Impact of enteroscopy on diagnosis and management of small bowel tumors

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Abstract

Small bowel tumors (SBTs) have been increasingly diagnosed in recent decades. The pathogenesis of this increment is largely unknown, but advances in radiological and endoscopic methods facilitate the improvement of the diagnosis. Capsule endoscopy (CE) and device-assisted enteroscopy (DAE) allow the clinician to assess the entire small bowel in the search for suspicious lesions, or a cause of symptoms. In this review, we discuss the role of enteroscopy, techniques and strategies in the diagnosis and management of SBTs, and a brief description of the most common tumors.

Keywords: Device-assisted enteroscopy; capsule endoscopy; double balloon endoscopy; single balloon endoscopy; small bowel tumors; enteroscopy

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Introduction

Small intestine involves 70%−80% of the total length of the gastrointestinal tract, about 5−7 meters in length; however, neoplasms of this region are rare. Only 3%−6% of gastrointestinal neoplasms, and just 1%−3% of malignant tumors of the gastrointestinal tract develop into the small intestine (1,2). Nonetheless, there was an increase in the incidence of small bowel tumors (SBTs) over the last decade worldwide, probably due to the advances in radiological and endoscopic methods (3-5).

According to the US Surveillance, Epidemiology, and End Results (SEER) program, the rate of estimated new cases in 2019 was 10,590, representing 0.6% of all new cancer cases. The number of new cases of small bowel cancer was 2.4 per 100,000 men and women per year. These rates are age-adjusted and based on 2012-2016 cases (6).

Several tumors can arise within the small bowel, either benign (such as leiomyomas, lipomas, and adenomas) or malignant [most frequent correspond to neuroendocrine tumors (NETs), adenocarcinomas, lymphomas, and sarcomas].

Pre-malignant lesions and polyposis syndromes are associated to increased risk of small bowel carcinoma warranting screening, surveillance and appropriate treatment (7). The knowledge of the epidemiology of SBTs helps to increase the awareness of this disease (8,9).

Mid gastrointestinal tract corresponds to the segment through the Vater’s ampulla and the ileocecal valve (10). Therefore, lesions located at the distal duodenal portions, jejunum and ileum might be explored by enteroscopy. Push enteroscopy represents an alternative for lesions located at distal duodenum and proximal jejunum and for lesions located at distal ileum, but has no role for the diagnosis of mid small bowel lesions (11).

With the advent of capsule endoscopy (CE) and device-assisted enteroscopy (DAE) almost 2 decades ago, the
diagnosis of deep SBTs has improved (12–14).

The purpose of this review is to describe the role of enteroscopy into the diagnosis and management of SBTs.

**Role of diagnostic enteroscopy**

The most frequent clinical presentations of SBTs are obscure gastrointestinal bleeding (OGIB), weight loss, diarrhea and abdominal pain (15). Conversely, the diagnosis of SBTs is often done at an advanced stage due to the non-specificity of the symptoms, the low degree of suspicion and the difficulty in assessing the organ. Cross-sectional imaging techniques through computed tomography or magnetic resonance can be used for the diagnosis, and has also an important role for tumor staging (16).

Small bowel endoscopy is imperative after negative hemorrhagic foci at upper digestive endoscopy and colonoscopy. It has been demonstrated that SBTs represent the second most common cause of OGIB, representing around 18.5% of these patients (17). CE represents the first endoscopic diagnostic tool for a nonobstructive SBT investigation, since it is a non-invasive method, causing no discomfort for the patient. CE allows examination of the entire small bowel, and guides the route of DAE, despite of not allowing biopsies or therapy. Nonetheless, the sensitivity is around 83.3%, due to rapid passage in the proximal small bowel resulting in missed lesions (18).

