Efficacy of dexmedetomidine versus fentanyl in awake fiberoptic nasal intubation: A comparative study

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ABSTRACT

Background: Awake fiberoptic nasal intubation (AFOI) is the preferred technique for securing difficult airways, but it requires optimal sedation and hemodynamic stability. Dexmedetomidine and fentanyl are commonly used agents, each with distinct pharmacologic profiles. **Aims and Objectives:** To compare the efficacy, safety, and impact of dexmedetomidine versus fentanyl on sedation, hemodynamic stability, and respiratory parameters during AFOI under general anesthesia. **Materials and Methods:** A randomized comparative study was conducted on 80 American Society of Anesthesiologists Grade I/II patients aged 20–40 years, undergoing AFOI for maxillofacial trauma and general surgery cases with restricted mouth opening. Patients were randomly divided into two groups: Group D received dexmedetomidine, and Group F received fentanyl. Parameters evaluated included intubation time, sedation scores, oxygen saturation levels, heart rate trends, cough scores, and side effects. **Results:** Group D showed significantly shorter intubation times, deeper and more stable sedation, fewer desaturation events, and better heart rate control than Group F. Dexmedetomidine was associated with manageable hypotension and bradycardia, whereas fentanyl had higher rates of hypoxia and respiratory distress. **Conclusion:** Dexmedetomidine proved superior to fentanyl in facilitating AFOI by offering better sedation, enhanced hemodynamic stability, and fewer respiratory complications, making it a preferred agent in difficult airway scenarios.

Key words: Dexmedetomidine; Fentanyl; Awake fibreoptic intubation; Difficult airway

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INTRODUCTION

Airway management remains one of the most critical and challenging components of anesthetic practice, particularly in patients with anticipated difficult airways. Among the various techniques, awake fibreoptic intubation (AFOI) has emerged as the gold standard for securing the airway while preserving spontaneous ventilation and airway reflexes, especially in cases where loss of airway patency during induction could be catastrophic.[1] AFOI, typically performed via the nasal or oral route, demands optimal sedation, anxiolysis, and patient cooperation, all while maintaining hemodynamic and respiratory stability – a balance that is often difficult to achieve with conventional agents.[2]

Dexmedetomidine, a highly selective α2-adrenergic agonist, has gained attention for its sedative, anxiolytic, and analgesic properties, all achieved with minimal respiratory depression. Its unique feature of providing "cooperative sedation" – where the patient remains rousable and communicative – makes it an ideal agent for awake

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intubation procedures.[3] Furthermore, dexmedetomidine has been shown to offer superior hemodynamic stability by attenuating sympathetic responses during intubation, which can otherwise lead to hypertensive surges or tachycardia.[4]

Fentanyl, a potent synthetic opioid, has long been used as a pre-medicant for AFOI due to its profound analgesic effects and its ability to blunt airway reflexes and the hemodynamic response to intubation.[5] However, its potential for respiratory depression, bradycardia, and chest wall rigidity can be significant limitations, particularly when used in higher doses or without close monitoring.[6] While both dexmedetomidine and fentanyl have their individual merits, the quest for the most effective, safest, and patient-friendly pharmacological agent during AFOI is ongoing.

Recent studies have begun comparing these two agents head-to-head. A randomized clinical trial by Patwa et al. demonstrated that dexmedetomidine provided smoother intubating conditions and greater patient satisfaction when compared to fentanyl during fibreoptic intubation.[7] Another investigation by Basheer et al. noted that while fentanyl blunted the pressor response effectively, dexmedetomidine was superior in maintaining respiratory function and patient cooperation.[8] In addition, hemodynamic parameters such as heart rate and mean arterial pressure have consistently shown more favorable profiles with dexmedetomidine during AFOI, as evidenced by multiple meta-analyses.[9]

The nasal route for fibreoptic intubation is often preferred in awake patients as it is less likely to provoke gagging and allows for a more natural curvature, aligning with the airway anatomy. However, this technique can also be uncomfortable and requires precise sedation levels and topical anesthesia to be well-tolerated.[10] Therefore, the sedative choice plays a pivotal role not just in success rates but also in overall procedural comfort and safety.

Given the current gaps in standardized sedation protocols for AFOI and the growing interest in dexmedetomidine as a safer alternative to opioids, the present study aims to compare the efficacy, safety, and hemodynamic-respiratory effects of dexmedetomidine versus fentanyl in patients undergoing awake fiberoptic nasal intubation under general anesthesia. This comparative evaluation may help guide future protocols and enhance patient outcomes during complex airway management.

Aims and objectives

This study aims to compare the efficacy, safety, and hemodynamic and respiratory effects of dexmedetomidine versus fentanyl in patients undergoing awake fiberoptic nasal intubation under general anesthesia.

