RESEARCH PAPER

Comparison of Dexmedetomidine Versus Midazolam for Procedural Sedation During Upper Gastrointestinal Endoscopy: A Cross-Sectional Comparative Study

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ABSTRACT

Background: Upper gastrointestinal endoscopy requires effective procedural sedation to improve patient comfort and procedural success. Dexmedetomidine, a selective α2-adrenergic agonist, has emerged as an alternative to conventional sedatives like midazolam due to its minimal respiratory depression and favorable sedation profile. **Aim:** To compare the efficacy and safety of dexmedetomidine versus midazolam for procedural sedation during upper gastrointestinal endoscopy. **Methods:** This cross-sectional comparative study included 120 patients undergoing elective upper gastrointestinal endoscopy, divided into dexmedetomidine (n=61) and midazolam (n=59) groups. Sedation quality was assessed using the Ramsay Sedation Score. Hemodynamic parameters, respiratory stability, recovery characteristics, patient satisfaction, and adverse events were recorded. Statistical analysis was performed using t-test and chi-square test, with $p<0.05$ considered significant. **Results:** Dexmedetomidine demonstrated significantly better sedation quality (Ramsay score: 3.42 ± 0.46 vs. 2.87 ± 0.52, $p<0.001$), lower requirement for rescue sedation (11.5% vs. 28.8%, $p=0.018$), and reduced patient movement and gag reflex. Respiratory stability was significantly better with dexmedetomidine, with lower incidence of oxygen desaturation (6.6% vs. 22.0%, $p=0.014$) and respiratory depression (3.3% vs. 15.3%, $p=0.023$). Recovery time was shorter (7.8 ± 2.1 vs. 11.6 ± 3.4 minutes, $p<0.001$), and patient satisfaction was higher (8.9 ± 1.0 vs. 7.6 ± 1.4, $p<0.001$). However, dexmedetomidine showed a higher tendency toward bradycardia and hypotension. **Conclusion:** Dexmedetomidine provides superior sedation quality, better respiratory safety, faster recovery, and higher patient satisfaction compared to midazolam, making it a preferred sedative agent for upper gastrointestinal endoscopy.

KEYWORDS: Dexmedetomidine. Midazolam. Upper gastrointestinal endoscopy.

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INTRODUCTION

Upper gastrointestinal (UGI) endoscopy is one of the most commonly performed diagnostic and therapeutic procedures in modern gastroenterology. Although it is minimally invasive, it is often associated with significant discomfort, anxiety, gag reflex, and pain, which can lead to poor patient cooperation and incomplete procedures. Therefore, procedural sedation has become an integral component of UGI endoscopy to improve patient comfort, procedural ease, and overall outcomes. The ideal sedative agent should provide adequate sedation, anxiolysis, analgesia, rapid onset, short duration of action, and minimal adverse effects, particularly respiratory depression and hemodynamic instability.[1]

Traditionally, benzodiazepines such as midazolam have been widely used for procedural sedation due to their anxiolytic, amnestic, and sedative properties. Midazolam acts on gamma-aminobutyric acid (GABA) receptors, producing central nervous system depression. However, it is associated with dose-dependent respiratory depression, prolonged sedation, paradoxical reactions, and delayed recovery, which may limit its safety and efficiency in outpatient endoscopic procedures.[2]

Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, has emerged as a promising alternative sedative agent. It provides sedation that closely resembles natural sleep, along with analgesic and anxiolytic effects, without causing significant respiratory depression. Additionally, dexmedetomidine has a favorable pharmacokinetic profile with easy titratability and smoother recovery. However, its use may be associated with bradycardia and hypotension due to its sympatholytic action.[3]

Recent studies have focused on comparing dexmedetomidine with conventional agents like midazolam in procedural sedation. Dexmedetomidine has been shown to provide better patient satisfaction, improved procedural conditions, and reduced need for additional analgesics. Furthermore, it offers superior hemodynamic stability in certain patient populations. On the other hand, midazolam remains widely used due to its familiarity, cost-effectiveness, and ease of administration.[4]

Despite increasing evidence, there is still variability in clinical practice regarding the choice of sedative agents for UGI endoscopy, especially in resource-limited settings. Comparative evaluation of these two drugs is essential to determine the optimal sedation strategy that balances efficacy, safety, recovery profile, and patient satisfaction. Therefore, this study aimed to compare dexmedetomidine and midazolam for procedural sedation during upper gastrointestinal endoscopy in terms of sedation quality, hemodynamic stability, adverse effects, and recovery characteristics.[5]

AIM

To compare the efficacy and safety of dexmedetomidine versus midazolam for

procedural sedation during upper gastrointestinal endoscopy.

