 adult patients who required elective awake fiberoptic intubation (AFOI) for various surgical procedures were enrolled in the study.

Inclusion Criteria

- Consent was obtained from all patients included in this study.
- Age 18 - 60 years, of both sexes.
- ASA class I, II and III.
- Anticipated difficult airway; SARI score ≥ 4, airway pathology, craniofacial abnormalities, or cervical spine instability.
- Scheduled for elective non-cardiac surgery requiring general anesthesia and endotracheal intubation.

Exclusion Criteria

- Patient refusal, uncooperative, and mentally retarded patients.
- Full stomach patients.
- Patients with nasal fractures or trauma, fracture base of the skull, bleeding disorder, epistaxis, or active oral bleeding.
- Active cough or respiratory tract infection and bronchial asthma.
- Allergy to lidocaine.
- Raised intracranial pressure or intraocular pressure.
- Cerebral aneurysm, history of recent acute myocardial infarction or cerebrovascular accident.

Bias

Randomization was employed to minimize selection bias. The individuals were assigned randomly to one of two groups (atomized local anesthetic group or nebulized local anesthetic group) using a computer-generated random number sequence. Blinding of the anesthesiologists performing the intubation and the patients were maintained to reduce performance and detection bias.

Data Collection

Data were collected using standardized forms that recorded patient demographics, anesthetic technique used, time for intubation, complications, and patient satisfaction scores. Each patient's vital signs, such as oxygen saturation, heart rate, and blood pressure, were monitored continuously during the procedure.

Procedure

Patients were assigned randomly to either the atomized or nebulized local anesthetic group. All patients' nasal mucosa was prepared with 1% Phenylephrine spray on the night before surgery. Proper consent with a detailed explanation of the procedure was obtained for each patient. In the preoperative area, Inj Glycopyrrolate 0.2mg and Inj Midazolam 1mg were administered after securing an intravenous cannula & attaching a standard ASA monitor.

In the atomized group, a modification of the McKenzie technique was used to atomize. One end of the oxygen bubble tubing was cut to fit into one connector of a 3-way tap. A 10-mL syringe filled with 2% lidocaine was attached to the other connector of the 3-way tap. The outer sheath of a 20 G IV cannula was attached to oxygen bubble tubing via the male Luer connector of the 3-way tap. The other end of the bubble tubing was then attached to an oxygen source turned on to deliver a flow of 6 L/min. As LA was slowly atomized as a jet-like spray, the cannula was directed toward the soft palate and posterior pharynx in a controlled fashion during the patients' inspiration to topicalize the airway. Patients were asked to take full vital capacity breaths of atomized LA-containing oxygen. Adequate topical anesthesia was confirmed by tongue heaviness or numbness.

In the nebulized group, 10ml of 2% Lignocaine was administered via a nebulizer facemask with an O2 flow rate of 8l/min. Patients were encouraged to inhale deeply and adequacy of nebulisation was indicated by numbness of tongue.

Transtracheal block with 3ml of injection lignocaine 4% was given in all patients in both groups.

After appropriate airway anesthesia was achieved, fiberoptic intubation was performed. The ease of intubation and patient discomfort were recorded during the procedure. TIME TAKEN FOR INTUBATION AND PATIENT SATISFACTION SCORE

Toxic doses of local anesthetic agents did not cross the allowable level in any group.

Awake nasal intubation was done using a flexible fibreoptic bronchoscope. Injection Fentanyl at 1mcg/kg was used as a rescue sedation when there was gagging or coughing.

The time taken to intubation was measured.

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Heart rate (HR), systolic (SBP), diastolic (DBP) blood pressure, and mean arterial pressure (MAP) were monitored at starting of the procedure, at starting intubation, after crossing vocal cords & 5 minutes after intubation.

The presence or absence of any episode of coughing, gagging, or head movement was taken as patient discomfort to be present or absent respectively.

Outcomes

The primary outcome was time taken to intubation and attempts for intubation whereas the Secondary outcome included patient satisfaction, adverse hemodynamic changes, and complications such as coughing, gagging, and desaturation.