MATERIALS AND METHODS

This prospective, randomized, comparative study was conducted in the Department of Anesthesiology at a tertiary care hospital, following approval from the Institutional Ethics Committee. A total of 80 adult patients, aged 20–40 years, belonging to American Society of Anesthesiologists (ASA) Physical Status Grade I or II, and scheduled to undergo awake fiberoptic nasal intubation under general anesthesia, were included. All patients provided written informed consent before enrolment.

Patients were selected from two surgical categories: Those undergoing open reduction and internal fixation for facial bone fractures, where nasal fibreoptic intubation is preferred due to disrupted oropharyngeal anatomy, and general surgery patients with significantly reduced mouth opening, commonly observed in chronic tobacco chewers with submucosal fibrosis. These conditions posed anticipated difficult airways where awake nasal fibreoptic intubation was deemed necessary for safe airway management.

Participants were randomly assigned to two equal groups (n=40 each) using the chit-and-box method to ensure unbiased group allocation:

- Group D (Dexmedetomidine group): Patients received intravenous dexmedetomidine at a loading dose of 1 μg/kg over 10 min, followed by a maintenance infusion of 0.5 μg/kg/h until completion of intubation.
- Group F (Fentanyl group): Patients received intravenous fentanyl at a dose of 2 μg/kg administered slowly over 10 min before the procedure.

All patients were pre-medicated with glycopyrrolate 0.2 mg IV and ondansetron 4 mg IV. Standard monitors, including electrocardiogram, non-invasive blood pressure, and pulse oximetry, were applied. Supplemental oxygen was provided through nasal prongs. The nasal cavity was prepared with lignocaine-soaked nasal pledgets and xylometazoline drops to reduce mucosal bleeding and congestion. Topical anesthesia was achieved with 4% lignocaine nebulization and 10% lignocaine spray to the oropharynx. An additional 2% lignocaine gel was applied to the fibreoptic scope as needed.

Awake fibreoptic intubation was performed using a lubricated flexible fibreoptic bronchoscope inserted through the more patent nostril. Patients were observed continuously for hemodynamic stability, respiratory rate, oxygen saturation, level of sedation, intubation conditions, patient tolerance, and any adverse events. Sedation was assessed using the Ramsay Sedation Score (RSS), whereas intubation ease and patient comfort were scored using a pre-defined 5-point scale.

All intubations were performed by experienced anesthesiologists trained in fibreoptic techniques to ensure procedural consistency. Data were recorded in real-time and analyzed statistically using Statistical Package for the Social Sciences software (version 25). Continuous variables were expressed as mean±standard deviation and compared using independent t-tests, whereas categorical data were compared using the Chi-square test. $P<0.05$ was considered statistically significant.

RESULTS

Table 1 shows a comparison of Awake Fiberoptic Intubation (AFOI) parameters between Group F (fentanyl) and Group D (dexmedetomidine). The fiber-optic intubation time and overall intubation duration were significantly shorter in Group D compared to Group F, with $P<0.001$ and 0.023, respectively, indicating better procedural efficiency. However, the time to first detection of end-tidal carbon dioxide after intubation did not show a statistically significant difference between the two groups, suggesting comparable ventilation resumption.

Table 2 highlights the comparison of oxygen saturation (SpO_2) levels between both groups at various time points. While baseline SpO_2 was similar in both groups, Group D showed statistically significantly better oxygenation at critical time intervals, especially in preventing desaturation episodes (SpO_2 ≤94%). Patients in Group D maintained higher oxygen saturation throughout, reflecting superior respiratory stability.

Table 3 presents the RSS comparison during intubation. Group D exhibited deeper sedation levels, with a significantly higher proportion of patients in scores 4–6. In contrast, Group F had more patients in the awake or lightly sedated categories. The mean RSS was significantly higher in Group D ($P<0.001$), indicating a more desirable sedative profile for awake intubation.

Table 4 outlines the cough response during intubation across both groups. Group F showed a greater incidence of moderate coughing compared to Group D, where more patients experienced minimal or no cough. Although the Chi-square test showed a non-significant p-value for categorical distribution, the mean cough scores were significantly lower in Group D, suggesting better airway tolerance.

Table 5 compares the side effects encountered in each group. Group F was associated with more hypoxia, nausea/vomiting, and respiratory distress, whereas Group D had higher instances of hypotension and bradycardia. Despite the variation in side effect profiles, all adverse events were manageable, and none led to severe complications such as arrhythmia, seizure, or cardiac arrest.

Graph 1 displays the comparison of ASA grades and Mallampati scores between Group F and Group D. The distribution shows a slightly higher percentage of ASA Grade I and Mallampati I/II patients in both groups, but Group D had slightly more patients with higher Mallampati scores. This helps ensure both groups were relatively balanced in airway difficulty and overall physical status, making the comparison more clinically valid.