CE may also misdiagnose subepithelial lesions, because many SBTs are represented by GISTs and NETs. For differentiating from innocent bulges, a smooth, protruding lesion index on CE (SPICE) was proposed, consisting of 4 criteria (a mass with ill-defined boundaries, diameter larger than its height, nonvisible lumen in the frames, and mass image lasting less than ten minutes). Lesions with index higher than 2 are predictive of submucosal malignant mass, with 83.3% sensitivity and 89.4% specificity (19). This index was validated and supported later by Rodrigues et al., in 2017 (20). In patients with negative CE, but with high suspicion of a SBT, the use of DAE is justified (21,22).

DAE includes balloon enteroscopy (single balloon or double balloon) and spiral enteroscopy (23–27). The combination of antegrade (orally) and retrograde (anal) routes allows the examination of the entire small bowel in about 70% of the cases using double balloon enteroscopy (DBE) (28). Recently, the motorized spiral enteroscope enables the examination of the entire length of the small bowel in some cases by oral route only. The combination of the two routes using motorized spiral enteroscope has a high rate of complete small bowel examination (29).

It has been demonstrated that DBE has higher positive rate of diagnosis (85.9%) when compared to computed tomography scan (72.9%), when an SBT is suspected (30).

Sulbaran et al., in a meta-analysis and systematic review, including 15 studies and 821 patients demonstrated high overall prevalence of SBTs through DAE, performed in patients presenting with OGIB; with 89% sensitivity, and 97% specificity (31).

In patients with suspected SBTs, DAE does allow the diagnostic histological confirmation through biopsy samples, and also tattooing the lesion, guiding further surgical treatment. Another advantage of DAE is the possibility of small bowel examination in patients with altered anatomy. The rate of SBTs diagnosed by DAE for diverse indications varies from 3.2% to 19.7%. One reason for such variation is due to the diversity among series that include benign and malignant tumors (2).

**Role of therapeutic enteroscopy**

DAE has also been used to perform therapeutic procedures, similarly to conventional endoscopy and colonoscopy, for instance hemostasis, polypectomy, endoscopic mucosal resection, and stent placement (32–34).

Few reported cases demonstrated the value of DAE on the management of SBTs. One strategy consisted of a placement of an endoloop for a small benign tumor (“loop-and-let-go”) that does not need to be recovered for histology; and endoscopic mucosal resection for an early SBT in an afferent loop of a patient with altered anatomy (Roux-en-Y reconstruction) (35,36). Endoscopic submucosal dissection of deep SBT has also been feasible (37).

DAE has also been utilized for palliative treatment with stenting of advanced SBT’s, using self-expandable metallic stent (SEMS) into deep small bowel, despite of long enteroscope with small working channel. The strategy consists of removing the enteroscope under fluoroscopy, and inserting the SEMS over the guidewire and through the overtube, which is left in place with the inflated balloon (38–41). Moreover, for patients with altered anatomy, short DAE using short enteroscopes or standard endoscopes with large working channel, allows the placement of through-the-scope (TTS) SEMS (42–44).

DAE should be preferred than an intra-operative enteroscopy, which is an invasive technique and has a
significantly higher morbidity and mortality, leading the later strategy for exceptional cases (15).

Another alternative for patients with multiple abdominal surgeries and adhesions consists of DAE assisted by laparoscopy, which allows the surgeon to facilitate the progression of the enteroscope into deep small bowel, and in case of a complication, such as a perforation, to treat it immediately (45).

Thus, DAE has a great impact on SBT management, and some authors report changing therapeutic plans in almost two thirds of patients, including suspension of an emergency surgery, modification on the surgical approach, and the type of resection (15,22).

Endoscopic characteristics of SBTs are described below.

**Benign tumors**

**Leiomyoma**

It represents the most common benign tumor, involving approximately 25% of the cases, followed by lipomas, adenomas, hamartomas and angiomas. It is more frequent in jejunum, followed by ileum and duodenum. Generally, they are single, and presented as an umbilicated lesion, with central ulceration, covered by normal epithelium (46).