Statistical Analysis

Data was analyzed using SPSS 21.0. Mean and standard deviations; frequencies and percentages were calculated. Statistical significance was achieved with p-values below 0.05.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULTS

Table 1: Demographic Profile

Variable	Atomized Group (A) (n=35)	Nebulized Group (N) (n=35)	p-value
Age (years) Mean (SD)	45.2 ± 11.9	46.4 ± 12.1	0.71
Male, n (%)	21 (60%)	23 (65.7%)	0.63
Female, n (%)	14 (40%)	12 (34.3%)	0.63
BMI (kg/m²) Mean (SD)	25.0 ± 3.2	24.7 ± 3.1	0.78

The study enrolled 70 adult patients (35 in each group). Both groups were similar in terms of age, gender distribution, and BMI. There were no statistically significant differences between the groups regarding demographic characteristics (Table 1).

Table 2: Primary Outcome - Time for Intubation & Attempts of Intubation

Variable	Atomized Group (n=35)	Nebulized Group (n=35)	p-value	95% CI
Time for Intubation (minutes)	4.9 ± 1.1	7.0 ± 1.5	<0.001	1.5 to 2.8
Number of Attempts for Intubation	1.2 ± 0.4	1.6 ± 0.6	<0.005	0.1 to 0.6
- First Attempt Success, (n, %)	30 (85.7%)	22 (62.9%)	-	-
- Second Attempt Success, (n, %)	5 (14.3%)	13 (37.1%)	-	-

The Time for Intubation was shorter in the atomized group (4.9 ± 1.1 minutes) compared to the nebulized group (7.0 ± 1.5 minutes, $p < 0.001$). Additionally, 85.7% of patients in the atomized group were successfully intubated on the first attempt, compared to 62.9% in the nebulized group. The remaining patients required a second attempt, with 14.3% in the atomized group and 37.1% in the nebulized group. This difference was statistically significant ($p = <0.005$), indicating that atomized anesthesia improves both intubation time and first-attempt success rates (Table 2).

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Table 3: Secondary Outcome: Haemodynamic surge

Variable	Atomized Group (n=35)	Nebulized Group (n=35)	p-value	95% CI
Increase in MAP (mmHg)				
At the start of the procedure	8.4 ± 1.6	9.1 ± 1.8	0.28	-0.6 to 2.0
At starting of intubation	10.2 ± 2.1	12.5 ± 2.3	0.03	1.1 to 3.8
After crossing the vocal cords	15.6 ± 2.7	18.1 ± 2.9	0.02	1.4 to 4.5
After 5 minutes of intubation	5.9 ± 1.5	7.8 ± 1.7	0.04	0.9 to 3.3
Increase in HR (beats per minute)				
At the start of the procedure	6.2 ± 1.4	6.8 ± 1.5	0.36	-0.3 to 1.5
At starting of intubation	9.5 ± 1.9	12.3 ± 2.1	0.01	1.4 to 4.4
After crossing the vocal cords	14.1 ± 2.4	16.9 ± 2.6	0.02	1.2 to 4.2
After 5 minutes of intubation	4.7 ± 1.3	6.5 ± 1.4	0.03	0.8 to 3.2

In the hemodynamic analysis, the atomized group exhibited a lower increase in mean arterial pressure (MAP) and heart rate (HR) compared to the nebulized group at critical stages of the procedure (Table 3).
At the start of intubation, the MAP increased by 10.2 ± 2.1 mmHg in the atomized group versus 12.5 ± 2.3 mmHg in the nebulized group (p=0.03), and after crossing the vocal cords, the MAP rise was 15.6 ± 2.7 mmHg compared to 18.1 ± 2.9 mmHg (p=0.02).
Similarly, HR increased by 9.5 ± 1.9 beats per minute (bpm) in the atomized group versus 12.3 ± 2.1 bpm in the nebulized group (p=0.01) at intubation, and after crossing the vocal cords, it rose to 14.1 ± 2.4 bpm compared to 16.9 ± 2.6 bpm (p=0.02). These results suggest that atomized anesthesia results in less hemodynamic stress during awake fiberoptic intubation.

