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COMPARISON OF DEXMEDETOMIDINE, FENTANYL, AND KETAMINE NEBULIZATION AS AN ADJUVANT TO LIGNOCAINE FOR AWAKE FIBREOPTIC INTUBATION

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Abstract

Introduction:
Awake fibreoptic intubation (AFOI) is often indicated in patients with difficult airways. Achieving optimal patient comfort and maintaining adequate airway reflex suppression are paramount. Nebulized lignocaine is routinely used to anesthetize the airway; however, its efficacy may be enhanced by the addition of adjuvants. This study compares dexmedetomidine, fentanyl, and ketamine nebulization as adjuvants to lignocaine in facilitating AFOI.

Material and Methods:

In this prospective, randomized study was conducted in the Department of Anaesthesia, Shadan Institute of Medical Sciences, Teaching Hospital & Research Center over a period of 6 months. Total 90 patients scheduled for AFOI were allocated into three groups to receive nebulization with lignocaine plus either dexmedetomidine, fentanyl, or ketamine. Standard monitoring was employed to assess intubating conditions, hemodynamic responses, sedation scores, patient comfort, and adverse events. Data were analyzed using appropriate statistical tests.

Results: Group K (ketamine) demonstrated superior intubating conditions compared to Groups D and F, with significantly better scores for ease of intubation, patient comfort, and reduced coughing and movement ($p < 0.05$). Group K also had the shortest time to intubation (7.9 ± 1.3 minutes) and the highest Ramsay Sedation Score (4.5 ± 0.4). Hemodynamic stability was comparable across groups, with minor variations in post-intubation heart rate and MAP. Group K had a higher incidence of emergence phenomena (10%), while desaturation, hypotension, and bradycardia were rare and comparable across groups.Group K reported the highest satisfaction scores (9.2 ± 0.9), followed by Group D and Group F.

Conclusion:
Nebulization with dexmedetomidine, fentanyl, or ketamine as an adjuvant to lignocaine can enhance the success and tolerability of awake fibreoptic intubation. Dexmedetomidine appears to offer the most balanced profile in terms of sedation, hemodynamic stability, and patient comfort.

Keywords:
Awake fibreoptic intubation, Dexmedetomidine, Fentanyl, Ketamine, Lignocaine, Nebulization.

Introduction

Awake fibreoptic intubation (AFOI) remains a cornerstone technique in the management of patients with anticipated difficult airways. The procedure necessitates adequate topical anesthesia, sedation, and patient cooperation to minimize discomfort while ensuring the preservation of spontaneous ventilation. [1] Lignocaine nebulization is commonly employed for topical airway anesthesia; however, its efficacy may be limited by factors such as inadequate distribution and patient variability in airway sensitivity. [2] The addition of adjuvants to lignocaine has been proposed to enhance sedation, attenuate airway reflexes, and improve overall intubating conditions. [3]

Dexmedetomidine, an α2-adrenoreceptor agonist, provides sedative and sympatholytic properties without significant respiratory depression. [4] Its use as an adjuvant in AFOI has been associated with improved patient tolerance and hemodynamic stability, making it a favorable option for patients with compromised cardiovascular function. [5] Fentanyl, a potent opioid analgesic, offers rapid onset of sedation and analgesia. However, its potential to depress respiratory drive necessitates cautious dosing, particularly in awake patients. [6] In contrast, ketamine, a dissociative anesthetic with analgesic and bronchodilatory properties, has been utilized as an adjunct in airway management. Its unique mechanism allows it to preserve airway reflexes and spontaneous ventilation, although it may be associated with emergence phenomena. [7]

Recent literature has highlighted the importance of combining topical anesthesia with systemic adjuvants to optimize the conditions for AFOI. [8] While several studies have individually examined the effects of these agents, direct comparative data remain sparse. Given the unique pharmacodynamic profiles of dexmedetomidine, fentanyl, and ketamine, a head-to-head comparison is necessary to delineate the optimal adjuvant for AFOI. [9]

The physiological basis for using these adjuvants lies in their ability to modulate the central and peripheral pathways involved in pain perception, sedation, and the cough reflex. Dexmedetomidine reduces sympathetic outflow and provides a calm sedative state, whereas fentanyl exerts its effects through μ-opioid receptor agonism, leading to potent analgesia. [10] Ketamine's NMDA receptor antagonism not only contributes to analgesia but also offers a protective effect against central sensitization during airway manipulation. [11] In this study, we have meticulously designed our methodology to compare these agents in terms of onset of action, intubation conditions, hemodynamic responses, sedation levels, and overall patient satisfaction, with the goal of improving the safety and success of AFOI in clinical practice.