OBJECTIVES

1. To compare the level and quality of sedation between dexmedetomidine and midazolam.
2. To evaluate hemodynamic parameters and respiratory stability during the procedure.
3. To assess recovery time, patient satisfaction, and incidence of adverse effects between the two groups.

MATERIALS AND METHODOLOGY

Source of Data

The data were collected from patients undergoing upper gastrointestinal endoscopy in the Department of Gastroenterology/General Medicine at a tertiary care hospital.

Study Design

This study was conducted as a cross-sectional comparative study.

Study Location

The study was carried out at a tertiary care teaching hospital.

Study Duration

The study was conducted over a period of 12 months.

Sample Size

A total of 120 patients were included in the study and divided equally into two groups (60 patients in each group: Dexmedetomidine group and Midazolam group).

Inclusion Criteria

- Patients aged 18-70 years.
- Patients scheduled for elective upper gastrointestinal endoscopy.
- Patients classified as ASA grade I and II.
- Patients who provided informed written consent.

Exclusion Criteria

- Patients with severe cardiac, hepatic, or renal dysfunction.
- Patients with known allergy to study drugs.
- Patients with psychiatric illness or neurological disorders.
- Pregnant or lactating women.
- Patients with severe respiratory compromise.

Procedure and Methodology

After obtaining informed consent, eligible patients were randomly allocated into two groups. Baseline parameters including heart rate, blood pressure, respiratory rate, and oxygen saturation were recorded.

Group D (Dexmedetomidine group) received an initial loading dose of dexmedetomidine (1 µg/kg) over 10 minutes followed by maintenance infusion (0.2-0.7 µg/kg/hr). Group M (Midazolam group) received intravenous midazolam (0.02-0.05 mg/kg) titrated to achieve adequate sedation.

Sedation levels were assessed using a standardized sedation scale (e.g., Ramsay Sedation Score). Continuous monitoring of vital parameters was performed throughout the procedure. Any adverse events such as hypotension, bradycardia, respiratory depression, or desaturation were recorded.

After completion of the procedure, recovery time was assessed using recovery scoring systems, and patient satisfaction was evaluated.

Sample Processing

Clinical parameters and observations were recorded in a pre-designed case record proforma. No laboratory sample processing was required as the study was based on clinical observations.

Statistical Methods

Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Quantitative variables were expressed as mean ± standard deviation (SD), and qualitative variables were expressed as percentages.

- Student's t-test was used for comparison of continuous variables.

- Chi-square test was used for categorical variables.
- A p-value of <0.05 was considered statistically significant.

Data Collection

Data were collected prospectively using a structured proforma, including demographic details, clinical parameters, sedation scores, hemodynamic variables, recovery characteristics, and adverse events. Continuous monitoring ensured accurate and complete data recording during the procedure.

OBSERVATION AND RESULTS

Table 1: Comparison of overall efficacy and safety between dexmedetomidine and midazolam

Variable	Dexmedetomidine (n=61)	Midazolam (n=59)	Test value	95% CI	p-value
Adequate procedural sedation achieved	53 (86.9%)	43 (72.9%)	χ^2=3.69	OR 2.46 (0.97-6.22)	0.055
Need for rescue sedation	7 (11.5%)	17 (28.8%)	χ^2=5.63	OR 0.32 (0.12-0.85)	0.018
Successful completion of endoscopy	59 (96.7%)	54 (91.5%)	χ^2=1.45	OR 2.70 (0.50-14.51)	0.229
Overall adverse events	13 (21.3%)	23 (39.0%)	χ^2=4.47	OR 0.42 (0.18-0.96)	0.034
Mean procedure time, minutes	12.8 ± 3.4	13.6 ± 3.9	t=1.20	-2.12 to 0.52	0.233

Table 1 demonstrates that dexmedetomidine showed a higher proportion of adequate procedural sedation (86.9%) compared to midazolam (72.9%), although this difference did not reach statistical significance (p=0.055). The requirement for rescue sedation was significantly lower in the dexmedetomidine group (11.5%) than in the midazolam group (28.8%) (p=0.018), indicating better primary efficacy. Successful completion of endoscopy was slightly higher with dexmedetomidine (96.7%) compared to midazolam (91.5%), but this difference was not statistically significant (p=0.229). Importantly, overall adverse events were significantly fewer in the dexmedetomidine group (21.3%) compared to the midazolam group (39.0%) (p=0.034), suggesting a better safety profile. The mean procedure time was comparable between the two groups (12.8 ± 3.4 vs. 13.6 ± 3.9 minutes, p=0.233), indicating no significant procedural delay with either drug.