Table 4: Secondary Outcome - Patient Satisfaction

Variable	Atomized Group (n=35)	Nebulized Group (n=35)	p-value	95% CI
Patient Satisfaction (Score out of 10)	9.0 ± 1.0	7.4 ± 1.3	0.002	0.7 to 2.5
Score 1 - Excellent, calm patient	22 (62.9%)	10 (28.6%)	0.001	-
Score 2 - Good, comfortable patient	10 (28.6%)	15 (42.9%)	0.20	-
Score 3 - Moderately comfortable	3 (8.6%)	10 (28.6%)	0.05	-

Patient comfort scores were higher in the atomized group (9.0 ± 1.0) compared to the nebulized group (7.4 ± 1.3), with statistical significance (p = 0.002) (Table 4). Notably, 62.9% of patients in the atomized group were rated as "Excellent" (calm patients), while only 28.6% in the nebulized group achieved this score. Additionally, fewer patients in the atomized group (8.6%) were moderately comfortable and needed pacifying compared to 28.6% in the nebulized group. This indicates superior comfort and tolerance in patients who received atomized anesthesia.

Table 5: Secondary Outcome - Complications

Complication	Atomized Group (n=35)	Nebulized Group (n=35)	p-value
Coughing n (%)	7 (20%)	12 (34.3%)	0.10
Gagging n (%)	4 (11.4%)	8 (22.9%)	0.15
Desaturation (SpO2 < 90%) n (%)	3 (8.6%)	6 (17.1%)	0.18

While the atomized group had fewer complications like coughing (20% vs. 34.3%), gagging (11.4% vs. 22.9%), and desaturation (8.6% vs. 17.1%), the differences were not statistically significant (Table 5).

DISCUSSION

The study comparing the efficacy of atomized versus nebulized local anesthesia for awake fiberoptic intubation (AFOI) enrolled 70 adult patients and randomized them into two groups (atomized and nebulized). The patients in both groups exhibited comparable demographic

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characteristics, with no statistically significant differences in terms of age, gender, or BMI, ensuring a balanced comparison (Table 1).

The time required for intubation was significantly shorter in the atomized group (4.9 ± 1.1 minutes) compared to the nebulized group (7.0 ± 1.5 minutes), with a p-value of <0.001. Additionally, first-attempt success was higher in the atomized group (85.7%) compared to the nebulized group (62.9%), with statistical significance (p = <0.005). This demonstrates that atomized anesthesia leads to faster intubation times and a higher likelihood of first-attempt success, indicating that it may be a more efficient method for delivering local anesthesia during AFOI (Table 2).

The atomized group experienced significantly lower increases in mean arterial pressure (MAP) and heart rate (HR) at critical points of the procedure. For example, at the start of intubation, MAP rose by 10.2 ± 2.1 mmHg in the atomized group versus 12.5 ± 2.3 mmHg in the nebulized group (p=0.03), and after crossing the vocal cords, the difference in MAP became even more pronounced (15.6 ± 2.7 mmHg vs. 18.1 ± 2.9 mmHg, p=0.02). Similarly, HR increases followed the same trend. These findings suggest that atomized local anesthesia results in less hemodynamic stress during AFOI, which can be beneficial for patients, particularly those with cardiovascular vulnerabilities (Table 3).

Patient satisfaction was notably higher in the atomized group. The average satisfaction score was 9.0 ± 1.0 in the atomized group compared to 7.4 ± 1.3 in the nebulized group (p=0.002). A larger percentage of patients in the atomized group (62.9%) were rated as "Excellent" (calm patients) compared to only 28.6% in the nebulized group. These results indicate that atomized local anesthesia offers a more comfortable and tolerable experience for patients, further supporting its effectiveness during AFOI (Table 4).

Although fewer complications such as coughing, gagging, and desaturation were observed in the atomized group, the differences were not statistically significant. The atomized group experienced lower rates of coughing (20% vs. 34.3%), gagging (11.4% vs. 22.9%), and desaturation (8.6% vs. 17.1%), which suggests a trend toward reduced complications with atomized anesthesia, even though the results did not reach statistical significance (Table 5).

