Anesthesia for digestive tract endoscopy

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Purpose of review
Nonoperating room anesthesia for digestive tract endoscopy has its own specificities and requires practical training. Monitoring devices, anesthetic drugs, understanding of procedures and management of complications are critical aspects.

Recent findings
New data are available regarding risk factors for intra- and postoperative complications (based on anesthesia registries), airway management, new anesthetic drugs, techniques of administration and management of advances in interventional endoscopy procedures.

Summary
Digestive tract endoscopy is a common procedure that takes place outside the operating room most of the time and has become more and more complex due to advanced invasive procedures. Prior evaluation of the patient's comorbidities and a good understanding of the objectives and constraints of the endoscopic procedures are required. Assessing the risk of gastric content aspiration is critical for determining appropriate anesthetic protocols. The availability of adequate monitoring (capnographs adapted to spontaneous ventilation, bispectral index), devices for administration of anesthetic/sedative agents (target-controlled infusion) and oxygenation (high flow nasal oxygenation) guarantees the quality of sedation and patient' safety during endoscopic procedures. Knowledge of the specificities of each interventional endoscopic procedure (endoscopic retrograde cholangiopancreatography, submucosal dissection) allows preventing complications during anesthesia.

Keywords
anesthesia, digestive tract endoscopy, endoscopic retrograde cholangiopancreatography, interventional endoscopy, sedation

INTRODUCTION

Each year, around 18 and 3 million gastrointestinal (GI) endoscopies are performed in the United States and in France, respectively [1,2]. To undergo these potentially painful invasive procedures, patients commonly require sedation or anesthesia to guarantee comfort and satisfaction while optimizing the quality of the procedure [3]. A 2014 survey conducted by the French Society of Digestive Endoscopy showed that 90% of lower tract endoscopies and 70% of upper tract endoscopies were performed under sedation [4]. In other countries such as Norway and Portugal, <40% of colonoscopies are performed under sedation [5]. Although anesthesia is associated with additional costs, it has to be balanced by the improvement in safety and comfort for the patient [6,7]. The staff involved in the conduct of sedation/anesthesia for GI endoscopy varies greatly throughout the world. Endoscopist's administered sedation is advocated in several countries [8]. However, in the United States, the percentage of procedures monitored by an anesthesia professional has increased from 14% in 2003 to 53% in 2013 [9,10]. This review will describe the various circumstances of GI endoscopy guiding patients' management for appropriate anesthesia or sedation.

PREOPERATIVE ASSESSMENT

Patient's medical history

The major increase in the number of endoscopic procedures performed each year and the evolution

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KEY POINTS

- Prior evaluation of patient's comorbidities focusing on at-risk conditions for hypoxia (congestive heart failure, obesity, obstructive sleep apnea) or aspiration (dysphagia, diabetes, gastroesophageal reflux disease) is crucial.
- Apart from the formal indications of airway protection, orotracheal intubation during gastrointestinal endoscopy relies on specific clinical and procedure characteristics (indication, risk of complications, position, timing and duration of the procedure).
- Regarding sedation with spontaneous ventilation, the value brought by capnographic monitoring of respiratory rate is now undisputable.
- Compared with other hypnotic drugs, propofol use is associated with a faster recovery, earlier discharge, better sedation level, reduced incidence of nausea/vomiting and greater patient satisfaction without any increase in cardiopulmonary complications.
- Knowledge of the specificities of each interventional endoscopic procedure (endoscopic retrograde cholangiopancreatography, submucosal dissection) allows preventing technical difficulties related to anesthesia.

of the techniques and indications have led to a widening of the population concerned, commonly aged with comorbidities. Eighty percentage of patients undergoing GI endoscopy are, indeed, older than 50 years and >40% of patients have an *American Society of Anesthesiologists physical status* (ASA) higher than or equal to 2 [4,11]. ASA 3 and 4 patients are twice as often managed in public hospitals than in private facilities [12].

In this setting, assessment of the risk of aspiration of GI content is a critical part of patients' evaluation. A US registry study, including nearly 5 million outpatients undergoing GI endoscopy, reports 1.1% aspiration pneumonia within 30 days after the procedure. Risk factors were: a previous history of pneumonia, stroke, dysphagia and congestive heart failure [13]. The risk increases to 3.4% regarding endoscopic retrograde cholangiopancreatography (ERCP) and 4.8% in case of upper GI bleeding [14,15].

