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CLINICAL ENDOSCOPY

Respiratory complications during recovery from gastrointestinal endoscopies performed by gastroenterologists under moderate sedation

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Background/Aims: Data on the incidence of adverse respiratory events during recovery from gastrointestinal endoscopy are limited. The aim of this study was to investigate the incidence of these complications.

Methods: In this retrospective cohort study, data were obtained from the electronic records of 657 consecutive patients, who underwent gastroenterological procedures under sedation.

Results: Pulse oximetry oxygen saturation (SpO_2) <90% for <60 seconds occurred in 82 patients (12.5%), and in 11 patients (1.7%), SpO_2 of <90% for >60 seconds occurred in 79 patients (12.0%) and in 14 patients (2.1%), and SpO_2 <75% occurred in four patients (0.6%) and in no patients during the procedure and recovery period, respectively. No major complications were noted. The occurrence of desaturation during recovery was correlated with desaturation during the procedure (p<0.001). Higher American Society of Anesthesiologists score (odds ratio [OR], 1.867; 95% confidence interval [CI], 1.008–3.458), ischemic heart disease (OR, 1.815; 95% CI, 0.649–5.080), hypertension (OR, 1.289; 95% CI, 0.472–3.516), and diabetes mellitus (OR, 2.406; 95% CI, 0.950–6.095) increased the occurrence of desaturation during recovery.

Conclusions: We found no major complications during recovery after balanced propofol-based sedation administered by a gastroenterologist-nurse team. Patients with the identified risk predictors must be monitored carefully.

Keywords: Conscious sedation; Gastroenterologists; Gastrointestinal endoscopy; Hypoxia; Recovery room

INTRODUCTION

Sedation for gastrointestinal endoscopies provides improved patient tolerance to the procedures by relieving anxiety, discomfort, and pain.[1] Sedation may also provide improved conditions to the endoscopist and improve the quality of the examination.[2] Hypoxia is the most common sedation-related adverse event during endoscopy, and its causes include respiratory depression, airway obstruction, and decreased compliance of the chest wall. The incidence of hypoxemia during gastrointestinal endoscopy has been reported to be in the range of 1.5% to 70%, depending largely on differences in definitions and the types of practitioners.[3-9]

The incidence of respiratory complications in the immediate post-anesthesia period in patients undergoing surgery is high and well documented.[10,11] The American Society of Anesthesiologists (ASA) recommends that patients in the immediate period after moderate sedation be observed and monitored until they are near their baseline level of consciousness and are no

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longer at increased risk for cardiorespiratory depression.[12] Similar but less detailed guidelines were defined by the American Society of Gastroenterologists.[13] However, there are only limited data on the incidence of respiratory complications during the post-procedure period in patients undergoing gastrointestinal endoscopy under sedation. One study found that half of hypoxemia cases occurred during the recovery period after the completion of esophagogastroscopy,[14] but no other data are available.

The aim of this preliminary study was to assess the incidence of respiratory complications and their risk factors during the recovery period following gastrointestinal endoscopy under sedation performed by gastroenterologists. We assumed that because endoscopies are less invasive than surgical procedures performed under sedation and not under general anesthesia, the incidence of complications will be lower than that in the postoperative period. The study also explored the incidence of respiratory complications leading to emergency room or ambulatory visits in the three-day period following gastrointestinal endoscopy.

METHODS

In this retrospective study, data were collected from 657 patients undergoing gastroscopy and/or colonoscopy, endoscopic ultrasonography, or endoscopic retrograde cholangiopancreatography (ERCP). The procedure and sedation were performed by a team of gastroenterologists and nurses, respectively. According to institutional protocol, sedation was initiated with intravenous administration of midazolam (1–2 mg), fentanyl (50 μg), and/or propofol (30–50 mg). Propofol was administered in boluses, as needed, during the procedure. Monitoring during the procedure included blood pressure measurement before the beginning of the procedure, and then at five-minute intervals. Heart rate and pulse oximetry oxygen saturation (SpO_2) were continuously monitored and automatically recorded throughout the procedure. Capnography was not used for monitoring. At the end of the procedure, the patients were admitted to the post-procedure recovery area for one-hour observation. During the post-procedure recovery period, patients were continuously monitored for heart rate, SpO_2, and blood pressure at five-minute intervals for the first 30 minutes. Ambulatory patients were discharged after becoming fully awake and able to drink and eat a light meal, and vital signs were similar to baseline values. Patients were instructed to contact the gastroenterology department if they experienced abdominal pain, chest pain, fever, black stool, persistent vomiting, or difficulty breathing. Hospitalized patients were discharged after being fully awake, and their vital signs were similar to baseline values.