The study suggests that atomized local anesthesia is more effective than nebulized anesthesia for AFOI, offering shorter intubation times, higher success rates on the first attempt, better patient satisfaction, and reduced hemodynamic stress. Although the differences in complications were not statistically significant, the atomized group had fewer occurrences of adverse events, pointing toward a potentially safer profile. These findings indicate that atomized local anesthesia could be a superior technique for AFOI in cases of anticipated difficult airway management.

A study compared airway anesthesia using nerve blocks and a local anesthesia atomizer in patients with cervical spine injuries. The study found that nerve blocks provided faster intubation times and reduced the frequency of coughing and gagging episodes compared to the atomizer, suggesting a potential advantage of nerve blocks for AFOI in such patients [4]. Similarly, a study compared airway nerve blocks and atomized lidocaine administered via the Laryngotracheal Mucosal Atomization Device (LMA MADgic) for AFOI. The findings indicated that nerve blocks resulted in faster intubation and less patient discomfort than atomized lidocaine, highlighting the effectiveness of nerve blocks in managing difficult airways [5].

Another study compared lignocaine nebulization with airway nerve blocks for awake fiberoptic bronchoscopy-guided nasotracheal intubation. The results demonstrated that nerve blocks provided superior anesthesia, leading to shorter intubation times and higher patient satisfaction when compared to nebulization. This study supports the use of nerve blocks as a preferred method for airway anesthesia in AFOI [6]. In contrast, a study focused on the administration routes of a combination of dexmedetomidine and ketamine, comparing the intravenous and nebulized routes for patients undergoing AFOI. Their findings suggested that the intravenous route was more effective than nebulization, resulting in faster intubation times and improved patient tolerance, indicating the importance of the administration route in optimizing AFOI conditions [7].

A systematic review and meta-analysis of randomized controlled trials assessed various protocols for AFOI in patients with anticipated difficult airways. They concluded that different methods for achieving local anesthesia performed similarly well, but dexmedetomidine might offer a better safety profile compared to other sedatives. The study found high efficacy and safety across the evaluated protocols, with minimal differences among them, suggesting flexibility in choosing anesthesia protocols for AFOI [8]. The research explored the use of airway blocks versus local anesthesia nebulization for AFOI in patients with oral malignancies. The study concluded that airway blocks facilitated successful fiber-optic intubation with fewer complications, indicating the effectiveness of nerve blocks in securing airways in complex cases [9].

A study compared nebulization with airway nerve blocks using lignocaine for awake fiberoptic nasotracheal intubation in oral cancer patients. They found that airway nerve blocks provided superior airway anesthesia, characterized by easier intubation and improved patient comfort compared to nebulization. The study suggests that while nebulization can be a suitable alternative when nerve blocks are not feasible, airway nerve blocks may offer better intubating conditions for AFOI [10].

Generalizability

The external validity and applicability of this trial's findings are somewhat limited due to its relatively small sample size and the specific setting of a single medical

institution. However, the study's results offer valuable insights into the effectiveness of atomized versus nebulized local anesthesia for awake fiberoptic intubation, particularly in patients with anticipated difficult airways. Given the similar demographic characteristics between groups and the standardized protocols used, the findings may apply to other surgical centers with comparable patient populations. Nevertheless, larger, multicenter trials would be required to generalize the results more broadly across diverse healthcare environments.

CONCLUSION

The study concludes that atomized local anesthesia is more effective than nebulized anesthesia for awake fiberoptic intubation in patients with difficult airways. It provides higher patient comfort, facilitates easier and quicker intubation, and results in greater patient satisfaction. While the atomized group showed a trend toward fewer complications, further research with larger samples is needed to confirm these findings. Overall, atomized anesthesia should be considered the preferred method for AFOI due to its superior efficacy and patient-centered benefits.

Limitations

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

Recommendation

Atomized local anesthesia is recommended for AFOI, particularly in patients with difficult airways, due to its higher efficacy and patient satisfaction. To validate these results and investigate long-term consequences, further extensive research is required.

Acknowledgment

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List of abbreviations

AFOI - Awake Fiberoptic Intubation
COPD - Chronic Obstructive Pulmonary Disease
BMI - Body Mass Index
CI - Confidence Interval
SpO2 - Peripheral Oxygen Saturation

Source of funding

No funding was received.

Conflict of interest

The authors have no conflicting interests to declare.

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