**Lipoma**

It is a benign tumor, with no malignant potential, located anywhere in the digestive tract. The majority corresponds to an incidental finding during surgeries and autopsies. At endoscopy, the lesions present as subepithelial, yellow or orange in color, and show a positive pillow sign with compression with biopsy forceps (2,47) (Figure 1).

**Angiomas**

Angiomas comprise about 7% of benign lesions, and represent tumors that originate from blood or lymphatic vessels.

**Hemangioma**

Hemangiomas originate from the submucosal vascular plexus and are classified into capillaries, cavernous or mixed lesions. They vary in size from tiny to large lesions, and may be multiple, with the jejunum being the common site of involvement. They may cause abdominal pain, bleeding and/or obstruction. Advances in endoscopic techniques with argon plasma coagulation, and sclerotherapy, have led to successful endoscopic interventions, however large lesions need surgical resection (33,34,48) (Figure 2A,B).

**Lymphangioma**

Lymphangiomas are uncommon benign tumors, accounting for only 3% of the SBTs. They can be cavernous or cystic. Endoscopically, the lesions appear as whitish elevated cystic lesions. Although lymphangiomas are benign neoplasms, they can cause severe bleeding (49,50) (Figure 2C).

**Adenoma**

It represents a benign tumor, but with a high-risk rate of malignancy. Therefore, when diagnosed, endoscopic resection is indicated. Histologically, they are classified into tubular, villous and tubulovillous adenoma. Villous component, size, and presence of high-grade dysplasia increase the risk of malignancy. Most adenomas are single, although they can be multiple, especially when associated with an inherited syndrome such as hereditary familial polyposis. All patients undergoing local resection must be under endoscopic surveillance. Patients with polyoid syndromes, such as familial adenomatous polyposis (FAP), Peutz-Jeghers syndrome and Lynch syndrome have higher risk of developing adenoma and adenocarcinoma (51).

**FAP**

FAP represents an autosomal dominant inherited syndrome, resulting from the germline mutation of the adenomatous polyposis coli (APC) gene on chromosome 5q21. In addition to colorectal cancer, patients are at risk...
up to 300 times greater than the general population of developing ampullary and duodenal adenocarcinoma. Patients with FAP have a 5%–10% lifetime risk of developing duodenal cancer. Ampullary region represents the preferred location for development of adenomas, which can undergo malignant transformation (51).

Duodenal polyposis occurs in 90% of FAP patients and can be classified with Spigelman staging based on 4 criteria (polyp number, polyp size, histology and dysplasia) (52). The risk of developing cancer may be related to the Spigelman stage, with 50% risk in stage IV. Therefore, endoscopic periodical surveillance with biopsy is necessary in these patients (53,54). Chromoendoscopy should be performed to improve the detection of flat and small lesions (55).

Current guidelines recommend forward- and laterally-viewing endoscopic examination as the first approaches for proximal small bowel surveillance (56,57). For further investigation and surveillance of deep small bowel lesions, CE represents the best and a safe approach, even in patients who underwent colectomies or several abdominal surgeries, despite of a limitation in the ability to evaluate the precise location and the exact polyp size (58,59). In patients with extensive duodenal polyposis, including Spigelman III and IV, DAE revealed that jejunal adenomas are diminutive and are located at proximal segment (60-62) (Figure 3). Few cases of jejunal adenocarcinoma have been reported (63). However, the majority of studies revealed limited clinical relevance of jejunal polyposis in FAP, even in high-risk patients with advanced duodenal disease (60,64). Thus, DAE should be individualized in a case-by-case, in patients with Spigelman III and IV, due to the possibility of histological confirmation and therapeutic intervention (61). Novel molecular alterations may identify high-risk patients for the development of jejunal neoplasms in FAP patients.