Data on patient demographics, procedures, and sedation were collected from the patients' electronic records. Demographic data included age; sex (male/female); body mass index; physical status classification according to the ASA (score 1, 2, or 3); and background diseases (ischemic heart disease [IHD], hypertension [HTN], diabetes mellitus [DM], chronic heart failure, chronic respiratory disease, and obstructive sleep apnea). Data on the procedure included the procedure type and length, and the type and dose of medications administered.

Data on sedation-related respiratory complications were collected from the patients' electronic records. We used the definition of complications suggested by Mason and colleagues, whereby hypoxemia was defined as SpO_2 <90% for less than 60 seconds, SpO_2 <90% for more than 60 seconds, or SpO_2 <75% for any time period.[15] Other complications included apnea, airway obstruction, cardiogenic shock, and cardiac arrest, as indicated in the charts by the gastroenterologist and the nurse.

Using patients' electronic medical records, information on emergency department visits or hospital admissions during the three days following the procedure were explored, and their relevance for sedation was defined. Relevant findings were defined as fever >38°C, respiratory complaints (cough and dyspnea), and SpO_2 <94%.

Statistical differences were tested using Pearson's chi-square test. The correlation between the occurrence of desaturation during the procedure and desaturation in the post-anesthesia care unit was tested using Fisher's exact test. Statistical analysis was performed using R ver. 3.4.4 (R Foundation for Statistical Computing, Vienna, Austria). Ordinal logistic regression was used to calculate both univariate and multivariate *p*-values and odds ratios (ORs). The multivariate model included age, sex, and any other variables that were identified as significant in the univariate analysis. SAS software ver. 9.4 (SAS Institute, Cary, NC, USA) was used for all calculations.

Ethical statements

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of Sheba medical center (protocol code SMC 5488-18 and date of approval 28 October 2018).

RESULTS

Demographics and procedures

Data (mean±standard deviation) of 657 patients, showed an age of 63±15.3 years, with 360 men and 297 women included. Of the patients, 385 (58.6%) had ASA status 1 to 2 (healthy patients or patients with mild systemic disease), 271 (41.2%) had ASA status 3 (patients with severe systemic disease), and ASA was not specified in one (0.2%) patient. The background demographics and patient characteristics are shown in Table 1. Of these patients, 189 (28.8%) underwent gastroscopy, 306 (46.6%) underwent colonoscopy, 110 (16.7%) underwent both gastroscopy and colonoscopy, 35 (5.3%) underwent ERCP, and 17 (2.6%) underwent endoscopic ultrasonography. Other data regarding these procedures are presented in Table 2.

Respiratory complications

During the procedure, SpO_2 of <90% for <60 seconds occurred in 82 patients (12.5%), and for >60 seconds in 79 patients (12.0%). SpO_2 <75% occurred in four patients (0.6%). No major complications, such as apnea or airway obstruction, occurred, and no patients required bag-mask ventilation or tracheal intubation (Table 3).

During the first 30 minutes of the recovery period, SpO_2 of <90% for <60 seconds was observed in 11 patients (1.7%), and for >60 seconds in 14 patients (2.1%). There were no events with SpO_2 <75% or any other major complications (Table 3).

There were no major respiratory events, such as apnea or airway obstruction, requiring intervention in the post-anesthesia care unit.

Desaturation in the post-procedure recovery period was more common in inpatients aged >65 years (1.2%–3.9% in patients within this age group vs. 0.7%-1% in younger patients, p=0.045), IHD (3.6% vs. 1%, p=0.011), DM (2%–6% vs. 0.6%–1.7%, p<0.001), and endoscopic ultrasound and ERCP procedure types, compared to that in gastroscopy, colonoscopy, and both

Table 1. Patient characteristics

Characteristic	Value
Age (yr)	63.0±15.3
Age (yr)	
<65	296 (45.1)
65–79	281 (42.8)
≥80	80 (12.2)
Male:female	360 (54.8):297 (45.2)
Body mass index (kg/m^2)	26.8±5.2
<30	465 (70.8)
≥30	149 (22.7)
Unspecified	43 (6.5)
ASA physical score	
1	55 (8.4)
2	330 (50.2)
3	271 (41.2)
Unspecified	1 (0.2)
Co-morbidities	
Ischemic heart disease	104 (15.8)
Hypertension	285 (43.4)
Diabetes mellitus	173 (26.3)
Heart failure	30 (4.6)
Chronic respiratory disease	71 (10.8)
Obstructive sleep apnea	30 (4.6)

Values are presented as mean±standard deviation or number (%).
ASA, American Society of Anesthesiologists.