Gastroesophageal reflux disease (GERD) is a frequent indication for upper GI endoscopy. In a survey conducted in 8000 adults, 31.3% declared suffering from GERD occurring more than once a week for 7.8% of the respondents [16]. GERD does not systematically justify orotracheal intubation (OTI). However, it may be recommended in case of severe and/or documented GERD, occurring during fasting or more than once a week, resistant to proton pump inhibitors or responsible for severe lesions such as Barrett's esophagus [17].

Patients with long-standing or uncontrolled diabetes are prone to develop autonomic dysfunction that may result in gastroparesis. In an observational study including 52 type 2 diabetes patients with at least 6 h of fasting, nearly 48% had actually a 'full stomach' based on measurement of antral surface area; diabetic retinopathy was an independent risk factor for the occurrence of full stomach [18]. In these patients, an ultrasonographic evaluation of gastric content before induction of anesthesia is advised, as it could be in all patients with autonomic nervous system disorder [19].

OTI prevents potential aspiration due to patient characteristics or intra-procedural maneuvers. The choice of rapid sequence intubation is often required in the presence of gastrointestinal motility or emptying disorders (gastroparesis, achalasia and esophageal stenosis), intrinsic or extrinsic gastric or intestinal obstructions (abdominal compartment, ascites, advanced pregnancy).

Airway management

Most of GI tract endoscopies only require light to moderate sedation. Preoxygenation is required to avoid desaturation after the initial bolus of sedation. Even if light sedation is planned during the procedure, airway assessment is mandatory to determine adequate intubation strategy if necessary.

Patients with risk factors of hypoxemia (age > 60 years old, obesity, heart/respiratory failure, diabetes, hypertension, obstructive sleep apnea) and ASA ≥2 patients may benefit from a high nasal flow oxygenation (HFO) [20,21]. Patients with a high STOP-BANG score, are prone to develop adverse respiratory events and require more maneuvers to control airways [22▪]. In a recent study in which 379 patients at risk of hypoxemia, had HFO (70 l/min) or standard oxygen (5–6 l/min), the occurrence of O_2 desaturation <92%, desaturation >1 min, and the need to perform an airway clearance maneuver, were significantly lower in the group receiving OHD [23▪▪]. The value of OHD was confirmed in case of prone ERCP [24▪▪].

Apart from the definite indications of airway protection related to 'full stomachs', OTI during GI endoscopy relies on specific clinical and procedure characteristics (BMI, risk of hypoxemia, risk of aspiration, position, timing and duration of the procedure). Algorithms designed for decision-making encourage airway protection for a score greater than or equal to 4 (Table 1) [25,26].

Table 1. Decision-making algorithm for airway protection during GI endoscopy

	Score
BMI (kg/m^2)	
<25	0
25–35	1
>35	2
Timing	
Elective	0
Urgent/starts after 6 pm/weekend	1
Lower GI bleed emergency	2
Upper GI bleed emergency	4
Aspiration risk	
Nil per os	0
No or controlled GERD	0
Active GERD/history of aspiration/NG tube	1
Cardiopulmonary function	
Stable	0
Sepsis/pulmonary hypertension/requires supplemental oxygen	1
Unstable	2
Airways	
Mallampati <3	0
Mallampati ≥3	1
Confirmed or suspected sleep apnea	1

Data from [25,26].
BMI, body mass index; GI, gastrointestinal; GERD, gastroesophageal reflux disease; NG, nasogastric.

CONDUCTING ANESTHESIA FOR DIGESTIVE ENDOSCOPY

Monitoring

Whatever the anesthetic procedure: sedation or anesthesia, conventional monitoring is required. In patients sedated in spontaneous ventilation, the value brought by capnographic monitoring of respiratory rate is now undisputable [27].

Exhaled CO_2 trace is easily accessible from specific nasal cannulas and face masks devices. The use of a capnograph during endoscopy significantly reduces the incidence and duration of apnea, airway obstruction, desaturations and hypoxias [28–31]. In a US registry study, the use of a capnograph was associated with a significant decrease in in-hospital mortality [32]. In two articles reporting legal actions following adverse events during sedation, most respiratory events would have been preventable with the presence of a capnograph [33,34].