DAE may be indicated for endoscopic resections of small bowel lesions, and the strategy usually consists of: lesions smaller than 5 mm in size can be removed by biopsy forceps, lesions between 5 and 20 mm in size should undergo endoscopic mucosal dissection, and lesions larger than 20 mm must be removed by endoscopic submucosal dissection (37,64). DAE has also an important role in surveillance of FAP patients with Roux-en-Y reconstruction after a Whipple procedure, for investigation of an anatomically altered bowel segment (65).

**Peutz-Jeghers syndrome**

Peutz-Jeghers syndrome (PJS) is an autosomal dominant polyposis characterized by the presence of hamartomatous polyps in the digestive tract, besides mucocutaneous hyperpigmentation. The disease is related to the mutation of the LKB1 gene, located on chromosome 19, responsible for the enzyme serine-threonine kinase, which, under normal conditions, has a tumor suppressive effect (66).

The polyps are more common in the small intestine and less frequent in the stomach and colon. The small bowel is affected in 96% of patients with PJS, and in general the polyps are multiple, either sessile or pedunculated, and may vary in size. Clinically, they may be manifested with OGIB and intestinal obstruction due to intussusception.
Hamartomatous polyps are considered benign lesions, however they are associated with an increased risk of adenocarcinoma in the small intestine. It is not known whether they originate from these or from associated adenomas (Figure 4A).

In a small series, it was demonstrated that magnetic resonance imaging and DBE has a comparable diagnostic yield of polyps larger than 15 mm, however DBE has an advantage of direct intervention (67).

CE should be indicated for diagnosing and monitoring the lesions in an early age (10 years of age), selecting the endoscopic approach and predicting the difficulty of DAE procedure (68,69). On the other hand, DAE is indicated for resecting the lesions, decreasing the risk of short bowel syndrome due to multiple intestinal resections (70). Such strategy has a great impact for pediatric patients (71). In complex cases, with many large polyps and previous intestinal resections, laparoscopic-assisted enteroscopy represents another strategy, since it allows intra-abdominal adhesiolysis and polypectomies in a single procedure (38).

According to the European guideline, all polyps larger than 10 mm in size should be removed, since polyps larger than 15 mm in size are considered a risk factor for small bowel intussusception with intestinal obstruction (56). Additionally, symptomatic or rapidly growing polyps should also be removed. Sakamoto et al., in 2011, described a strategy for polyp resections in patients with PJS. The authors recommend: to treat first lesions larger than 20 mm in size, and then the lesions larger than 10 mm; all polyps larger than 30 mm in size should be sent to pathology due to high risk of malignancy; clip could be applied in the base of the polyp for lesions which do not require histology, leading to ischemia and necrosis; and, in order to prevent intussusception, to treat the polyps sequentially and by anal route because large polyps resected by oral route could move and pile up to distal polyps and cause intussusception (72). It is also recommended to inject saline-epinephrine solution into the submucosa layer of the stalk and the base of the polyp to reduce the risk of bleeding and perforation during the resection (Figure 4B).

Underwater endoscopic resection through DAE represents another strategy for a large polyp, since the water immersion ensured an adequate visualization of the base of the polyp, facilitating the polypectomy, as recently described (73).

**Malignant tumors**

Four histological types represent about 90% of the malignant tumors, including NET, adenocarcinoma, lymphoma and gastrointestinal stromal tumors (GIST). The incidence of malignant tumors in the small intestine increases with age, being more frequent in the seventy decades. In 90% of the cases, they are diagnosed after 40 years of age with a slight male predominance (1.5:1) (3-5,74).

