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Endoscopic Ultrasound Assessment of the Duodenal Wall Lesions

Andrada Seicean, Voicu Rednic and Radu Seicean

Abstract

Subepithelial tumors (SETs) in the upper digestive tract are rare and only 10% of are located in the duodenum. Assessment of lesions protruding from the duodenal wall is difficult. Upper gastrointestinal (GI) endoscopy and computed tomography (CT) are not able to completely distinguish between different tumors and guide their subsequent management. Endoscopic ultrasonography (EUS) has a significant diagnostic yield in this context. EUS is able to accurately diagnose duodenal lesions, perform a biopsy if considered useful, guide the approach for resection and provide appropriate follow-up. SETs reported during upper GI endoscopy are more commonly cysts, polyps, lipomas, Brunner's gland adenoma, ectopic pancreas, gastrointestinal stromal tumors (GISTs) or neuroendocrine tumors (NETs). In addition, although more rarely, adenocarcinomas and lymphomas can be identified. EUS should be performed for any duodenal lesion larger than 1 cm that lacks the endoscopic characteristics of a cyst or a lipoma.

Keywords: subepithelial tumors, intramural lesions, endoscopic ultrasound, duodenum, endoscopy, interventional endoscopy

1. Introduction

Lesions of the upper gastrointestinal (GI) tract are usually assessed by esophagogastroduodenoscopy (EGD), but less importance is shown for lesions of the small intestine. Protrusive lesions of the small intestine can arise from mucosa, with endoscopic features that allow their characterization. However, deep organ involvement cannot be assessed by endoscopy. The same is true for lesions from subepithelial layers, known as subepithelial lesions (SELs). These appear as bulging lesions covered by normal mucosa, and are firm as they are "palpated" with closed biopsy forceps. The mucosa covering these lesions is usually normal, and standard biopsies or "bite-to-bite" biopsies have low diagnostic accuracy. Assessing these lesions can be difficult, as computed tomography (CT) and magnetic resonance imaging (MRI) lack the resolution to properly describe them because of their size.

Endoscopic ultrasound (EUS) overcomes these drawbacks. Due to high resolution and ability to differentiate between all layers of the GI tract [1], EUS assesses the layer of origin, size, morphologic features, and involvement of the neighboring organs. Combined with the possibility of targeted biopsies from the deeper layers, EUS is the most effective for evaluating SETs of the duodenum.

SETs of the duodenum can be true intramural lesions of the duodenal wall or extrinsic compressions. Extrinsic compression comes from adjacent structures, like the gallbladder or blood vessels. Around 1 in 5 SETs found in the upper GI tract is an extramural compression [2, 3]. Data regarding external compressions on the duodenum are few, but clinical experience suggests that they are less frequent than in the stomach. Intramural lesions can be true submucosal or pseudo-submucosal lesions. The latter are usually polyps or inflammatory lesions. True submucosal lesions originate from one of the deeper layers of the duodenal wall. Benign SETs of the duodenum include cysts, gastrointestinal stromal tumors (GISTs), leiomyomas (very rare) of the minor papilla (which at EGD can be confused with SETs), lipomas, neuroendocrine tumors (NETs) and ectopic pancreas. Malignant SETs can be malignant mesenchymal tumors, adenocarcinomas or lymphomas (**Table 1**).

A correct and complete diagnosis of an SET, including extension and proximity to other structures, is essential in deciding the following steps, as the complex localization and surroundings of the duodenum make surgical interventions difficult. Its thin walls and proximity to the biliary and pancreatic ducts makes even endoscopic therapeutic interventions more prone to serious complications like perforation. In this context, the diagnosis, prognosis and possible therapeutic options should always be properly weighed and presented to the patient before a decision is made.

SETs should be resected, endoscopically or surgically, if there is a suspicion of malignancy or if they are symptomatic. Tumors with malignant potential, like GISTs or NETs, should be resected, or in certain circumstances followed endoscopically. EUS can help guide the treatment. Generally, lesions limited to the mucosa and submucosa can be removed endoscopically, with a high safety profile, using advanced techniques like endoscopic submucosal resection (ESD). Tumors arising from the muscularis usually need surgical intervention.

	Xu et al. [4]	Markovic et al. [5]	Kawamoto et al. [6]
Total number	169	80	24
Mucosal lesions			
Inflammatory protruding or polyps	36 (21%)	13 (16%)	1(4%)
Submucosal lesions			
Cysts	40 (24%)	—	8(34%)
Brunner's adenoma	25(15%)	7 (9%)	6(25%)
Lymphangioma	—	—	1(4%)
Lipoma	6 (4%)	6 (8%)	1(4%)
Ectopic pancreas	19(11%)	—	1(4%)
Stromal tumors	17 (10%)	33 (41%)	1(4%)
NET	—	3 (4%)	—
Gangliocytic paraganglionas	—	—	1(4%)
Others			
Extrinsic compression	12(7%)	—	—
Minor papilla	12(7%)	—	—
Malignant tumors			
Malignant tumors	2 (1%)	18 (22%)	4(17%)

Table 1.
Different studies evaluating the final diagnosis in duodenal lesions referred to EUS. Most, but not all, are confirmed histologically after EUS.