Although not recommended by expert groups, the use of the bispectral index (BIS), to monitor the depth of anesthesia, has demonstrated its benefit on the lowering of sedation drug dose, the reduction of cognitive performance's decline and the optimization of patient and endoscopist satisfaction [35▪▪,36,37].

Anesthetic agents for sedation

Routine upper and/or lower GI tract endoscopy is a rapid procedure when no additional biopsy or resection is planned; the goals of sedation are improving patient' comfort during the procedure and allowing rapid awakening and discharge of outpatients. Sedation should be sufficient to inhibit the gag reflex and laryngospasm during the introduction of the endoscope without causing apnea and hypoxia. The 'modified observer's assessment of alertness/sedation scale' is a validated tool to evaluate the depth of sedation (Table 2) [38].

Propofol is commonly used given its rapid onset of action, its ease of handling and its short half-life. Compared to other hypnotic drugs, propofol is associated with a faster recovery, earlier discharge, more appropriate sedation level, reduced incidence of nausea/vomiting and greater patient satisfaction without any increase in cardiac and respiratory complications [39,40]. Due to its respiratory depressant and hypotensive effects, the use of propofol should be limited to properly trained medical staff.

Table 2. The modified observer's alertness/sedation scale (MOAA/S)

Score	Description	Level of sedation or anesthesia
5	Responds readily to name spoken	Minimal
4	Lethargic response to name spoken	Moderate
3	Responds after name called loudly/repeatedly	Moderate
2	Purposeful response to mild-to-moderate shaking	Moderate
1	Responds to trapezius squeeze	Deep
0	No response to trapezius squeeze	Light general anesthesia

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Propofol can be administered by bolus, continuous infusion or target controlled infusions (TCI). Compared to manual intermittent administration, propofol TCI showed significant benefit on the occurrence of hypoxia, hypotension and patient satisfaction [41,42].

Midazolam is used predominantly worldwide for sedation during GI endoscopy especially in countries where administration is performed by nonanesthetists [7]. In a survey performed by the American College of Gastroenterology in 2006, the combination of midazolam and fentanyl was used in 75% of colonoscopies in the United States [43]. However, when compared to propofol, midazolam produce less adequate sedation, prolonged recovery and more frequent episodes of hypoxia [39].

Remimazolam is a new benzodiazepine rapidly metabolized by plasma esterases. Its onset of action ranges between 1 and 3 min and elimination half-life is about 7 min. This new drug is subject to numerous recent and ongoing clinical trials and could be a promising alternative to propofol in this setting [44–47].

Dexmedetomidine is a selective alpha-2 receptor agonist with sedative, anxiolytic and mild analgesic properties, devoided of significant respiratory depressor effect. However, it induces hypotension, bradycardia and, sometimes, cardiac sinus blocks. In addition, it takes a longer time compared to propofol to achieve adequate sedation for the procedure. Current data in the literature are against its routine use in GI endoscopy due to lower patient satisfaction, delayed discharge and increased hemodynamic complications [48,49]. However, in combination with midazolam, dexmedetomidine lowered the incidence of respiratory complications and sedative drug dose when conducting ERCP in elderly patients [50▪].

Rapidly eliminated opioids such as alfentanil and remifentanil would be given in patients when the procedure is supposed to be especially painful. The combination with an hypnotic drug allows to decrease the nociceptive stimuli but also to limit their reflexogenic consequences [51]. In several studies, administration of opioids allows reducing the propofol dose, accelerates outpatient discharge and decreases postoperative cognitive dysfunction and pain after the procedure in several studies [52,53▪,54].

ACUTE GASTROINTESTINAL BLEEDING

The incidence of acute upper GI bleeding is 143/100 000 inhabitants per year [55,56]. Any acute upper GI bleeding should be investigated by GI endoscopy within 24 h. The Glasgow-Blatchford score, is used to stratify the risk of poor prognosis for upper GI bleeding [57]. The time to perform endoscopy should be <12 h in case of hemodynamic instability, intra-hospital hemorrhage, contraindication to discontinuation of anticoagulants, or portal hypertension [58].