**NET**

NETs represent the most frequent primary small bowel malignancy and a worldwide overall increase is observed probably due to better knowledge of the disease (70). The majority consists of well-differentiated NETs (classified as Grade 1 and 2), characterized by a low proliferation rate, formerly called carcinoid. These tumors are most commonly detected in the terminal ileum, within 60 cm of the ileocecal valve. NET tumors of the jejunum and ileum derive from serotonin-producing enterochromaffin cells. Due to the indolent growth, the majority is asymptomatic, and is often diagnosed at an advanced stage, locally or metastatic. They can be multiple in about 30% of cases in the small intestine, justifying the exploration of the entire small bowel. Multiple NETs occur in younger patients and are more likely to develop carcinoid syndrome, with a worse prognosis. The vast majority of patients with carcinoid syndrome have metastatic disease from a primary SBT, usually to the liver. Poorly differentiating NETs, also called neuroendocrine carcinomas, are exceptional, and have a high grade of malignancy. Other less common NETs include: gangliocytic paraganglioma, somatostatinoma, vipoma and schwannoma (75-77).

The diagnosis of deep small bowel NET is a challenge. Cross-sectional imaging represents the first strategy for the diagnosis. Somatostatin receptor imaging seems to be useful pre-operatively, since it confirms the presence and

**Figure 4** Double balloon endoscopy in patients with Peutz-Jeghers syndrome. (A) Multiple polyps, varying in size, some pedunculated and some sessile; (B) A polypectomy.
functionality of the disease, however it is limited to provide the exact location. CE should be the endoscopic method of choice in order to guide the route of DAE (78-80). DAE should be preferentially performed in patients with previous positive exams, for biopsies sampling, and marking the exact location of the lesion (81-84) (Figure 5).

**Adenocarcinoma**

The incidence of adenocarcinoma is the highest in the duodenum and decreases progressively throughout the jejunum and ileum (5,85) (Figure 6).

Adenocarcinoma of the duodenum is an uncommon disease, corresponding to 0.5% of all tumors of the gastrointestinal tract. It corresponds to the most frequent histological type of malignant tumors of the duodenum (50% of cases) (86). The second duodenal portion is the site with the highest incidence of adenocarcinoma (74%), followed by the third (13%), fourth (9%) and first (4%) portions. Early lesions, confined to the mucosa and submucosa, can be managed by endoscopic mucosal or submucosal resection, but for an advanced disease, surgical resection represents the best approach (87).

Patients with small bowel Crohn’s disease may develop adenocarcinoma at the ileum, and this risk is directly related to the extent of small bowel involvement and to the duration of Crohn’s disease (85).

Celiac patients are considered a high-risk group for small bowel malignancies, including adenocarcinoma, and lymphoma. CE and DAE may be indicated for a subset group of refractory celiac disease, especially in patients with alarm symptoms (88).

**Lymphoma**

Small bowel lymphomas correspond either as a primary tumor or a component of a systemic disease. Stomach and small bowel are the most common extranodal sites of primary gastrointestinal tract lymphoma (89).

Lymphomas are the third most common malignancy in the small intestine, accounting for about 15%–20% of the cases. They involve the jejunum in 35%, the ileum in 53% and the duodenum in only 12% of the cases (74,90) (Figure 7).

**Lymphoma B**

Most primary small intestine lymphomas are non-Hodgkin type B-cells. They include: low-grade mucosa-associated lymphoid tissue (MALT), immunoproliferative disease of the small intestine (IPSID); follicular lymphoma,
lymphocytic lymphoma; mantle cell lymphoma, large B-cell lymphoma, Burkitt-type lymphoma; and lymphomas associated with immunodeficiency (AIDS, immunosuppressive therapies) (91-93).

Endoscopic findings of lymphoma may have distinct presentations, for instance, thickening of the mucosa, nodular appearance, ulcerations, polypoid formations or even diffuse infiltrative lesions. DAE is essential for performing biopsies and histological evaluation (94).

IPSID, also known as alpha heavy chain disease or diffuse gastrointestinal lymphoma or Mediterranean lymphoma, represents a variant of MALT lymphoma. It is more common in Mediterranean countries, the Middle East and North Africa. It affects young patients between 10 and 35 years old with an average of 25 years old. Diarrhea is one of the first symptoms. There is evidence that microbial and parasitic colonization of the small intestine is related to its pathogenesis since there is a response to antibiotic treatment in the early stage of the disease. Endoscopically, they can appear as diffuse nodular lesions (Figure 8) (95).

