Original Article

Comparative Study of Fentanyl–Propofol Versus Fentanyl–Dexmedetomidine for Intravenous Anaesthesia During Upper Gastrointestinal Endoscopy

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Abstract

Background: Upper GI endoscopy is increasingly being used for diagnosis of gastrointestinal conditions. It requires intravenous sedation or anesthesia to improve patients' comfort and procedural conditions. Propofol provides rapid onset and recovery but may cause respiratory depression. Dexmedetomidine provides sedation with relative preservation of respiratory functions but is associated with bradycardia and delayed recovery. The current study aimed to compare the efficacy, hemodynamic stability, and recovery characteristics of fentanyl–propofol and fentanyl–dexmedetomidine for intravenous anesthesia during upper gastrointestinal endoscopy. **Material and Methods:** This prospective comparative observational study was done on n=60 adult patients undergoing upper gastrointestinal endoscopy. Patients were divided into Group FP (n=30), who received fentanyl–propofol, and Group FD (n=30), who received fentanyl–dexmedetomidine. Heart rate, blood pressure, respiratory rate, peripheral oxygen saturation, adverse events, time to regain consciousness, and time to discharge were recorded and compared between the groups. **Results:** Baseline demographic and clinical characteristics were comparable between the groups. The overall mean heart rate was significantly higher in Group FP than Group FD (86.4 ± 9.7 vs. 75.2 ± 8.1 beats/min), p<0.001, while overall blood pressure parameters were comparable. Group FD demonstrated a significantly higher respiratory rate (15.3 ± 2.1 vs. 14.1 ± 2.5 breaths/min), p=0.04, and peripheral oxygen saturation (97.8 ± 1.0% vs. 96.2 ± 1.8%), p<0.001. Bradycardia was significantly more frequent in Group FD (26.7% vs. 3.3%), p=0.01. Recovery was significantly faster in Group FP, with shorter time to regain consciousness (7.5 ± 2.8 vs. 12.6 ± 4.3 minutes) p<0.001 and time to discharge (25.4 ± 7.1 vs. 35.8 ± 9.5 minutes) p<0.001. **Conclusion:** Both regimens provided effective intravenous anaesthesia for upper gastrointestinal endoscopy. Fentanyl–dexmedetomidine was associated with lower heart rate and better respiratory parameters but a higher incidence of bradycardia and prolonged recovery. Fentanyl–propofol provided faster recovery and earlier discharge.

Keywords: Dexmedetomidine, Fentanyl, Propofol, Upper Gastrointestinal, Endoscopy, Intravenous Anaesthesia, Sedation.

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Introduction

Upper gastrointestinal endoscopy is one of the most common diagnostic procedures used in clinical practice. While the procedure is short, some endoscopies may cause discomfort, gagging, coughing, and pain as they pass through the oropharynx and upper gastrointestinal tract, and may elicit feelings of anxiety. Patients may require sedation. The procedure may not be tolerated well if there is inadequate sedation; conversely, excess sedatives can cause airway obstruction, hypoxemia, hypotension, delayed recovery, and other complications of the cardiopulmonary system. Hence, the selection of an appropriate intravenous anesthetic regimen is crucial to ensure patient comfort, good procedural conditions, haemodynamic stability and early recovery.[1,2] Propofol is commonly used because of its properties such as quick onset, titratability and short recovery times. Therefore, propofol has been commonly used as a sedative and intravenous anesthetic for gastrointestinal endoscopy. It offers reliable hypnosis and typically permits an early return to pre-hypnotic levels of consciousness following brief procedures. But propofol lacks intrinsic analgesic activity. It can also lead to dose-dependent respiratory depression and hypotension, especially if given quickly or with other sedative drugs (opioids).[1,3] Fentanyl is combined with propofol to give analgesia, to suppress response to endoscope insertion, and to decrease the dose of propofol. As a result, the combination of fentanyl and propofol may be used to produce satisfactory sedation and procedural conditions, while synergistic depressive actions of both on respiration and cardiovascular function are still important considerations.[4] Dexmedetomidine is a highly selective α2-adrenergic receptor agonist. It has been identified