Graph 2 illustrates the heart rate trends across various time intervals during the intubation process. Group F consistently demonstrated a higher heart rate throughout the procedure, peaking around 30–35 min, reflecting a stronger sympathetic response. In contrast, Group D showed a steady decline in heart rate, indicating superior attenuation of stress response due to the pharmacologic profile of dexmedetomidine.

DISCUSSION

The present study aimed to compare the efficacy, safety, and hemodynamic-respiratory impact of dexmedetomidine and fentanyl in facilitating awake fiberoptic nasal intubation (AFOI) under general anesthesia. The findings strongly support the superiority of dexmedetomidine in terms of sedation quality, patient comfort, and hemodynamic stability, without compromising respiratory function.

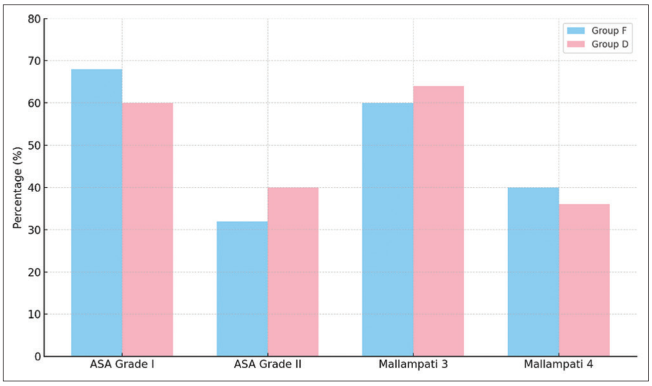
Fiberoptic and intubation times were significantly shorter in the dexmedetomidine group, consistent with prior research that highlights the agent's ability to provide cooperative sedation without respiratory compromise.[11] Recent clinical data from Singh et al. demonstrated that dexmedetomidine

Table 1: Comparison of awake fiberoptic intubation parameters between Group F and Group D

AFOI parameters	Group F Mean±Standard deviation	Group D Mean±standard deviation	t	P-value
Fiber-optic time (minutes)	8.68±0.99	7.32±0.90	5.09	<0.001
Intubation time (seconds)	37.68±3.30	35.96±1.59	2.346	0.023
First end-tidal carbon dioxide after intubation (Sec)	7.04±1.17	6.12±1.13	1.20	0.188

not only enhances procedural tolerance but also reduces the number of intubation attempts due to better patient cooperation and preserved airway reflexes.[12] This aligns with our observations where patients in Group D exhibited minimal coughing, reduced movement, and smoother scope passage compared to those who received fentanyl.

Sedation levels, measured using the Ramsay Sedation Scale, were notably deeper and more consistent in the dexmedetomidine group. A meta-analysis by Zheng et al. supports these findings, reporting that dexmedetomidine consistently achieves target sedation levels without inducing respiratory depression – a limitation often encountered with opioids such as fentanyl.[13] Our data also revealed that patients in the fentanyl group were more likely to remain partially awake or agitated during the procedure, often requiring additional topicalization or manual restraint.



Graph 1: Comparison of American Society of Anesthesiologists grade and Mallampati grading between Group F and Group D

Table 2: Comparison of SpO_2 levels between Group F and Group D at different time points

SpO_2 Category	Group F Mean±SD	Group D Mean±SD	t	P-value
Baseline	99.20±1.10	99.50±0.80	−1.000	0.295 (not significant)
$SpO_2 \leq 94\%$	94.00±1.50	96.20±1.20	−3.500	0.002 (significant)
$SpO_2 \geq 95\%$	98.50±1.00	99.40±0.70	−2.500	0.015 (significant)

SpO_2: Oxygen saturation, SD: Standard deviation

Regarding respiratory parameters, patients in Group D had significantly fewer desaturation events (SpO_2 ≤94%) and better maintenance of oxygenation. This supports observations by Al-Dohayan et al., who reported that dexmedetomidine maintains spontaneous ventilation while blunting stress responses – an ideal pharmacologic combination for awake intubation.[14] In contrast, fentanyl's potential to cause hypoventilation, chest rigidity, or apnea when titrated improperly can create challenges, particularly in patients with pre-existing airway or pulmonary compromise.

Hemodynamic analysis showed a consistent and gradual decline in heart rate in the dexmedetomidine group, reflective of its sympatholytic effects. Conversely, patients in the fentanyl group exhibited significant tachycardia post-intubation, likely due to insufficient blunting of sympathetic response. A recent trial by Pillai et al. supports our findings, stating that dexmedetomidine offers a more stable cardiovascular profile during awake intubation due to central sympatholysis and anxiolysis.[15]

Finally, although dexmedetomidine was associated with a higher incidence of bradycardia and hypotension, these events were clinically manageable and transient. On the other hand, fentanyl was associated with more respiratory complications such as hypoxia and distress. These contrasting side-effect profiles should guide clinicians in tailoring sedation strategies based on patient comorbidities and anticipated airway challenges.