Table 2: Comparison of level and quality of sedation between dexmedetomidine and midazolam

Variable	Dexmedetomidine (n=61)	Midazolam (n=59)	Test value	95% CI	p-value
Mean Ramsay Sedation Score	3.42 ± 0.46	2.87 ± 0.52	t=6.13	0.37 to 0.73	<0.001
Time to achieve adequate sedation, min	6.9 ± 1.8	5.4 ± 1.6	t=4.82	0.88 to 2.12	<0.001

Excellent sedation quality	47 (77.0%)	34 (57.6%)	χ^2=5.12	OR 2.47 (1.13-5.38)	0.024
Patient movement during procedure	8 (13.1%)	19 (32.2%)	χ^2=6.27	OR 0.32 (0.13-0.81)	0.012
Gag reflex during procedure	11 (18.0%)	22 (37.3%)	χ^2=5.63	OR 0.37 (0.16-0.87)	0.018
Endoscopist satisfaction score	8.6 ± 1.1	7.4 ± 1.3	t=5.46	0.76 to 1.64	<0.001

Table 2 shows that dexmedetomidine provided significantly deeper and better-quality sedation than midazolam, as evidenced by a higher mean Ramsay Sedation Score (3.42 ± 0.46 vs. 2.87 ± 0.52, p<0.001). However, the time to achieve adequate sedation was significantly longer in the dexmedetomidine group (6.9 ± 1.8 minutes) compared to the midazolam group (5.4 ± 1.6 minutes, p<0.001). A significantly higher proportion of patients in the dexmedetomidine group experienced excellent sedation quality (77.0% vs. 57.6%, p=0.024). Additionally, patient movement during the procedure was significantly less with dexmedetomidine (13.1%) compared to midazolam (32.2%) (p=0.012), and the incidence of gag reflex was also significantly reduced (18.0% vs. 37.3%, p=0.018). Endoscopist satisfaction scores were significantly higher with dexmedetomidine (8.6 ± 1.1 vs. 7.4 ± 1.3, p<0.001), indicating superior procedural conditions.

Table 3: Comparison of hemodynamic parameters and respiratory stability during procedure

Variable	Dexmedetomidine (n=61)	Midazolam (n=59)	Test value	95% CI	p-value
Baseline heart rate, beats/min	82.6 ± 9.8	78.4 ± 10.6	t=2.25	0.51 to 7.89	0.026
Lowest heart rate, beats/min	68.9 ± 8.7	73.6 ± 9.4	t=2.84	-7.98 to -1.42	0.005
Bradycardia	9 (14.8%)	3 (5.1%)	χ^2=3.11	OR 3.23 (0.83-12.51)	0.078
Baseline MAP, mmHg	91.7 ± 8.9	92.4 ± 9.2	t=0.42	-3.97 to 2.57	0.673
Lowest MAP, mmHg	76.8 ± 7.6	81.9 ± 8.3	t=3.51	-7.98 to -2.22	0.001
Hypotension	12 (19.7%)	6 (10.2%)	χ^2=2.16	OR 2.16 (0.75-6.21)	0.142
Lowest SpO_2, %	96.1 ± 2.4	93.8 ± 3.7	t=4.03	1.17 to 3.43	<0.001
Oxygen desaturation	4 (6.6%)	13 (22.0%)	χ^2=5.98	OR 0.25 (0.08-0.82)	0.014
Respiratory depression	2 (3.3%)	9 (15.3%)	χ^2=5.17	OR 0.19 (0.04-0.91)	0.023

Table 3 indicates that baseline heart rate was slightly higher in the dexmedetomidine group (82.6 ± 9.8 bpm) compared to the midazolam group (78.4 ± 10.6 bpm), which was statistically significant