Table 2. Procedures

	Value
Exam duration (min)	
All exams (n=657)	25.0±14.2
<30 min:≥30 min	444 (67.6): 213 (32.4)
Gastroscopy	16.0±9.2
Colonoscopy	26.0±13.3
Endoscopic ultrasound	40.0±20.5
ERCP	33.0±14.8
Gastroscopy+colonoscopy	33.0±13.7
Medications used	
Midazolam (mg)	2.0±0.8
Fentanyl administered (50 μg): not administered	507 (77.2): 150 (22.8)
Propofol dose (mg)	84.0±64.3
Propofol >50 mg	401 (61.0)

Values are presented as mean±standard deviation or number (%).
ERCP, endoscopic retrograde cholangiopancreatography.

Table 3. Respiratory complications

	During the procedure	During post-procedure recovery period
SpO_2 <90%, <60 sec	82 (12.5)	11 (1.7)
SpO_2 <90%, >60 sec	79 (12.0)	14 (2.1)
SpO_2 <75%	4 (0.6)	0 (0)
Apnea	0 (0)	0 (0)
Airway obstruction	0 (0)	0 (0)

Values are presented as number (%).
SpO_2, pulse oximetry oxygen saturation.

Table 4. Risk factors associated with desaturation during the procedure and the post-procedure recovery period: multivariate analysis and univariate analysis

Risk factor	Multivariate analysis		Univariate analysis
	Pr	OR (95% CI)	*p*-value
During the procedure			
Sex (male vs. female)	0.171	0.778 (0.543–1.115)	0.295
Age	0.511	1.004 (0.992–1.016)	0.200
ASA score	0.032	1.314 (1.024–1.688)	0.027
Pulmonary disease	0.038	1.754 (1.030–2.985)	0.026
Length of procedure	0.024	1.014 (1.002–1.027)	0.008
Fentanyl	0.044	1.011 (1.000–1.022)	0.057
During the post-procedure recovery period			
Sex (male vs. female)	0.113	0.494 (0.206–1.183)	0.480
Age	0.760	1.005 (0.971–1.040)	0.102
ASA score	0.047	1.867 (1.008–3.458)	0.002
Ischemic heart disease	0.256	1.815 (0.649–5.080)	0.006
Hypertension	0.627	1.289 (0.472–3.516)	0.037
Diabetes mellitus	0.064	2.406 (0.950–6.095)	0.001

Pr, probability; OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists.

examinations combined (5%–11% vs. 1%–2%, p=0.026; Table 4).

Factors increasing the occurrence of desaturation events during the procedure included ASA score (OR, 1.314; 95% CI, 1.024–1.668), pulmonary disease (OR, 1.754; 95% CI, 1.030–2.985), length of procedure (OR, 1.014; 95% CI, 1.002–1.027), and fentanyl use (OR, 1.011; 95% CI, 1.000–1.022; Table 4).

Factors that increased the occurrence of desaturation events during the post-procedure period included ASA score (OR, 1.867; 95% CI, 1.008–3.458), IHD (OR, 1.815; 95% CI, 0.649–5.080), HTN (OR, 1.289; 95% CI, 0.472–3.516), and DM (OR, 2.406; 95% CI, 0.950–6.095; Table 4).

The occurrence of a desaturation event during the procedure was correlated with the subsequent occurrence of desaturation in the post-anesthesia care unit (p<0.001) (Table 5).

Other complications

There were no cardiovascular events that required medical intervention, such as hypotension/HTN, tachy/bradyarrhythmia, cardiogenic shock, or cardiac arrest during the procedure or in the post-procedure recovery period.

Two patients (0.3%) visited the emergency room within the three-day period after the procedure. None of the patients had a fever or respiratory complaints.