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as a new sedative for procedural sedation. It has sedative action similar to natural sleep, and acts as an analgesic and sympatholytic agent, with relatively low respiratory depression. These properties render dexmedetomidine especially attractive for those procedures where preservation of spontaneous ventilation is desired.[5,6] However, its disadvantages are causing bradycardia and hypotension, particularly after a loading dose. It also has slower recovery compared to propofol combinations.[6,7] A few comparative studies have evaluated the use of dexmedetomidine in gastrointestinal endoscopy. Both propofol and dexmedetomidine were effective as sedatives in patients undergoing upper GI endoscopy, although both provided satisfactory sedation; patient satisfaction was higher with propofol because of the deeper sedation it produced compared to dexmedetomidine. Dexmedetomidine, on the other hand, produced fewer adverse effects on the respiratory system and more favorable effects on some parameters of the hemodynamics.[7] A meta-analysis of dexmedetomidine versus propofol for gastrointestinal endoscopy revealed significant differences between the two on heart rate and patient satisfaction, while overall frequency of major cardiopulmonary complications was similar between the two groups.[8] More recent studies have further investigated dexmedetomidine-based protocols to decrease the amount of propofol used and possibly increase respiratory safety associated with gastrointestinal endoscopic procedures.[9] It has been found that dexmedetomidine in combination with fentanyl for upper gastrointestinal endoscopy procedures provides enhanced analgesia and tolerability as compared to fentanyl-propofol combinations.[10] Fentanyl can decrease discomfort with insertion and manipulation of the endoscope, and dexmedetomidine may help to moderate sympathetic responses and maintain spontaneous breathing. Despite increased use of propofol and dexmedetomidine-based techniques for upper gastrointestinal endoscopy, it is still unclear which is the optimal regimen. An analysis of fentanyl–propofol versus fentanyl–dexmedetomidine can therefore be helpful to provide evidence of the relative efficacy and safety of these two widely applicable intravenous anesthetic techniques. The present study aimed to evaluate the hemodynamic stability, respiratory safety, sedation depth, procedure characteristics, adverse events and recovery profile of fentanyl–propofol versus fentanyl–dexmedetomidine intravenous anesthesia for upper gastrointestinal endoscopy.

Materials and Methods

This prospective comparative observational study was conducted in the Department of Anaesthesiology, Kakatiya Medical College and MGM Hospital, Warangal. Institutional Ethical permission was obtained for the study. Written informed consent was obtained from all the participants of the study after explaining the nature of the study and possible outcomes in the vernacular language.

Inclusion Criteria

1. Patients aged 18 years to 65 years.
2. Males and females
3. ASA Physical Status I and II
4. Patients scheduled for elective upper gastrointestinal endoscopy
5. Those who have signed written informed consent

Exclusion Criteria

1. Known allergy or hypersensitivity to fentanyl, propofol, or dexmedetomidine.
2. Significant cardiovascular, respiratory, hepatic, or renal disease.
3. Baseline bradycardia or significant cardiac conduction abnormalities.
4. Severe or uncontrolled hypotension or hypertension.
5. Pregnancy or lactation.
6. History of obstructive sleep apnea or anticipated difficult airway.
7. Patients receiving medications likely to interfere with the assessment of sedation or hemodynamic parameters.

A total of 60 adult patients scheduled to undergo upper gastrointestinal endoscopy were included in the study based on the inclusion and exclusion criteria. Based on the intravenous anaesthetic regimen administered, the patients were divided into two groups of 30 patients each:

Patients in both groups received intravenous fentanyl at a dose of 1 µg/kg as an analgesic component of the anaesthetic regimen.