(p=0.026). However, the lowest heart rate recorded during the procedure was significantly lower in the dexmedetomidine group (68.9 ± 8.7 bpm vs. 73.6 ± 9.4 bpm, p=0.005), reflecting its known bradycardic effect. Although bradycardia was more frequent with dexmedetomidine (14.8% vs. 5.1%), the difference was not statistically significant (p=0.078). Baseline mean arterial pressure (MAP) was comparable between groups (p=0.673), but the lowest MAP was significantly lower in the dexmedetomidine group (76.8 ± 7.6 mmHg vs. 81.9 ± 8.3 mmHg, p=0.001). Hypotension was more frequent with dexmedetomidine, though not statistically significant (p=0.142). In terms of respiratory parameters, dexmedetomidine showed significantly better oxygenation with higher lowest SpO_2 values (96.1 ± 2.4% vs. 93.8 ± 3.7%, p<0.001). Furthermore, oxygen desaturation (6.6% vs. 22.0%, p=0.014) and respiratory depression (3.3% vs. 15.3%, p=0.023) were significantly lower in the dexmedetomidine group, indicating superior respiratory safety.

Table 4: Comparison of recovery time, patient satisfaction, and adverse effects

Variable	Dexmedetomidine (n=61)	Midazolam (n=59)	Test value	95% CI	p-value
Recovery time, minutes	7.8 ± 2.1	11.6 ± 3.4	t=7.34	-4.83 to -2.77	<0.001
Time to discharge readiness, minutes	22.7 ± 5.8	29.4 ± 7.1	t=5.67	-9.04 to -4.36	<0.001
Patient satisfaction score	8.9 ± 1.0	7.6 ± 1.4	t=5.84	0.86 to 1.74	<0.001
Nausea/vomiting	5 (8.2%)	11 (18.6%)	χ^2=2.82	OR 0.39 (0.13-1.20)	0.093
Restlessness/agitation	3 (4.9%)	12 (20.3%)	χ^2=6.74	OR 0.20 (0.05-0.75)	0.009
Delayed recovery	4 (6.6%)	14 (23.7%)	χ^2=7.04	OR 0.23 (0.07-0.75)	0.008
Overall satisfaction excellent	51 (83.6%)	39 (66.1%)	χ^2=4.93	OR 2.61 (1.12-6.10)	0.026

Table 4 reveals that dexmedetomidine was associated with significantly faster recovery, as evidenced by a shorter recovery time (7.8 ± 2.1 minutes vs. 11.6 ± 3.4 minutes, p<0.001) and earlier readiness for discharge (22.7 ± 5.8 minutes vs. 29.4 ± 7.1 minutes, p<0.001). Patient satisfaction scores were significantly higher in the dexmedetomidine group (8.9 ± 1.0 vs. 7.6 ± 1.4, p<0.001), and a greater proportion reported excellent overall satisfaction (83.6% vs. 66.1%, p=0.026). Although nausea and vomiting were less frequent with dexmedetomidine (8.2% vs. 18.6%), this difference was not statistically significant (p=0.093). However, restlessness/agitation (4.9% vs. 20.3%, p=0.009) and delayed recovery (6.6% vs. 23.7%, p=0.008) were significantly lower in the dexmedetomidine group.

DISCUSSION

In the present study, dexmedetomidine showed better overall efficacy and safety compared with midazolam for procedural sedation during upper gastrointestinal endoscopy. Adequate procedural sedation was achieved in 86.9% of patients in the

dexmedetomidine group compared with 72.9% in the midazolam group, although the difference was borderline significant. The requirement for rescue sedation was significantly lower with dexmedetomidine, indicating more sustained and satisfactory sedation. Similar findings were reported by Liu W et al.(2024)[1], who in a systematic review and meta-analysis demonstrated superior sedation quality and reduced additional sedative requirement with dexmedetomidine. Likewise, Li J et al.(2025)[2] in a network meta-analysis reported that dexmedetomidine offers improved sedation efficacy with fewer complications compared to conventional sedatives such as midazolam.

With respect to sedation quality, the present study found a significantly higher Ramsay Sedation Score in the dexmedetomidine group than in the midazolam group. Excellent sedation quality was observed in 77.0% of patients receiving dexmedetomidine compared with 57.6% receiving midazolam. Patient movement and gag reflex were also significantly lower in the dexmedetomidine group, and endoscopist satisfaction was significantly higher. These findings are in agreement with Liu Y et al.(2025)[3], who reported improved sedation depth and better procedural conditions with dexmedetomidine-based regimens. Similarly, Tang R et al.(2023)[4] demonstrated that dexmedetomidine significantly enhances sedation quality and reduces procedural discomfort in gastrointestinal endoscopy.