An emergency upper GI endoscopy is also recommended in case of lower GI bleeding with persisting hypotension and/or severe hematochezia associated with one of the following criteria: melena, cirrhosis, aspirin or nonsteroidal anti-inflammatory drugs or previous history of upper GI bleeding. In the absence of an identified source of upper GI bleeding, a colonoscopy is also performed and could be delayed within 12–48 h after adequate preparation when the hemodynamic status is stable [59,60▪▪].

In case of emergency endoscopy for GI bleeding, it is now recommended to protect the airway from gastric content aspiration by OTI, even more in the presence of encephalopathy or agitation, but the level of recommendations is low. To improve the tolerability of a rapid sequence intubation in a patient with hemodynamic instability, it is mandatory to initiate prior fluid resuscitation and vasopressor support (low-dose norepinephrine) if necessary. Permissive hypotension (systolic BP between 80 and 100 mmHg) can be tolerated [61▪]. Extubation should be performed as soon as possible after endoscopy.

SPECIFIC PROCEDURES AND POSSIBLE ISSUES

Endoscopic retrograde cholangiopancreatography

The anesthetic management of ERCP is challenging. First, the patient may be positioned in lateral or prone position, which limits airways access. In addition, the procedure requires complete immobility of the patient (particularly during intracorporeal lithotripsy); anesthesia is therefore advised. The duration varies greatly whether a simple removal of a biliary prosthesis or a complex extraction of biliary lithiasis is performed. Anesthesia with OTI is consequently the gold standard for a majority of ERCP. In a randomized controlled trial, comparing deep sedation and anesthesia with OTI for ERCP in 200 patients at risk for sedation-related adverse events (STOP BANG ≥ 3, Ascites, BMI ≥ 35, chronic lung disease, ASA >3, Mallampati 4, chronic alcoholism), the occurrence of adverse events was higher in the sedation group in which 10% rescue OTI was necessary. However, there was no significant difference between the two groups, in the quality and duration

of the procedure and in the Aldrete scores in the recovery room [62]. When deep sedation without intubation is performed, the use of high-flow oxygenation is a validated and safe strategy [24▪▪,63▪].

Patients requiring ERCP may suffer from severe acute or chronic pathology, sepsis or septic shock. In case of severe acute angiocholitis, it is suggested to perform main bile duct deobstruction within 24–48 h [64]. The 2018 revised Tokyo criteria and the 2019 ESGE guidelines shorten the delay to 12 h in case of septic shock [65,66]. In most cases, antibiotic prophylaxis or curative treatment is recommended [67].

Air embolism is one of the most severe and potentially fatal complication during ERCP [68]. Its incidence, diagnosed by precordial Doppler, is 2.4% but only half of the patients has hemodynamic disturbances related to embolism [69]. The diagnosis is evoked in case of sudden oxygen desaturation associated with end-tidal CO_2 and cardiovascular collapse. Management consists in stopping the procedure and the insufflation, switching to 100% inspired oxygen fraction, stopping the positive expiratory pressure if any, administering fluid load and, if required, a vasopressor support.

Mucosectomy and endoscopic submucosal dissection

Endoscopic submucosal dissection allows a monobloc resection of superficial flat precancerous and cancerous lesions of the esophagus, stomach, colon and upper rectum [70]. These procedures, requiring general anesthesia, are performed under carbon dioxide insufflation in order to reduce the occurrence of postoperative complications [71,72]. The ventilatory parameters must therefore be adapted to avoid the occurrence of severe hypercapnia. Large resections, particularly submucosal resections, may last several hours. Antibiotic prophylaxis is advised for colonic and rectal lesions. A urinary catheterization for procedures lasting more than 2 h should be considered. As with conventional surgery, prevention of postoperative nausea and vomiting and administration of analgesics at the end of the procedure are necessary. For upper resections (esophageal or gastric), a proton pump inhibitor treatment could be indicated. The use of topical or intravenous local anesthetics has shown interesting results on the management of ESD postoperative pain [73,74].