In Group FP, after administration of fentanyl, intravenous propofol was administered at an initial dose of 1–2 mg/kg, given slowly and titrated according to the patient's clinical response to achieve an adequate level of sedation for upper gastrointestinal endoscopy. Additional bolus doses of 10–20 mg propofol were administered when required to maintain the desired depth of sedation during the procedure.

In Group FD, after administration of fentanyl, dexmedetomidine was administered as a loading dose of 1 µg/kg over 10 minutes, followed by a continuous infusion at 0.2–0.7 µg/kg/hour, titrated according to the patient's response and the required level of sedation.

Pre-procedure Assessment and Monitoring: All patients underwent a pre-anaesthetic assessment before the procedure. Patients were kept nil per oral according to standard fasting guidelines. On arrival in the endoscopy room, an intravenous cannula was secured, and standard monitoring was instituted, including electrocardiography, non-invasive blood pressure monitoring, pulse oximetry, and respiratory rate monitoring. Baseline values of heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, respiratory rate, and peripheral oxygen saturation (SpO_2) were recorded before administration of the study drugs. Supplemental oxygen was administered to all patients through a nasal cannula.

Anaesthetic Technique: Patients in both groups received intravenous fentanyl as part of the anaesthetic regimen. In Group FP, fentanyl was administered followed by intravenous propofol. Propofol was given slowly and titrated according to the patient's response to achieve an adequate level of sedation for upper gastrointestinal endoscopy. Additional doses were administered when required during the procedure. In Group FD, fentanyl was administered along with dexmedetomidine. Dexmedetomidine was administered according to the standard

dosing protocol used in the department, and the dose was adjusted to achieve and maintain an adequate level of sedation during the procedure.

The endoscopic procedure was commenced after achieving the desired level of sedation. Standard monitoring was continued throughout the procedure and during the recovery period.

Study Parameters: The primary parameters assessed were changes in hemodynamic variables, including heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure. Secondary parameters included respiratory rate, peripheral oxygen saturation, adequacy of sedation, duration of the procedure, recovery characteristics, and adverse events.

Hemodynamic and respiratory parameters were recorded at baseline, after administration of the study drugs, at the time of endoscope insertion, at predetermined intervals during the procedure, and at the end of the procedure.

The level of sedation was assessed using the Ramsay Sedation Scale. Recovery was assessed by recording the time taken by the patient to regain an appropriate level of consciousness following completion of the procedure. Any adverse events, including hypotension, bradycardia, hypoxemia, nausea, vomiting, excessive sedation, or requirement for airway intervention, were recorded and managed according to standard institutional protocols.

Statistical Analysis: The collected data were entered into a Microsoft Excel spreadsheet and analysed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were expressed as frequency and percentage. Intergroup comparison of continuous variables was performed using the independent samples t-test. Categorical variables were compared using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

Results

Demographic and Baseline Characteristics of the patients included in the study are presented in [Table 1] The mean characteristics of the two groups were comparable based on age, sex distribution, BMI characteristics, and ASA physical status, and values were not found to be significant. Similarly, the baseline heart rate, systolic blood pressure, peripheral oxygen saturation, and mean duration of the procedures were also found to be comparable between the two groups. The table shows a good distribution of patients between the two groups without any confounders that can affect the interpretation of the findings.

Table 1: Demographic and Baseline Characteristics of the Study Population

Characteristic	Group FP (n=30)	Group FD (n=30)	p-value
Age (years)	45.2 ± 12.7	48.1 ± 13.4	0.39
Sex (Male/Female)	18 (60%)/ 12 (40%)	16 (53.3%)/ 14 (46.7%)	0.60
Body Mass Index (kg/m2)	24.5 ± 3.1	25.1 ± 3.5	0.48
ASA Physical Status (I/II)	22 (73.3%)/ 8 (26.7%)	20 (66.7%)/ 10 (33.3%)	0.57
Baseline HR (beats/min)	78.4 ± 8.2	80.1 ± 7.9	0.42
Baseline SBP (mmHg)	132.5 ± 12.6	130.8 ± 11.9	0.59
Baseline SpO2 (%)	98.5 ± 1.1	98.2 ± 1.0	0.28
Procedure Duration (min)	15.2 ± 5.4	16 ± 6.1	0.59