DISCUSSION

Sedation is an important tool for facilitating gastroenterological procedures. The definition of procedural sedation, as proposed by the International Committee for the Advancement of Procedural Sedation, is the administration of one or more pharmacological agents to facilitate a diagnostic or therapeutic procedure, while targeting a state during which airway patency, spontaneous respiration, protective airway reflexes, and hemodynamic stability are preserved, while alleviating anxiety and pain.[16] There are many definitions of procedural adverse events. We chose to use the adverse event sedation reporting tool, which has standardized the reporting of sedation-related adverse events.[15]

Previous studies reported hemoglobin desaturation incidences during sedation of 6.7%,[17] 12.8%,[18] and 4.7%.[19] In our study, the incidence was 12.5%. However, the definition of hemoglobin oxygen desaturation was not uniform in all reports. In a large international study including 160,000 patients that used the same definitions as in our study, the incidence of desaturation was reported to be only 7.8 per 1,000 procedures.[20] The higher incidence in our study may be explained by the fact that in our study, the percentage of ASA 3 patients was high (41%), and the data did not include children. Indeed, an ASA score ≥3 was reported to be a predictor of respiratory complications.[15]

Table 5. Desaturation during the procedure and in the post-procedure recovery period

	During post-procedure recovery				
	Number	SpO_2 < 90%, <60 sec	SpO_2 <90%, >60 sec	SpO_2 <75%	Total
During the exam					
No	483 (98.2)	6 (1.2)	3 (0.6)	0 (0)	492 (100)
SpO_2 <90%, <60 sec	78 (95.1)	2 (2.4)	2 (2.4)	0 (0)	82 (100)
SpO_2 <90%, >60 sec	68 (86.1)	3 (3.8)	8 (10.1)	0 (0)	79 (100)
SpO_2 <75%	3 (75.0)	0 (0)	1 (25.0)	0 (0)	4 (100)

Values are presented as number (%).
SpO_2, pulse oximetry oxygen saturation.

Notably, ASA score and other parameters such as age, body mass index, background disease, procedure type, or duration, which were previously reported to be risk factors for respiratory adverse events, were not found to be predictors for desaturation in our study, possibly stemming from the higher proportion of non-healthy patients.

In our study, we examined the incidence of respiratory adverse events during the post-procedure recovery period. We found that the incidence of minor respiratory events was low and no major adverse events occurred. The incidence of respiratory adverse events in the post-procedure period in the present study was much lower than that in previous reports in the post-surgical and general anesthesia periods. Although not tested directly in our study, these differences may stem from the particular lower-risk features of upper and lower endoscopies compared with most surgical techniques, namely, the procedures are shorter, use only short-acting fentanyl of the opioid family of drugs, did not use muscle relaxants, and the procedures did not involve surgical incision altering lung mechanics.[21,22]

In the three-day period after gastrointestinal endoscopy, only two patients visited the emergency room, and both had complaints possibly related to the procedure itself, such as melena, vomiting, and abdominal pain. None of the patients had respiratory complaints or symptoms of pneumonia. Hence, the incidence of long-term complications was low.

Our study has some limitations, including the inclusion of different types of procedures (colonoscopy, gastroscopy, endoscopic ultrasonography, and ERCP). The study was performed in a tertiary hospital with a high percentage of patients with ASA 3 scores, and the number of patients was limited to 657. However, the present data indicate that balanced propofol-based sedation is relatively safe, both in the procedural and post-procedural recovery periods, with only infrequent minor events noted in the post-procedural recovery period.

In summary, we found that pulmonary disease, ASA score, length of procedure, and fentanyl use increased the occurrence of desaturation events during the procedure. The ASA score, the comorbidity of IHD, DM, and HTN, and desaturation during the procedure increased the occurrence of desaturation events during recovery from the procedure.

Notwithstanding, meticulous vital sign tracking should be used, especially in patients with identified predictors of complications, such as coexisting disease and desaturation during the procedure. Further studies are needed to determine whether these events have clinical implications, such as a greater risk of pulmonary aspiration and pneumonia.

Conflicts of Interest

The authors have no potential conflicts of interest.

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Author Contributions

Conceptualization: IEP, AZ, HB; Data curation: IEP, AZ; Formal analysis: GZ; Supervision: HB; Validation: HB, MN, DO; Visualization: IEP; Writing–original draft: IEP; Writing–review & editing: all authors.

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