2. Evaluation of a duodenal subepithelial tumor

2.1 Initial evaluation

SETs identified in the upper GI tract are rare, being found in around 1 in 300 EGDs [7]. Only around 10% of those are located in the duodenum [8]. The true prevalence probably remains unknown, as most SETs are asymptomatic and are found to be completely unrelated to the reason the EGD was performed. In a study involving 346 EUS examinations of upper GI SETs, 87% of the lesions were unrelated to the presenting symptoms of the patient [2]. The rare symptomatic cases usually manifest through occult bleeding or abdominal pain. Evaluation of a duodenal SET starts during the initial EGD. Its location, size, mobility and color should be noted. Modifications of the mucosa and "tenting" sign are also important. A firm lesion with a "pillow" sign is usually a lipoma, while a firm and translucent lesion can be a cyst. A central depression along mucosal irregularities can suggest an ectopic pancreas, while a central ulceration can be a sign of a GIST. Mucosal biopsies are rarely useful, as they only touch the mucosa and are unable to retrieve tissue from the lesion. More invasive methods, like "buttonhole" biopsies or jumbo forceps, are not always successful and carry high risk of adverse events [9]. If the lesion is not a cyst or lipoma, tissue acquisition should be performed for diagnosis, especially because some of the duodenal SELs have malignant potential.

2.2 Endoscopic ultrasound

The endosonographic morphology of SETs is based on size, layer of origin, echogenicity, echotexture, vascularity and lymph nodes [2]. The procedure is difficult in cases of large lesions or inaccessible regions like the jejunum, ileum or, sometimes, the fourth part of the duodenum.

Size should be reported in two orthogonal planes. There are five layers visible when examining the digestive tract. The first layer (hyperechoic) is the interface of the superficial mucosa with the contrast medium. The second layer (hypoechoic) is the deep part of the mucosa, containing the muscularis mucosae and lamina propria. The third layer (hyperechoic) is the submucosa and the interface between the submucosa and the muscularis propria. The fourth layer (hypoechoic) is the muscularis propria. The fifth layer is the serosa and the interface with adjacent structures. In addition, an SET described at EGD, as mentioned before, can actually be an extrinsic compression, originating beyond all layers. The relation with adjacent layers and structures has to be described. Are the layers immediately above and below distinguishable? Do they present ulcerations or irregularities? Can the neighboring structures be clearly distinguished or is there invasion? All these questions should be answered in a correctly redacted EUS result. The echogenicity of the tumor has to be noted. It can be anechoic (compare to the water in the lumen), hypoechoic (compare to muscularis propria), hyperechoic (compare to submucosa). The texture can also give useful information, as inhomogeneous lesions can raise suspicions of malignancy, as can irregular margins. For further description one can also mention the adjacent vascularization, presence of regional lymph nodes, hepatic lesions or free liquid in the peritoneum. Of all the characteristics mentioned, the most important are layer of origin and echogenicity (**Table 2**).

EUS without histological examination has a high diagnostic yield in duodenal SETs. Xu et al. reported an efficiency of up to 93.3% in a group of 75 duodenal SETs that had a later histological diagnosis [4]. However, diagnostic efficiency seems to be size related, as Brugge et al. reported a correct diagnosis in 45% of gastric lesions less than 2 cm in size and proposed, naturally, EUS with fine-needle aspiration (EUS-FNA) as the gold

	Layer of origin	Echogenicity	Size (mm)	Border	Malignancy potential
Duplication cysts	3rd/ external	Anechoic, without Doppler signal	—	Sharp, sometimes with five layers	No
Varices	3rd	Anechoic, with Doppler signal	—	Sharp, serpiginous shape	No
Lym phangiomas	3rd	Anechoic with internal septa, without Doppler signal	—	Sharp	No
Inflammatory fibroid polyp	2nd, 3rd	Hypoechoic, homogenous, polypoid	8–18	Indistinct	No
Neuroendocrine tumors	2nd, 3rd	Hypoechoic/ Intermediate echogenicity/ hyperechoic		Sharp	Yes
Ectopic pancreas	3rd, 4th	Hypoechoic, heterogeneous echotexture, with cysts or ducts inside, umbilication	< 5–20	Indistinct	No
GIST	2nd/4th	Hypoechoic, heterogenous, hypervascular	Any	Sharp when benign	Yes, when >30 mm, with cystic space or echogenic foci
Lymphoma	2nd, 3rd, 4th	Hypoechoic	Can vary	Irregular	Yes
Metastasis	Any	Hypoechoic		Irregular	Yes
Lipoma	3rd	Hyperechoic homogenous	Can vary	Sharp	No
Brunner gland hyperplasia	2nd or 3rd	Iso/Hyperechoic homogenous (less then lipoma)		Sharp	No

Table 2.
Main ultrasonographic characteristics of duodenal lesions.

standard [10]. As literature regarding duodenal SETs is scarce, there is no consensus about when to perform EUS-FNA, but as previously mentioned, EUS can perform poorly in diagnosing small lesions, so biopsies should be performed in all lesions that are considered suspicious (possible malignant or with malignity potential). All lesions of the fourth layer (muscularis propria) should be biopsied, as most gastrointestinal mesenchymal tumors (GIMTs) have these characteristics. Techniques to obtain deep biopsies, like "jumbo" or "buttonhole" biopsies, may have better outcomes than EUS-FNA in submucosal lesions, but carry high risk of hemorrhage [9, 11].