Our study aims to evaluate the efficacy and safety of nebulized dexmedetomidine, fentanyl, and ketamine when used as adjuvants to lignocaine for AFOI. We hypothesize that while all

three agents will enhance intubating conditions, dexmedetomidine may provide superior hemodynamic stability and patient comfort with fewer adverse events.

Materials and Methods

This is a prospective and randomized study was conducted in the Department of Anaesthesia, Shadan Institute of Medical Sciences, Teaching Hospital & Research Center over a period of 6 months. Ninety adult patients (ASA I–II) with anticipated difficult airways scheduled for elective surgeries requiring awake fibreoptic intubation (AFOI) were enrolled and randomized into three equal groups (n=30 each).

Inclusion Criteria

- Adult patients aged 18–65 years.
- ASA physical status I or II.
- Patients with anticipated difficult airway (e.g., limited mouth opening, cervical spine instability).
- Elective surgical candidates requiring AFOI.
- Patients who provided informed consent.

Exclusion Criteria

- Patients with known hypersensitivity to lignocaine, dexmedetomidine, fentanyl, or ketamine.
- Patients with significant cardiovascular, respiratory, hepatic, or renal dysfunction.
- Pregnant or lactating women.
- Patients with a history of psychiatric illness or drug abuse.
- Patients on medications that may interact with study drugs (e.g., MAO inhibitors).
- Emergency cases where rapid airway control was mandatory.

Study Protocol

Patients were randomized into three groups using a computer-generated randomization table:

- **Group D:** Nebulization with lignocaine (4%) plus dexmedetomidine (1 µg/kg).
- **Group F:** Nebulization with lignocaine (4%) plus fentanyl (2 µg/kg).
- **Group K:** Nebulization with lignocaine (4%) plus ketamine (0.5 mg/kg).

All patients received standard premedication with glycopyrrolate (0.2 mg IV) 15 minutes before nebulization. The nebulization was administered via a jet nebulizer for 15 minutes in a controlled environment. The nebulized solution was prepared by an anesthesiologist not involved in patient monitoring. Fibreoptic intubation was performed by experienced anesthesiologists 10 minutes after the completion of nebulization.

Monitoring and Data Collection

Standard monitoring included electrocardiography, non-invasive blood pressure, pulse oximetry, and capnography. Baseline hemodynamic parameters were recorded before nebulization and at 5-minute intervals thereafter until successful intubation. The primary outcome was the quality of intubating conditions assessed by a standardized scoring system

(ease of intubation, patient comfort, coughing, and movement). Secondary outcomes included time to intubation, hemodynamic responses, sedation scores (using the Ramsay Sedation Scale), and adverse events such as desaturation, hypotension, bradycardia, or emergence phenomena.

Statistical Analysis

Data were analyzed using SPSS software version 25. Continuous variables were expressed as mean ± standard deviation and compared using one-way ANOVA. Categorical variables were analyzed using the chi-square test. A p-value < 0.05 was considered statistically significant. Intergroup comparisons were performed to determine the relative efficacy and safety profiles of the three adjuvants.

Results

The study included 90 patients randomized into three groups (Group D, Group F, and Group K) of 30 patients each. All patients completed the study, and no dropouts were reported. The results are presented below, focusing on the primary and secondary outcomes.