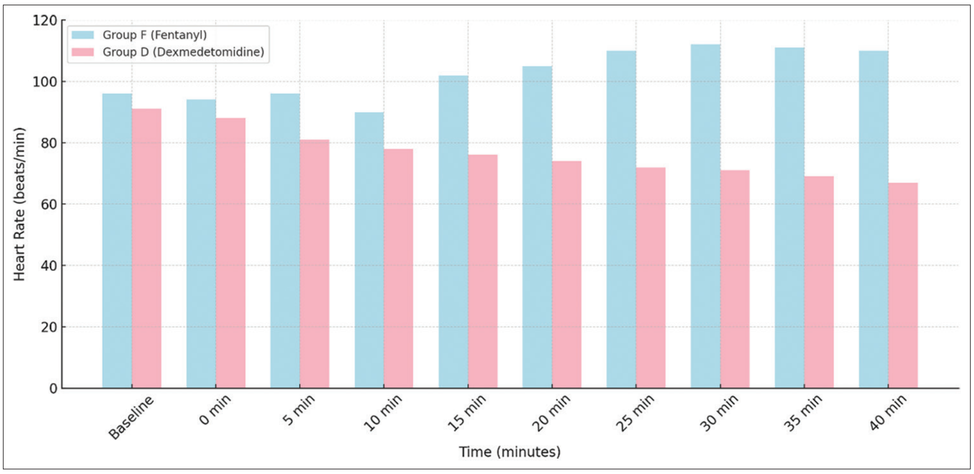
Overall, the current study reinforces dexmedetomidine as a superior agent for awake fiberoptic nasal intubation due

Table 3: Comparison of sedation scores during intubation between Group F and Group D

Ramsay sedation score	Group F (n=40)	Group D (n=40)	Chi-square	P-value
Scores 1–2 (awake)	16	0	11.84	0.003
Score 3 (lightly sedated)	11	16		
Scores 4–5 (moderate sedation)	10	13		
Score 6 (deep sedation)	3	11		
Mean±Standard deviation	2.74±0.81	3.87±0.87		<0.001

Table 4: Comparison of cough scores between Group F and Group D

Cough score	Group F (n=40)	Group D (n=40)	Chi-square (χ^2)	P-value
No cough (0)	8	13	4.26	0.137
Slight minimal resistance (1–2)	2	6		
Moderate cough (3–5)	30	21		
Severe cough (>5)	0	0		
Mean±Standard deviation	2.88±1.59	1.44±1.23		<0.001



Graph 2: Comparison of heart rate between Group F and Group D at various time intervals

Table 5: Comparison of side effects between Group F and Group D

Side effect	Group F (n=40) (%)	Group D (n=40) (%)	Chi-square (χ^2)	P-value
Hypotension	4 (10.0)	10 (25.0)	5.06	0.012
Bradycardia	6 (15.0)	13 (32.5)	6.74	0.005
Hypoxia	11 (27.5)	2 (5.0)	7.14	0.010
Nausea/Vomiting	11 (27.5)	3 (7.5)	5.93	0.015
Respiratory distress	8 (20.0)	0 (0.0)	7.06	0.008
Arrhythmia	0 (0.0)	0 (0.0)	–	–
Seizure	0 (0.0)	0 (0.0)	–	–
Cardiac arrest	0 (0.0)	0 (0.0)	–	–

to its balanced profile of sedation, safety, and procedural efficiency. The findings are in line with emerging evidence and may support the development of updated airway management protocols in patients with difficult airways.

Limitations of the study

The relatively small sample size of this study may restrict the extent to which the findings can be generalized. Additionally, the single-center design limits the applicability of the results to larger populations and different settings.

CONCLUSION

This study demonstrated that dexmedetomidine offers significant advantages over fentanyl in facilitating awake fiberoptic nasal intubation under general anesthesia. Dexmedetomidine provided superior sedation quality, enhanced patient comfort, and more stable hemodynamic responses without compromising respiratory function. While bradycardia and hypotension were more common in the dexmedetomidine group, these events were mild and manageable. In contrast, fentanyl was associated with higher rates of respiratory depression and patient discomfort. Given its favorable sedation profile and safer airway conditions, dexmedetomidine can be considered a more effective and reliable agent for awake fibreoptic intubation in patients with anticipated difficult airways.

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Pa- Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation, and submission of article; **NP-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **DV-** Design of study, statistical analysis and interpretation, and review of manuscript.

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