3. Lesions of the duodenal wall

3.1 Vascular lesions

Anechoic SETs account for a large number of different possible diagnoses. Doppler-color ultrasonography is the best method to differentiate between vascular and cystic lesions. Vascular lesions in the duodenum are most frequently varices;

other vascular malformations are rare. Varices are located in the third layer (submucosa) and are anechoic. Even in the absence of Doppler facilities, varices can be diagnosed by following their course, identifying other collateral vessels and perforating veins. Small varices can be compressed by the tip of the echoendoscope and misdiagnosed, so it is important to be careful. Therapeutic interventions like cyanoacrylate injection or coiling can be EUS guided.

3.2 Cystic and mixed lesions

Cystic tumors are liquid-filled cavities, hence anechogenic, that present in many different shapes and sizes. Many different lesions can present themselves as cystic or cystic-like. The most used classifications are simple cystic, polycystic or mixed (with liquid and solid components) [8].

3.2.1 Duplication cysts

Cysts are rounded, unilocular and clearly delineated, with a completely anechoic content and dorsal enhancement. The most common diagnosis is a duplication cyst, which forms from a maldevelopment of the gut. Duplication cysts are located in the third layer (submucosa) and have a characteristic duplication of all the layers of the gut wall. They have a low risk of malignant transformation, or they can become symptomatic following increasing in size, infection or rupture. EUS-FNA is rarely needed when the diagnosis is unclear.

3.2.2 Brunner's gland hyperplasia

Brunner's glands are found in the duodenum and have an alkaline secretion, neutralizing stomach acid. Hyperplasia of these glands is usually asymptomatic, but can give a polyposis-like duodenum. The cause is thought to be excessive stimulation from excessive gastric acids, chronic inflammation or the decrease of pancreatic function. They are located mainly, if not exclusively, in the duodenal bulb [5].

Echoendoscopic appearance can vary as isoechoic or hyperechoic, sometimes with cysts inside. They arise from the third layer (submucosa) and much more rarely from the second one (deep mucosa). The diagnosis is based on biopsy result (**Figure 1**).

3.2.3 Lymphangiomas

Lymphangiomas consist of multiple dilated lymphatic vessels situated mostly in the third layer (submucosa), rarely in the second layer (mucosa). They are thought to be benign malformations of the lymphatic system that form a mass in the digestive tract. Lymphangiectasias, in contrast, are dilations of existing mucosal lymphatic vessels and described endoscopically as multiple small, white polyp-like elevations in the duodenum. They are mainly found in the small intestine, have a polyp-like appearance and are soft and easily compressible with a normal overlying mucosa. Most are asymptomatic; rarely, the size can cause obstruction, abdominal pain and hemorrhage [12]. As previously mentioned, they are formed from dilated lymphatic vessels, but also from smooth muscle fibers and connective tissue. Endosonographically they most often appear as polycystic. Their appearance varies vastly depending on the amount of smooth muscle and connective tissue. When they take up a large share of the lymphangioma it appears inhomogeneous, rather than anechoic.
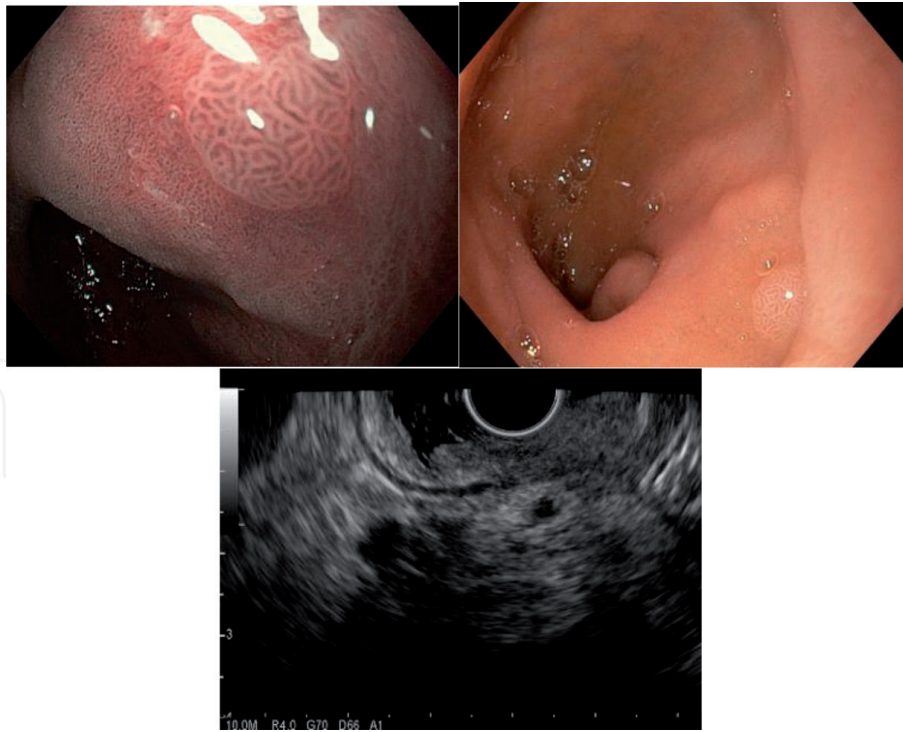
Figure 1.
Endoscopic (top row) and ultrasonographic (bottom row) appearance of Brunner's gland hyperplasia.