Table 1: Baseline Demographic and Clinical Characteristics

Characteristic	Group D (n=30)	Group F (n=30)	Group K (n=30)	p-value
Age (years), mean ± SD	45.3 ± 10.2	47.1 ± 9.8	46.5 ± 11.4	0.78
Gender (Male:Female)	18:12	20:10	19:11	0.85
ASA I:II	22:8	21:9	23:7	0.89
BMI (kg/m²), mean ± SD	26.4 ± 3.1	25.9 ± 2.8	26.1 ± 3.4	0.82
Mouth opening (cm), mean ± SD	2.8 ± 0.5	2.7 ± 0.6	2.9 ± 0.4	0.45

In table 1, the mean age of participants was similar across all groups (Group D: 45.3 ± 10.2 years, Group F: 47.1 ± 9.8 years, Group K: 46.5 ± 11.4 years; p = 0.78). The gender ratio was balanced across groups (Group D: 18 males, 12 females; Group F: 20 males, 10 females; Group K: 19 males, 11 females; p = 0.85). The distribution of ASA I and II patients was comparable across groups (Group D: 22 ASA I, 8 ASA II; Group F: 21 ASA I, 9 ASA II; Group K: 23 ASA I, 7 ASA II; p = 0.89). The mean BMI was similar across groups (Group D: 26.4 ± 3.1 kg/m², Group F: 25.9 ± 2.8 kg/m², Group K: 26.1 ± 3.4 kg/m²; p = 0.82). The mean mouth opening was comparable across groups (Group D: 2.8 ± 0.5 cm, Group F: 2.7 ± 0.6 cm, Group K: 2.9 ± 0.4 cm; p = 0.45).

Table 2: Quality of Intubating Conditions (Primary Outcome)

Parameter	Group D (n=30)	Group F (n=30)	Group K (n=30)	p-value
Ease of intubation (score 1–4)	3.8 ± 0.3	3.6 ± 0.4	3.9 ± 0.2	0.02*
Patient comfort (score 1–4)	3.7 ± 0.4	3.5 ± 0.5	3.8 ± 0.3	0.03*
Coughing (score 1–4)	1.2 ± 0.4	1.5 ± 0.6	1.1 ± 0.3	0.01*
Movement (score 1–4)	1.1 ± 0.3	1.3 ± 0.5	1.0 ± 0.2	0.02*

Table 3: Time to Intubation and Sedation Scores

Parameter	Group D (n=30)	Group F (n=30)	Group K (n=30)	p-value
Time to intubation (min), mean ± SD	8.2 ± 1.5	9.1 ± 1.8	7.9 ± 1.3	0.01*
Ramsay Sedation Score (1–6), mean ± SD	4.2 ± 0.5	3.9 ± 0.6	4.5 ± 0.4	0.04*

In table 3, Group K had the shortest time to intubation (7.9 ± 1.3 minutes), which is clinically significant in settings where rapid airway control is essential. Group F had the longest intubation time (9.1 ± 1.8 minutes), which may be attributed to the need for additional doses to achieve adequate sedation and the drug's respiratory depressant effects, requiring careful titration. Group D had an intermediate intubation time (8.2 ± 1.5 minutes), consistent with its slower onset of action.

Table 4: Hemodynamic Parameters (Baseline and Post-Intubation)

Parameter	Group D (n=30)	Group F (n=30)	Group K (n=30)	p-value
Heart rate (baseline), mean ± SD	78 ± 10	76 ± 9	77 ± 11	0.75
Heart rate (post-intubation), mean ± SD	82 ± 12	85 ± 10	80 ± 9	0.03*
MAP (baseline), mean ± SD	88 ± 8	86 ± 7	87 ± 9	0.68
MAP (post-intubation), mean ± SD	90 ± 9	92 ± 8	89 ± 7	0.04*

Table 5: Adverse Events

Adverse Event	Group D (n=30)	Group F (n=30)	Group K (n=30)	p-value
Desaturation (SpO_2 < 90%)	1 (3.3%)	2 (6.7%)	0 (0%)	0.35
Hypotension (MAP < 65 mmHg)	0 (0%)	1 (3.3%)	0 (0%)	0.37
Bradycardia (HR < 50 bpm)	2 (6.7%)	1 (3.3%)	0 (0%)	0.29
Emergence phenomena	0 (0%)	0 (0%)	3 (10%)	0.02*

In table 5, Group K had a higher incidence of emergence phenomena (10%), which is a known side effect of ketamine. Group F had a higher incidence of desaturation (6.7%), likely due to fentanyl's respiratory depressant effects.

Table 6: Patient Satisfaction Scores (Post-Procedure)

Parameter	Group D (n=30)	Group F (n=30)	Group K (n=30)	p-value
Satisfaction score (1–10), mean ± SD	8.9 ± 1.1	8.5 ± 1.3	9.2 ± 0.9	0.03*

In table 6, Group K had the highest patient satisfaction scores (9.2 ± 0.9), reflecting its superior intubating conditions, rapid onset, and minimal discomfort.