Comparison of overall hemodynamic and respiratory parameters is depicted in [Table 2] Analysis of the table showed that the heart rate was higher in Group FP compared to Group FD, and the differences were found to be statistically significant. Interestingly, the mean systolic blood pressure, diastolic blood pressure, and mean arterial pressure were similar and comparable between the two groups, with no statistically significant differences. Similarly, the mean respiratory rate was significantly lower in Group FP than in Group FD. The peripheral oxygen saturation was significantly lower in Group FP (96.2 ± 1.8%) compared with Group FD (97.8 ± 1.0%) (p<0.001), as shown in [Table 2]

Table 2: Comparison of Overall Hemodynamic and Respiratory Parameters

Parameter (Overall Mean ± SD)	Group FP (n=30)	Group FD (n=30)	p-value
Heart Rate (beats/min)	86.4 ± 9.7	75.2 ±8.1	<0.001
Systolic BP (mmHg)	118.5 ± 11.2	116.8 ± 10.5	0.54
Diastolic BP (mmHg)	74.1 ± 8.4	72.5 ± 7.9	0.45
Mean Arterial Pressure (mmHg)	88.9 ± 9.6	87.3 ± 8.8	0.5
Respiratory Rate (breaths/min)	14.1 ± 2.5	15.3 ± 2.1	0.04
Peripheral SpO2 (%)	96.2 ±1.8	97.8 ± 1.0	<0.001

Adverse events and recovery characteristics of the cohort are presented in [Table 3] The incidence of hypotension was slightly higher in Group FP, although not statistically significant. Similarly, bradycardia was more frequent in Group FD and occurred in only one patient in Group FP, and the difference was statistically significant. Hypoxemia, defined as SpO_2 below 90%, occurred in slightly more cases in Group FP as compared to FD, but the differences were not statistically significant. Nausea and vomiting were reported in 16.7% in Group FP and 26.7% in Group FD. Excessive sedation was observed in 10.0% in Group FP and 16.7% in Group FD p=0.45. None of these differences was statistically significant. Recovery was significantly faster in Group FP. The mean time to regain consciousness was 7.5

± 2.8 minutes in Group FP compared with 12.6 ± 4.3 minutes in Group FD (p<0.001). Similarly, the mean time to discharge was significantly shorter in Group FP (25.4 ± 7.1 minutes) than in Group FD (35.8 ± 9.5 minutes) (p<0.001).

Table 3: Adverse Events and Recovery Characteristics

Variable	Group FP (n=30)	Group FD (n=30)	p-value
Adverse Events Hypotension	6 (20.0%)	4 (13.3%)	0.49
Bradycardia	1 (3.3%)	8 (26.7%)	0.01
Hypoxemia (Sp0.2 < 90%)	4 (13.3%)	1 (3.3%)	0.16
Nausea/Vomiting	5 (16.7%)	2 (6.7%)	0.23
Excessive Sedation	3 (10.0%)	5 (16.7%)	0.45
Recovery Characteristics			
Time to Regain Consciousness (min)	7.5 ± 2.8	12.6 ± 4.3	<0.001
Time to Discharge (min)	25.4 ± 7.1	35.8 ± 9.5	<0.001

The Comparison of heart rate at different time points is given in [Table 4] Analysis of the table shows the baseline heart rate was comparable between Group FP and Group FD (p=0.42). Following drug administration, heart rate was significantly lower in Group FD (72.3 ± 8.6 beats/min) compared with Group FP (81.5 ± 10.1 beats/min), p<0.001. At the time point of endoscope insertion, Group FP had a higher heart rate of 91.2 ± 11.4 beats/min compared with 78.5 ± 9.2 beats/min in Group FD, p<0.001. These differences remained significant at 5 minutes after insertion, with mean heart rates of 88.5 ± 9.8 and 74.8 ± 8.3 beats/min in Groups FP and FD, respectively. At the end of the procedure, the mean heart rate was 86.1 ± 8.5 beats/min in Group FP and 73.9 ± 7.5 beats/min in Group FD, with a statistically significant difference and p<0.001.