3.2.4 Pancreatic rest

Pancreatic rest, also known as heterotopic pancreatic tissue or ectopic pancreas, is pancreatic tissue located, aberrantly, in the digestive tract wall, most often in the stomach. It is usually asymptomatic and is an incidental finding at EGD or CT scan. Its endoscopic characteristics are irregular overlaying mucosa and a central umbilication. Rests originate from the third and fourth layer (submucosa and muscularis propria) and their sonographic appearance is most often mixed (solid and liquid) but highly variable, depending on the dominant tissue. Type 1 heterotopia consists of both pancreatic acini and ducts. Type 2 consists solely of pancreatic acini, and type 3 of pancreatic ducts. Types 1 and 2 have a hypoechoic, inhomogeneous sonographic appearance, poorly delineated from the surrounding tissue (secondary to the lobulated structure of acinous tissue). Type 3 most often appears as a septated cyst (multiple dilated pancreatic ducts). A characteristic appearance of a pancreatic rest seems to be thickening of the fourth layer behind the mass (muscularis propria) [13]. Asymptomatic lesions should be followed endoscopically for size changes, and the rare cases of symptomatic lesions can be resected endoscopically by snare, band ligation or more advanced resection techniques. If the muscularis propria is involved and the heterotopic tissue must be removed, surgical resection is preferred [14].

3.3 Solid lesions

3.3.1 Lipomas

Lipomas are the most frequent solid, hyperechoic SETs in the duodenum. They are composed of mature lipocytes and originate from the third layer (the submucosa). They are most common in the colon, but are also in the stomach and small bowel. A characteristic endoscopic appearance, with a yellowish tint and a typical

indent when compressing it with a biopsy forceps ("pillow" sign), does not need follow-up with EUS.

Echoendoscopically lipomas are hyperechoic, homogenous, arise from the third layer and are very well differentiated from the other layers with a clear margin. This typical appearance does not need histological evaluation (EUS-FNA).

Lipomas do not need treatment/resection or follow-up when they have a typical appearance and are asymptomatic (**Figure 2**).

3.3.2 GISTs

GISTs are the most common mesenchymal tumors in the GI tract, most often found in the stomach and much more rarely in the duodenum. They originate from the pacemaker cells of the digestive tract wall, the interstitial cells of Cajal. They are a class of SETs that present the most difficulties in diagnosis and management: hypoechoic SETs that originate from the muscle layers (mainly the muscularis propria, sometimes muscularis mucosae). They are similar in sonographic structure and mesenchymal origin. The molecular particularity of GISTs is a mutation in the gene that codes the c-Kit protein. More than 95% of them are immunohistochemical CD117 positive [15]. All GISTs have malignant potential, with the main factors influencing prognosis being mitotic rate, size and location (small intestinal GISTs seem to have a worse prognosis than gastric ones). The most common first symptom is GI bleeding, but a large number of GISTs are probably asymptomatic, as they are a common finding in postmortem examinations or in gastric resection specimens. GISTs in the small intestine may be more aggressive than those located in the stomach, (40–50% of GISTs in the small intestine are malignant, compared with 20–25% of gastric GISTs) [16].

Endoscopically their appearance is similar to other SETs; a bulge in the wall of the digestive tract with normal overlaying mucosa. Sometimes there is a central ulceration or inflammation of the mucosa. They are hypoechoic, arising from a muscle layer. The large ones most often arise from the fourth layer (the muscularis propria). Leiomyomas and other mesenchymal tumors, like the schwannoma, have a similar appearance, but are benign. Therefore a correct diagnosis is essential before a therapeutic decision. Location can be the best indicator of a hypoechoic SET. In the duodenum they mostly turn out to be neuroendocrine tumors. More rarely they are GISTs or granular cell tumors, and they are almost never leiomyomas.

All GISTs have malignant potential, so even though small GISTs used to be followed endoscopically, the current trend is to remove all GISTs. Differentiating between a GIST and a leiomyoma is difficult, even with EUS-FNA/FNB sometimes, thus contrast enhancement is helpful in such cases.
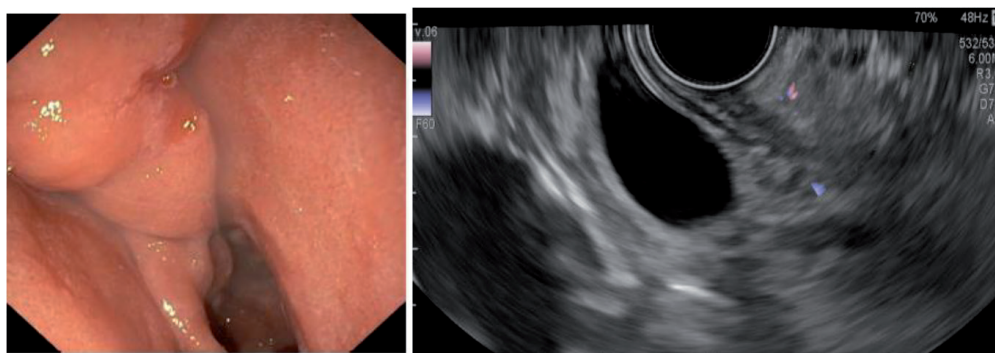

Figure 2.
Endoscopic (left) and ultrasonographic (right) appearance of a duodenal lipoma.