Enteroscopy

Enteroscopy is a diagnostic and therapeutic technique to explore the small intestine using a longer endoscope with two balloons to 'stack' the intestine. Enteroscopy is most often indicated in cases of bleeding from the bowel, which are detected by capsule endoscopy. This examination is often long and uncomfortable requires deep sedation. The indication for OTI will depend on the expected duration of the procedure conditioned by the location of the lesion (distance from the duodenojejunal flexure) and its size.

Gastrostomy per endoscopy

Percutaneous gastrostomy (PEG) is a frequently performed in elderly and comorbid patients. It requires antibiotic prophylaxis, local anesthesia at the puncture site and deep sedation possibly associated with an opioid injection at the most painful moment, during transparietal puncture and traction of the gastrostomy tube. In case of frequent dysphagia symptoms justifying the placement of GPE, airway protection is recommended. PEG can also contribute to improve quality of life and obstructive symptoms in palliative gastrointestinal cancer patient with a success rate superior to 95% and an incidence of complications lower than 5% [75].

Esophageal dilatation and upper stents

Esophageal dilatation may be indicated in patients with achalasia, inflammatory, caustic or tumor stenosis. The procedure is performed in the supine position and most often requires OTI because patients with these disorders are considered 'full stomach'. Intubation also seems to be necessary during upper GI stenting. These procedures are often performed under radiological control; they therefore require radiation protection equipment.

Preneoplastic lesions of the esophagus

Patients with endobrachyoesophagus (EBO) are at risk of developing esophageal adenocarcinoma. To prevent this occurrence, they might benefit from mucosectomy or radiofrequency ablation. To identify precancerous lesions, the operator may use acetic acid or Lugol's stain. When the latter is administered too close to the upper esophageal sphincter, the risk of bronchospasm is increased. OTI is recommended in case of staining with Lugol.

Endoscopic pancreatic necrosectomy

Minimally invasive management of fluid collection, secondary to severe acute pancreatitis, has shown a clear benefit compared to surgery [76,77▪▪]. Several sessions are often necessary to completely drain the collections. This long duration procedure can be

performed in the left lateral or supine position. Given the clinical status of the patients, the frequency of intercurrent sepsis and the major risk of aspiration of drained pancreatic necrosis, airway protection is mandatory. Bacteriological samples can be collected to guide ongoing or future antibiotic therapy. The concomitant placement of a naso-jejunal tube may allow the delivery of enteral nutrition below the pathological area.

Upper echo-endoscopy

Diagnostic echo-endoscopy is used for analysis and classification of tumors of the esophagus, stomach, pancreas, rectum and anus, for the search of lithiasis of the main biliary tract and for the diagnosis of cystic pancreatic lesions with or without biopsy. Upper GI echo-endoscopy procedures are most commonly performed in the left lateral decubitus position. Antibiotic prophylaxis should be considered in case of cyst puncture. This procedure does not systematically require general anesthesia with OTI; however, deep sedation conducted by an anesthesia professional increases the success rate of cytological diagnosis by 10% in fine needle puncture procedures [78]. The use of a propofol TCI ensures stable sedation and patient comfort [79].

Peroral endoscopic myotomy

Peroral Endoscopic Myotomy (POEM) is a recent treatment indicated for esophageal motility disorders and particularly for patients suffering from achalasia. This procedure drastically reduces the morbi-mortality of the procedure compared to a surgical myotomy. The risk of aspiration is major in patients suffering from achalasia, the indication of rapid sequence anesthesia with OTI is required. Prior esophageal emptying with a nasogastric tube may reduce aspiration risk. Pneumoperitoneum, pneumothorax, pleural effusion or subcutaneous emphysema may occur as complications of the procedure. Rigorous postoperative respiratory monitoring is preferable.

CONCLUSION

Stringent evaluation of patients scheduled for GI tract endoscopy, is essential for determination of appropriate anesthetic protocols. The controlled administration of anesthetic agents aiming at obtaining an optimal level of sedation associated with a thoughtful airway management ensures the quality and safety of GI spectrum of procedures. The availability of technical tools for monitoring (capnographs adapted to spontaneous ventilation, BIS), administration (TCI) and oxygenation (high flow nasal oxygenation) secures the clinical practice.

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Conflicts of interest

There are no conflicts of interest.

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