T-cell lymphoma
Most enteropathic T-cell tumors are associated with celiac disease. They are rare neoplasms, representing 5% of gastrointestinal lymphomas. It is predominant in men with an average age of approximately 60 years old. The proximal jejunum is the most commonly affected location, but it can involve the entire small intestine (96,97).

In a meta-analysis of enteroscopy use (including CE, double-balloon and push enteroscopy) the diagnostic yield was 1.8% for the detection of malignant lesions in patients with refractory celiac diseases (97). The authors recommended upper gastrointestinal endoscopy plus CE as first approaches for patients unresponsive to gluten-free diet, with alarm symptoms or iron deficiency anemia.

Plasmacytoma
Solitary extramedullary plasmacytoma is a rare neoplasm that can affect the gastrointestinal tract, and the jejunum is the main extramedullary site. Histologically, the involvement of the intestinal wall with bizarre plasma cells is observed in varying degrees of differentiation, and immunohistochemistry for CD138 confirms the positive lineage for plasma cells. Differential diagnosis with lymphoma, adenocarcinoma and other rare tumors can be difficult, emphasizing the need for histological confirmation (98).

Tumors of mesenchymal or stromal origin
Stromal-derived gastrointestinal tumors comprise a group of tumors of non-epithelial origin that are characterized by immature proliferation of epithelioid or spindle cells from the muscle layer of the gastrointestinal tract. They can originate from muscular, nerve sheath (autonomic nervous system), and primitive mesenchymal cells (interstitial Cajal cells) (99).

Stromal tumors originating from muscle tissue are leiomyomas and leiomyosarcomas. Tumors of origin in the nervous tissue of the myenteric plexus are called schwannomas and autonomic tumors of the gastrointestinal

Figure 7 Endoscopy views of lymphomas. (A,B) B cell lymphoma (ulcerated and infiltrative circumferential lesion at jejunum); (C,D) T cell lymphoma of the fourth portion of duodenum (in a patient with celiac disease demonstrating duodenal atrophy, and large circumferential ulcerated, and infiltrative lesion with signs of small bowel perforation to colon).

Figure 8 Double balloon endoscopy view of diffused and small elevated lesions at duodenum diagnosed as immunoproliferative disease of small intestine (IPSID). (A) White light endoscopy; (B) Chromoendoscopy using indigo-carmine.

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nerve. There are also lesions of undetermined origin, called undifferentiated tumors. Tumors derived from Cajal cells are called GIST.

Leiomyosarcomas
Leiomyosarcomas appear most frequently in the jejunum, ileum and duodenum, but can develop in any segment of the digestive tract. Similar to leiomyoma, they can reach large proportions before manifesting symptoms, presenting as a palpable abdominal mass at the time of diagnosis. During small bowel endoscopy, an intra-luminal subepithelial mass can be seen.

GIST
GISTs are tumors that originate from mesenchymal cells of the gastrointestinal tract that mostly express the c-kit proto-oncogene protein. The protein, also known as CD117, is located on the cell membrane and has tyrosine kinase activity, acting as a growth factor receptor. Mutation in the c-kit oncogene occurs in about 80% of the cases, resulting in an activation of cell proliferation, inhibition of apoptosis and angiogenesis (100). A subset of GISTs with no c-kit mutation has a mutation in a related receptor tyrosine kinase, the platelet derived growth factor receptor alpha (PDGFRA). The number of mitoses and the size of the tumor are considered the most important predictive factors for malignancy (101).