There is no specific study on contrast enhancement in case of duodenal SETs. A meta-analysis of gastric and esophageal SETs showed that contrast-enhanced endoscopic ultrasound is able to discriminate between GISTs and benign SETs with a pooled sensitivity of 89% and a specificity of 82%. For differentiating the malignant potential of GISTs, the sensitivity was 96% and the specificity was 53% [17]. An uptake of the contrast with the vascular hilum present suggests a leiomyoma, but a heterogenous vascularity suggests GISTs while irregular vessels suggest malignant GISTs.

3.3.3 Neuroendocrine tumors (NETs)

NETs (also known as carcinoid tumors) are mostly asymptomatic tumors with endocrine cell origin. Mostly, they are discovered incidentally, but they can cause hemorrhage, abdominal pain or syndromes related to functional active substances
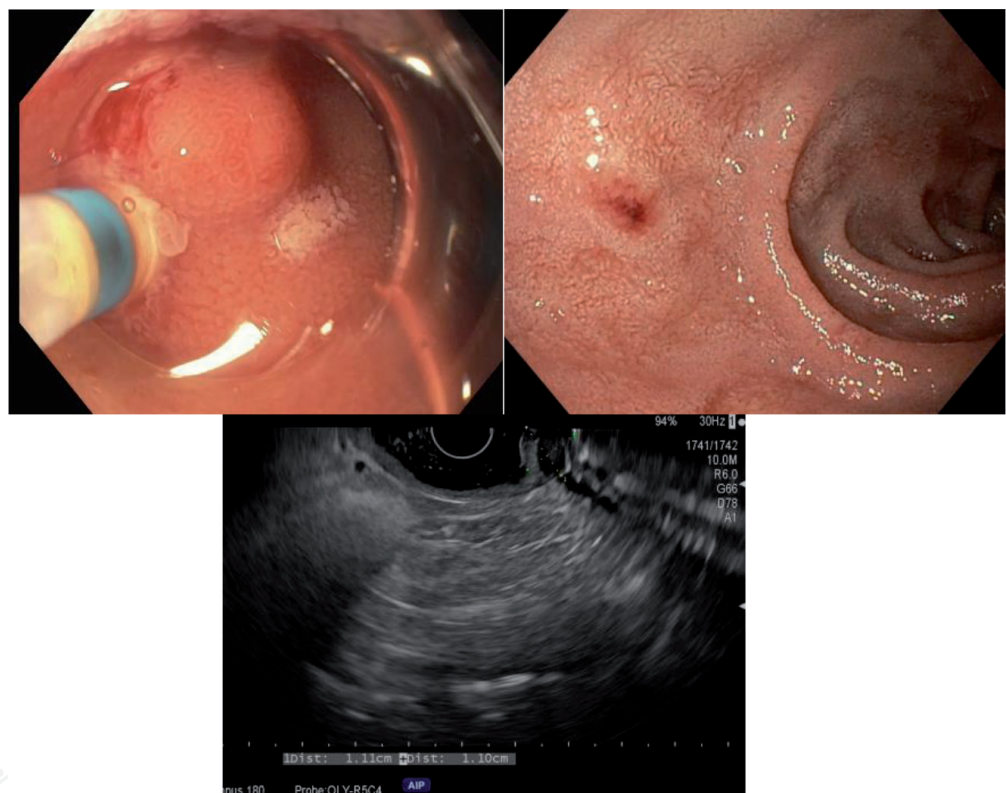

Figure 3.
(A) Endoscopic appearance during cap-assisted resection of a duodenal NET. (B) Same lesion after resection. (C) Echoendoscopic appearance of the same duodenal NET (hypoechoic, well delineated).
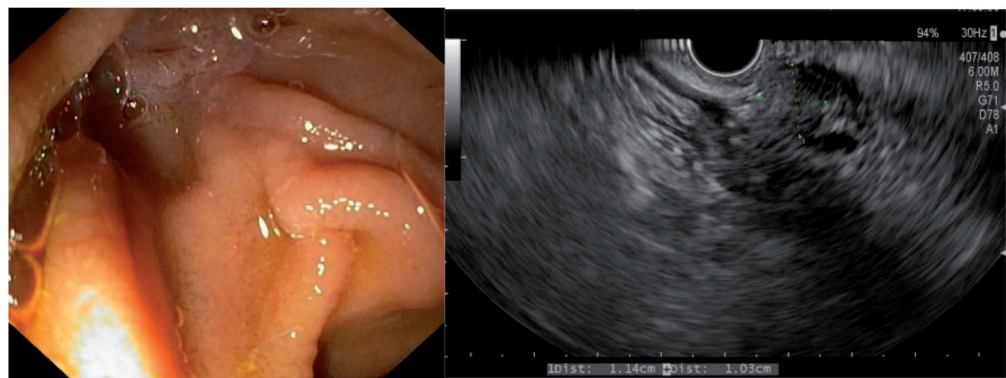

Figure 4.
Endoscopic (left) and ultrasonographic (right) appearance of the papilla.

secreted by them. They are found along the GI tract, more often in the rectum or stomach, but also in the small intestine.

Their endoscopic appearance is not characteristic, usually resembling a small polypoid lesion with normal overlaying mucosa. Endosonographically they are mostly hypoechoic or isoechoic, and arise from the second layer (mucosa), but can extend to the third layer (submucosa).

The variety of histological types, sizes and location origins, combined with the risk of malignant transformation, illustrate the necessity to resect NETs. In principle, if the lesion is smaller than 1 cm and does not invade the muscularis propria, endoscopic resection is possible, otherwise surgical resection is recommended (**Figure 3**).