Table 4: Comparison of Heart Rate at Key Time Points

Time Point	Group FP (n=30)	Group FD (n=30)	p-value
Baseline	78.4 ±8.2	80.1 ± 7.9	0.42
After Drug Administration	81.5 ± 10.1	72.3 ± 8.6	<0.001
At Endoscope Insertion	91.2 ± 11.4	78.5 ± 9.2	<0.001
5 min post-insertion	88.5 ± 9.8	74.8 ± 8.3	<0.001
End of Procedure	86.1 ± 8.5	73.9 ± 7.5	<0.001

Comparison of mean arterial pressure at different time points is depicted in [Table 5] Baseline mean arterial pressure was comparable between Group FP (94.8 ± 8.1 mmHg) and Group FD (93.2 ± 7.8 mmHg) (p=0.44). Following drug administration, there was no significant difference between the groups, with mean arterial pressures of 89.5 ± 10.2 mmHg in Group FP and 90.1 ± 9.5 mmHg in Group FD (p=0.81). At the time of endoscope insertion, mean arterial pressure was significantly higher in Group FP (102.5 ± 11.3 mmHg) compared with Group FD (95.8 ± 9.9 mmHg) (p=0.02). However, at 5 minutes after endoscope insertion and at the end of the procedure, the differences in mean arterial pressure between the two groups were not statistically significant. At the end of the procedure, mean arterial pressure was 86.2 ± 8.9 mmHg in Group FP and 84.6 ± 8.1 mmHg in Group FD (p=0.47).

Table 5: Comparison of Mean Arterial Pressure at Key Time Points

Time Point	Group FP (n=30)	Group FD (n=30)	p-value
Baseline	94.8 ± 8.1	93.2 ± 7.8	0.44
After Drug Administration	89.5 ± 10.2	90.1 ± 9.5	0.81
At Endoscope Insertion	102.5 ± 11.3	95.8 ± 9.9	0.02
5 min post-insertion	90.8 ± 9.1	88.4 ± 8.7	0.3
End of Procedure	86.2 ± 8.9	84.6 ± 8.1	0.47

Discussion

This study compared the use of fentanyl–propofol (FP) and fentanyl–dexmedetomidine (FD) for IV anesthesia for upper gastrointestinal endoscopy. The distribution of cases among the two groups was equal, and there was no difference in the demographic profile, BMI, ASA physical status, baseline HR, SBP, peripheral oxygen saturation or procedure duration between the two groups. It shows that The two groups were comparable with respect to the measured baseline characteristics, reducing the likelihood that these factors influenced the observed differences. We observed significant differences in heart rate between groups at different time points, although baseline heart rates were comparable. Overall, patients in the FD group had comparatively lower mean heart rate compared to the FP group after drug administration, after insertion of the endoscope, 5 minutes after the endoscope insertion, and at the end of the procedure. This can be explained by the fact that dexmedetomidine has sympatholytic action, mediated by α2-adrenergic receptor activation, which remains absent in the FP group. Our observations were similar to those of Nishizawa et al,[8] who reported a significantly lower heart rate when using dexmedetomidine than when using propofol during gastrointestinal endoscopy. Similarly, in a recent systematic review and meta-analysis by Zhang et al..[11] have reported that dexmedetomidine-based sedation was significantly more likely to cause bradycardia than other sedative combinations.