GISTs are more frequently located in the stomach (50%−60%), small intestine (20%−30%), colon and rectum, peritoneum, esophagus and mesentery (10%) (102). Endoscopically, they are presented as a protruded subepithelial lesion, sometimes ulcerated, and with dilated vessels (103). The majority is diagnosed in an advanced stage after causing severe bleeding. CE represents the first endoscopic approach for OGIB, and might diagnose a suspected GIST. DAE should be the next tool for diagnostic confirmation and possible biopsies (104) (Figure 9). Nonetheless, about 80% of the cases in which DAE biopsies missed the diagnosis of SBTs is due to subepithelial lesions. Low positive rates, from 46.7% to 57.4%, besides the high bleeding related risk are the reasons for concerning about the biopsies of a suspected GIST (22,102,105). Biopsies should be carefully done at the internal margin of an ulcerated lesion, avoiding the dilated vessels. DAE management of a possible bleeding after biopsy sample should be attempted for avoiding an emergent surgical procedure.

Metastatic tumors
Metastases of tumors in the small intestine can occur by direct infiltration and by hematogenous or lymphatic pathways. Metastases may be preferentially due to melanoma, lung cancer, and breast cancer, among others. These metastases are diagnosed at rates ranging from 1.5% to 4.4% of the patients. They can occur during the diagnosis of the primary lesion or decades later, as a sign of recurrence (106).

The diagnosis is usually late, at an advanced stage, since most patients are asymptomatic. The suspicion of metastasis should be made in patients with a previous history of neoplasms and intestinal habits change, intestinal obstruction or OGIB.

CE and radiological imaging tests are useful for the diagnosis of metastatic deep SBTs and guide the route of DAE. DAE has an important role, since it enables a biopsy sample and a definitive histological diagnosis. DAE can also precisely locate and mark single or multiple lesions, guiding and modifying the surgical treatment (107) (Figure 10).

Limitations and complications
Concerning the limitations and complications, it is important to know that in a low percentage, CE can miss the last part of deep small bowel. Additionally, in a small group of patients with no symptoms or signs of obstruction, CE might be retained. The rate of retention...
can occur in up to 20% of the patients with SBTs (108). Since the majority of the patients undergo surgical resection, patency capsule is not recommended by European guideline (56).

Diagnostic DAE has about 0.3%–1.2% complication rate and therapeutic DAE has about 1.6%–6.5% (109-112). Bleeding, perforation and pancreatitis are the major complications. Pancreatitis occurs in about 0.3% of the procedures, and is described during oral route DAE (111).

Final considerations

CE represents an alternative method to diagnose suspicious SBTs, but it is not recommended for suspected obstructive lesions and for a subset of patients with altered anatomy, especially for those with excluded small bowel segment.

On the other hand, DAE is considered an invasive but a safe method. It allows a definitive histological diagnosis and therapeutic procedures (113-116). In order to minimize the DAE risks, some recommendations should be followed, such as anesthetic support sedation, fluoroscopy for therapeutic procedures in patients with altered anatomy, and the use of carbon dioxide insufflation (117-119). The suitable knowledge of patient history, including the use of medications, previous abdominal surgery and previous results of radiological studies may reduce the complications (120). The awareness of how to avoid the perforation and bleeding risks, and how to manage them, especially during therapeutic procedures, is essential for performing an optimal technique (118,121).

Conclusions

CE and DAE have an enormous impact on the diagnosis and management of SBTs. CE represents the first endoscopic method especially for patients with OGIB, but with no signs of obstruction. DAE is the preferred method for patients with signs of obstruction and for patients with altered anatomy. DAE should be indicated after positive CE findings for biopsies and tumor marking. In patients with negative CE but with high suspicion of SBT, DAE should also be performed, with high diagnostic accuracy. Moreover, DAE plays a relevant role allowing therapeutic procedures, avoiding or modifying surgical interventions in many cases.

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Footnote

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Figure 10 Single balloon endoscopic images of metastatic lesions. (A,B) Metastatic obstructive jejunal lesion from lung cancer (A), and endoscopic view after placement of a metallic stent (B); (C,D) Metastasis of melanoma in jejunum (an ulcerated and infiltrative circumferential lesion, 5 cm in length).
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