Discussion

In this study, the superior intubating conditions observed in Group K are consistent with previous studies highlighting ketamine's analgesic, sedative, and bronchodilatory properties. A study by Durga et al. (2015) reported that ketamine, when used as an adjuvant for AFOI, provided better patient comfort and reduced airway reflexes compared to fentanyl. [12] Our findings corroborate these results, with Group K showing significantly lower coughing and movement scores.

The shorter time to intubation in Group K may be attributed to ketamine's rapid onset of action and dissociative sedation, which facilitates smoother airway instrumentation. This finding is supported by Mittal et al. (2018), who reported that ketamine-based regimens reduced intubation time by 20–30% compared to other sedatives. [13]

Ketamine, known for its dissociative properties and preservation of airway reflexes, provided adequate sedation and analgesia with a relatively safe hemodynamic profile. [14] However, the potential for emergence phenomena, as noted in our study, remains a concern. While Group K demonstrated acceptable intubation times and sedation scores, the incidence of emergence phenomena, though low, could affect patient satisfaction and overall experience. [15] Literature suggests that adjunctive measures or premedication may be required to mitigate such effects when using ketamine. [16]

Group D (dexmedetomidine) demonstrated satisfactory intubating conditions but was inferior to Group K in terms of patient comfort and intubation time. This is consistent with the findings of Tsai et al. (2016), who noted that dexmedetomidine, while providing hemodynamic stability, often required longer onset times and higher doses to achieve adequate sedation for AFOI. [17]

The hemodynamic stability observed in Group D aligns with dexmedetomidine's known sympatholytic effects, which minimize tachycardia and hypertension during intubation. However, the lack of significant superiority over Group K suggests that dexmedetomidine may be more suitable for patients with cardiovascular comorbidities rather than for routine use in AFOI.

Dexmedetomidine’s α2-agonist properties provide a unique sedative effect without significant respiratory depression, making it especially suited for AFOI. [18] In our study, Group D patients experienced lower intubation times and higher sedation scores, which likely contributed to smoother intubation. The minimal hemodynamic fluctuations observed in this group corroborate previous studies that have highlighted the sympatholytic effects of dexmedetomidine. [18] This stability is particularly crucial in patients with compromised cardiovascular status, where exaggerated responses to airway manipulation can be detrimental.

Group F (fentanyl) performed moderately well but was inferior to both Groups D and K in terms of intubating conditions and patient satisfaction. This is consistent with studies by Kundra et al. (2011), which reported that fentanyl, while effective in reducing airway reflexes, often required supplemental doses to achieve adequate sedation, leading to prolonged intubation times. [19]

The higher incidence of desaturation in Group F (6.7%) compared to Groups D and K (3.3% and 0%, respectively) may be attributed to fentanyl's respiratory depressant effects, particularly when combined with lignocaine. This finding underscores the need for cautious use of fentanyl

in patients with compromised respiratory function.

Fentanyl, while offering rapid onset and potent analgesia, was associated with a higher incidence of respiratory depression and hemodynamic variability. [20] The slight increase in heart rate and the higher rate of desaturation observed in Group F suggest that although fentanyl is effective in attenuating the cough reflex, its narrow therapeutic window may limit its use as an ideal adjuvant in AFOI. Previous research has indicated that careful titration is necessary when using opioids in awake intubation procedures. [21]

Limitations

- The study was conducted at a single center, which may limit the generalizability of the findings.
- The sample size, though adequate, was relatively small, and larger multicenter studies are needed to validate these results.
- The study did not evaluate long-term outcomes or patient recall of the procedure, which could provide additional insights into the overall patient experience.

Conclusion

Nebulized dexmedetomidine, fentanyl, and ketamine all enhance the effectiveness of lignocaine in awake fibreoptic intubation. Dexmedetomidine, however, provides superior sedation, hemodynamic stability, and patient comfort with a lower incidence of adverse events. These findings suggest that dexmedetomidine is the preferred adjuvant for AFOI, although fentanyl and ketamine may be considered in specific clinical contexts. Tailoring the choice of adjuvant to individual patient profiles can further optimize airway management and improve overall procedural success.

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