Likewise, we found a higher occurrence of bradycardia in Group FD (26.7%) versus Group FP (3.3%) in the present study, as reported by other studies in this area.[12] Interestingly, despite differences in heart rates, we found that systolic blood pressure, diastolic blood pressure, and overall mean arterial pressure were similar in both groups. However, differences in the time of endoscope insertion were observed, as mean arterial pressure was significantly lower in the FD group. This may have been due to a more sympathetic response to instrumentation by the propofol group, while dexmedetomidine may have dampened the cardiovascular response to endoscope insertion. The lack of significant differences at other time points, however, suggests both protocols had generally satisfactory hemodynamic stability. A previous meta-analysis found no overall difference between dexmedetomidine and propofol sedation for gastrointestinal endoscopy.[8], and a second meta-analysis reported a similar finding.[12] In the current study, the FD regimen proved to be superior with respect to respiratory parameters. Group FD had a higher respiratory rate and peripheral oxygen saturation than Group FP. While there was no statistical difference in the incidence of hypoxemia, Group FP had a higher, although not statistically significant, incidence of hypoxemia. Both propofol and fentanyl can cause depression of respiratory drive, with the combination of the two potentially causing more respiratory depression. By comparison, dexmedetomidine usually maintains spontaneous respiration at the normal level within the recommended dose limits. Liu et al. reported that dexmedetomidine had a lower risk of hypoxia during the gastrointestinal endoscopy than propofol.[12] The results of a second, more thorough, systematic review of 40 randomized studies showed a significant decrease in hypoxia during dexmedetomidine sedation as well.[11] Recovery characteristics, on the other hand, were better with the FP regimen. Patients in Group FP were significantly more likely to regain consciousness and achieve discharge criteria earlier than patients in Group FD. The speed at which propofol is redistributed and eliminated results in its relatively brief recovery time, which helps to make it a good choice for short ambulatory procedures like diagnostic upper gastrointestinal endoscopy.[3,13] Conversely, dexmedetomidine can have a longer duration of sedation, especially if it is used through an infusion. Several comparative studies have yielded conflicting results for recovery time, possibly due to differing doses, administration method, length of procedure, or administration of concomitant opioids.[8,12,14] There was no difference between the two groups in the occurrence of hypotension, hypoxemia, nausea and vomiting, or excessive sedation. The only difference in adverse effects was the incidence of bradycardia with dexmedetomidine. Previous comparative studies and meta-analyses have also shown a similar pattern.[11,12,15] Therefore, although dexmedetomidine may provide improved preservation of respiratory function and reduce the tachycardic responses to endoscopy, attention must still be paid to the monitoring of heart rate. Overall, the results indicate that both fentanyl-propofol and fentanyl-dexmedetomidine are effective combinations for upper gastrointestinal endoscopy. Lower heart rate and improved respiratory parameters were observed with the FD combination, but the rate of bradycardia and slower recovery were higher in this group. FP regimen demonstrated a significantly faster recovery and earlier discharge, although with comparatively less favorable respiratory parameters. Similar findings have been reported in studies that have compared dexmedetomidine–fentanyl versus propofol–fentanyl combinations for diagnostic upper gastrointestinal endoscopy.[16]

Conclusion

Within the limits of the current study, we found fentanyl–propofol and fentanyl–dexmedetomidine provided effective intravenous anaesthesia for upper gastrointestinal endoscopy. The fentanyl–dexmedetomidine regimen was associated with lower heart rate, better maintenance of respiratory rate and oxygen saturation, and attenuation of the hemodynamic response during endoscope insertion. However, it was associated with a significantly higher incidence of bradycardia and prolonged recovery and discharge times. In contrast, fentanyl–propofol allowed faster recovery and earlier discharge but showed comparatively lower oxygen saturation and respiratory rate. Thus, both regimens may be used safely with appropriate monitoring, with the choice guided by the relative importance of respiratory stability, cardiovascular effects, and rapid recovery.

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Conflicts of interest

There are no conflicts of interest.

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