3.3.4 Major and minor papilla lesions

The upstream ducts are well recognized. Following the duodenal wall, especially the muscularis major papilla represents the opening into the duodenum of the common bile duct and pancreatic duct. The tumor of the papilla is very well visualized during EUS and the dilatation of the propria can differentiate small ampullary tumors that are limited to papilla from distal common bile duct tumors, which are situated beyond the muscularis propria layer (**Figure 4**).

The pancreatic accessory duct arrives in the duodenum at the level of the minor papilla. Sometimes EGD can confound it with an SET [4]. EUS examination can easily differentiate it from a tumor, as it is not part of the duodenal wall and the secondary duct is visible arriving at this level.

3.3.5 Adenomas

Adenomas can appear in the duodenum, as anywhere else in the GI tract, sporadically or part of polyposis syndromes. They are premalignant lesions that usually necessitate removal. Peri-papillary location makes resection techniques more problematic, as simple resection can cause damage to the pancreatic or biliary ducts. Because they are mucosal lesions (second layer), solely EGD can be used for management. However, EUS can be necessary in certain circumstances, such as evaluating the depth of invasion if a malignancy is suspected, guiding the choice of treatment method (lesions extending to the submucosa need more advanced endoscopic resection techniques or surgery) and evaluating intraductal extension in peri-papillary lesions (**Figure 5**).

3.3.6 Malignant tumors

Malignant tumors of the duodenal wall are rare. Possible malignant tumors identified at this level include adenocarcinomas (from adenomas), malignant mesenchymal tumors (malignant GISTs), malignant NETs, lymphomas and metastases from other cancers (very rare).

These tumors share a common endosonographic characteristic by not respecting the layers of the duodenal wall (which are often lost) and often have adjacent lymphadenopathies.

3.4 Uncommon duodenal SETs

3.4.1 Leiomyomas

Leiomyomas are truly benign tumors arising from smooth muscle tissue, that is, the fourth layer and more rarely the second (muscularis mucosae). They are
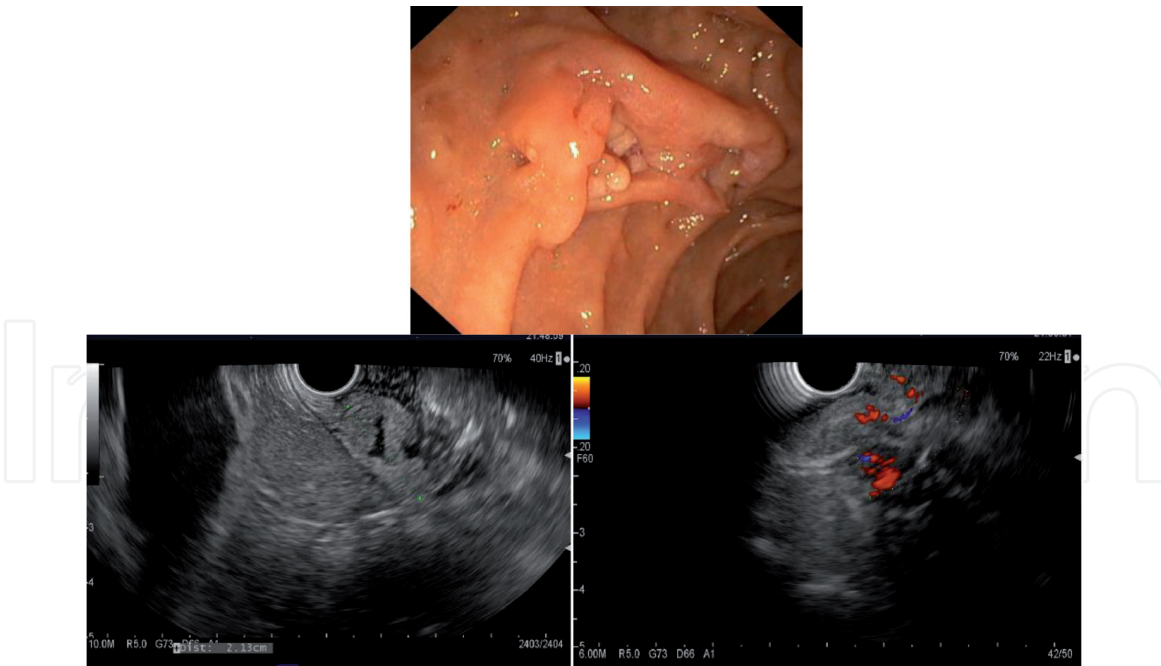
Figure 5.
Top: Endoscopic view of duodenal adenoma. Bottom: Echoendoscopic appearance of the same adenomas. Enhanced vascularization is visible.

mostly found in the esophagus, but they are described all over the GI tract. Their hypoechoic sonographic appearance makes them difficult to distinguish from other GIMTs. As such, EUS-FNA and histological examination are needed for a correct diagnosis. Resection is necessary only in case of symptoms.

3.4.2 Granular cell tumors

Granular cell tumors (also known as schwannomas) are benign lesions that arise from the peripheral nerve sheath. They are hypoechoic, homogenous, well delineated and arise from the second or third layer of the duodenum (submucosa or muscularis propria). Even though the endosonographic appearance makes them hard to differentiate from GISTs or leiomyomas, schwannomas are much more rarely encountered in the GI tract. Tissue acquisition discriminates the diagnosis in such situations.