In the present study, dexmedetomidine took slightly longer to achieve adequate sedation than midazolam. This may be due to its slower onset when administered as an infusion. However, once adequate sedation was achieved, dexmedetomidine provided smoother procedural conditions with less movement and gagging. Liu W et al.(2021)[5] also observed that dexmedetomidine requires careful titration and has a slower onset but provides stable and effective sedation during endoscopic procedures.

Hemodynamic findings in the present study showed that dexmedetomidine was associated with lower intra-procedural heart rate and mean arterial pressure. Bradycardia and hypotension were more frequent in the dexmedetomidine group, although these differences were not statistically significant. These findings are pharmacologically expected due to the sympatholytic action of dexmedetomidine. Similar observations were noted by Ghomeishi A et al.(2023)[6], who reported a higher incidence of bradycardia with dexmedetomidine. In contrast, Chen Y et al.(2022)[7] demonstrated that midazolam-based combinations may have relatively stable hemodynamic effects but are associated with other limitations such as respiratory depression.

Respiratory stability was significantly better in the dexmedetomidine group. Lowest SpO_2 was higher, while oxygen desaturation and respiratory depression were significantly lower compared with midazolam. This supports the advantage of dexmedetomidine as a sedative that produces minimal respiratory depression. Ghoul I et al.(2026)[8] also reported significantly lower respiratory complications with dexmedetomidine compared to midazolam. Similarly, Tekeli AE et al.(2020)[9] demonstrated that dexmedetomidine-based sedation regimens provide better respiratory safety than other sedative combinations used in upper gastrointestinal endoscopy.

Recovery profile was also superior with dexmedetomidine. The mean recovery time and time to discharge readiness were significantly shorter in the dexmedetomidine group. Patient satisfaction score was significantly higher, and excellent overall satisfaction was reported by 83.6% of patients compared with 66.1% in the midazolam group. Restlessness, agitation, and delayed recovery were also significantly

lower with dexmedetomidine. These findings are consistent with Ishido K et al.(2025)[10], who found higher patient and operator satisfaction with dexmedetomidine-based sedation protocols. Furthermore, Gotoda T et al.(2021)[11] in sedation guidelines emphasized that dexmedetomidine offers improved recovery characteristics and patient comfort when appropriately monitored.

CONCLUSION

The present study concludes that dexmedetomidine is a superior sedative agent compared to midazolam for procedural sedation during upper gastrointestinal endoscopy. Dexmedetomidine provided better sedation quality, as evidenced by higher Ramsay Sedation Scores, improved endoscopist satisfaction, and reduced patient movement and gag reflex during the procedure. It also significantly reduced the need for rescue sedation, indicating more effective and sustained sedation.

From a safety perspective, dexmedetomidine demonstrated a clear advantage in terms of respiratory stability, with significantly lower incidence of oxygen desaturation and respiratory depression compared to midazolam. Additionally, dexmedetomidine was associated with fewer overall adverse events and significantly improved recovery profile, including shorter recovery time and earlier readiness for discharge. Patient satisfaction was also significantly higher in the dexmedetomidine group, highlighting its clinical acceptability and comfort.

However, dexmedetomidine was associated with a higher tendency for bradycardia and hypotension, although these were not statistically significant and were manageable with appropriate monitoring. Midazolam, while effective and faster in onset, showed comparatively inferior sedation quality, higher respiratory complications, and prolonged recovery.

Overall, dexmedetomidine can be considered a safer and more effective alternative to midazolam for procedural sedation in upper gastrointestinal endoscopy, provided that careful hemodynamic monitoring is ensured.

LIMITATIONS OF THE STUDY

1. The study was conducted at a single tertiary care center, which may limit generalizability.
2. The sample size, although adequate, was relatively small for detecting rare adverse events.
3. The study design was cross-sectional, limiting causal inference.
4. Blinding of the investigator and endoscopist was not performed, introducing potential bias.
5. Subjective assessment tools such as Ramsay Sedation Score and satisfaction scores may introduce observer bias.
6. Long-term outcomes and delayed complications were not evaluated.
7. Cost-effectiveness analysis between dexmedetomidine and midazolam was not performed.
8. The study did not include high-risk patients (ASA III and above), limiting applicability in critically ill populations.
9. Variability in individual patient response to sedative drugs was not fully controlled.
10. The study did not compare combination regimens or adjunct analgesics, which are commonly used in practice.

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