3.4.3 Fibroid polyps

Fibroid polyps are rare inflammatory tumors, sometimes found in the duodenum. They arise from the second or third layers and are usually hyperechoic and inhomogeneous [18].

3.4.4 Hematomas

Duodenal hematomas have been described, especially after abdominal trauma. However, some are spontaneous or arise from complications of endoscopic biopsies or other invasive maneuvers. They are usually diagnosed by CT scan or EGD. EUS is only needed in cases when the diagnosis is unclear, which is rare. They arise from the deep layers of the mucosa or submucosa (second or third layer). They have a different sonographic appearance depending on when they are evaluated. Initially, they have a heterogenous appearance in the first 24 hrs, which turns hyperechoic as more clots are formed and then slowly turns hypoechoic over the following weeks as it resorbs.
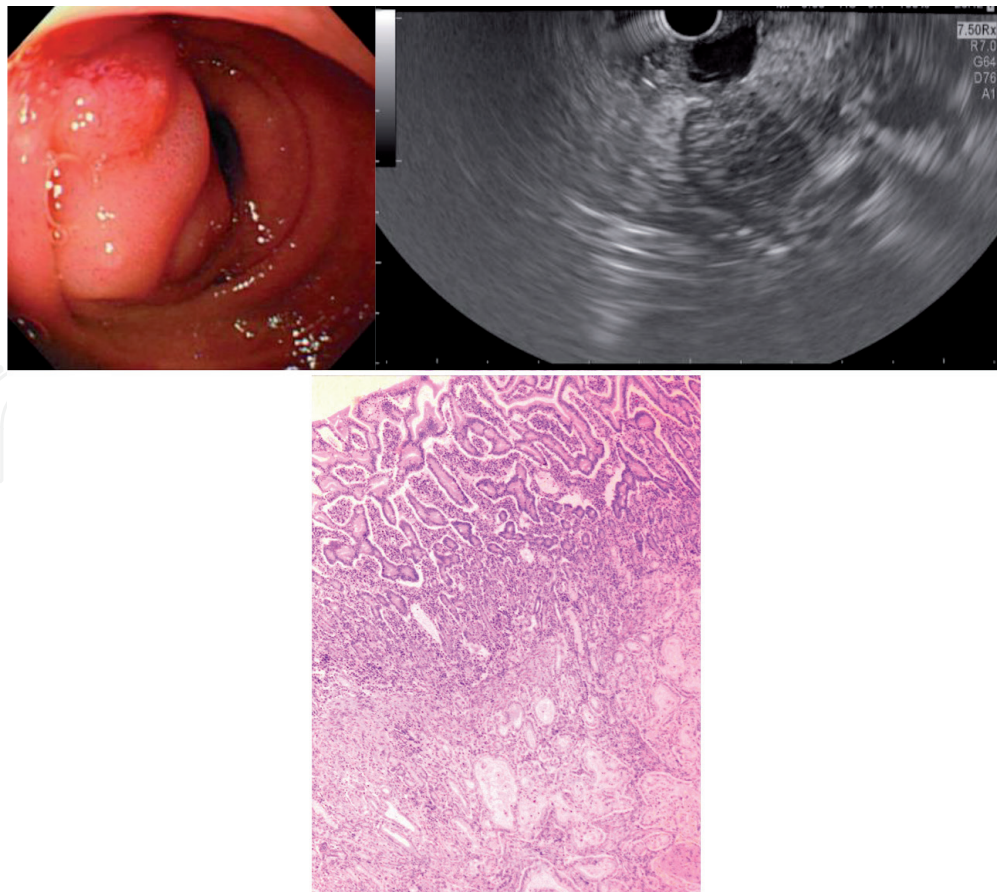
Figure 6.
(A) Endoscopic view of external compression in the duodenum. (B) The echoendoscopic view shows an anechogenic lesion close to the transducer, a cyst. The pancreatic parenchima shows modifications consistent with chronic pancreatitis. (C) EUS-FNA - Paraduodenal cyst lined by inflammation and granulation tissue with no epitheliallining (HE-5X).

3.4.5 Gangliocytic paraganglioma

Gangliocytic paragangliomas are GI mesenchymal tumors, most often found in the second part of the duodenum near the ampulla of Vater [19]. They are formed by a varying mixture of spindle cells, epithelioid cells and ganglion cells (cells found also in other GIMTs). They are located in the third layer (submucosa) and are hypoechoic and homogenous. Histology usually offers the final diagnosis, as hypoechoic SETs are hard to distinguish on EUS alone.

3.5 Extrinsic compressions

In a series of 169 suspected SETs in the duodenum, which were referred to EUS, 12 were extrinsic compressions, with seven from the gallbladder and five from the pancreas [4]. EUS is very efficient in these cases, as it can identify the layers of the duodenum wall and correctly identify the duodenal compression as being extrinsic, as well as determine the cause of the compression and/or invasion (**Figures 6** and 7).

4. EUS tissue acquisition

The sampling of SELs is unnecessary in case of lipoma or duplication cyst. However, some duodenal SETs (GISTs, neuroendocrine tumors) have malignant potential, so the size of the lesion is not a limitation for tissue acquisition. The
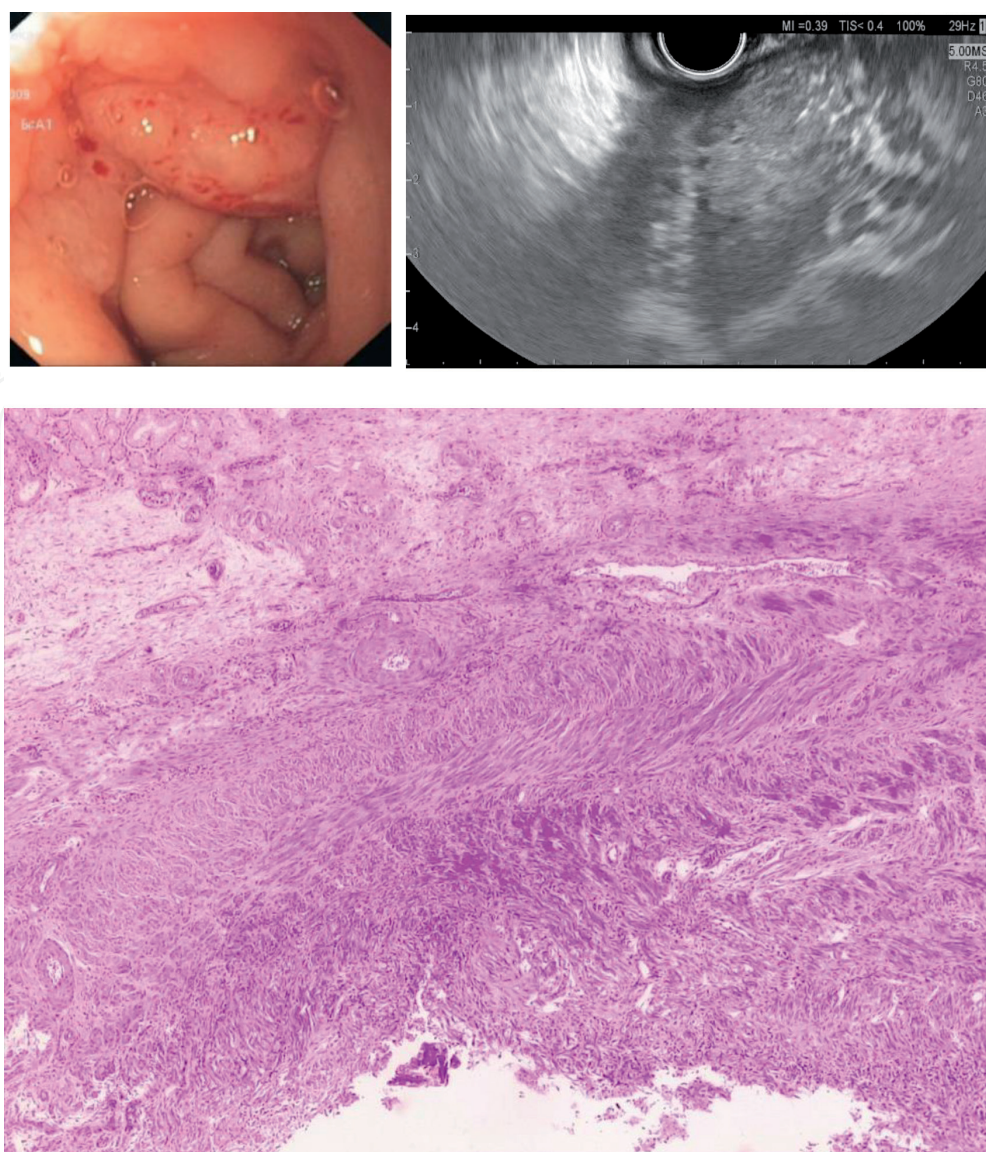
Figure 7.
External invasion from a pancreatic head adenocarcinoma. (A) Endoscopic view: There are mucosal modifications visible (as opposed to 6A). (B) Echoendoscopic view confirms there is a pancreatic tumor. (C) EUS-FNA - foci of pancreatic ductal adenocarcinoma infiltrating submucosa of the duodenal wall (HE-5X).

accuracy of EUS alone compared to the final histology (ESD or surgical specimen) varies between 44% and 66% and tissue acquisition is important for a correct diagnosis [20–22].

The sampling has to be performed using bite-to-bite biopsy followed by mucosal resection or submucosal resection in case of the lesions belonging to the second or third layers [11]. In case of the lesions originating from the fourth layer, the indication is for EUS-FNA or EUS–fine-needle biopsy (EUS-FNB) [23]. The unroofing method for sampling of fourth-layer lesions of gastric location was compared to EUS-FNB, but no difference for histologic core procurement was noted [24].

EUS sampling is preferred in case of lesions situated in the third or fourth layer, because the risk of bleeding is usually low and seeding into the peritoneum is avoided compared to percutaneous biopsy.

However, the use of EUS-FNA, especially with 22-guage and 25-guage needles, gave a diagnostic rate of 60% in a meta-analysis of 978 patients [25]. The main limitation is difficulty in assessing the architecture of the lesion sampled and the mitotic index. No influence of SET size on the diagnostic rate of FNA was found in a retrospective study of 112 patients [26]. The use of a pro-core needle compared to FNA needles does not improve the diagnostic rate [27–30]. However, only one study included SETs from

the duodenum [29]. The use of FNB gave better accuracy than EUS-FNA (88.03% vs. 77.19% [P = .030]) or EUS-FNA plus rapid on-site evaluation (ROSE) (87.25% vs. 68.00% [P = .024]), but no difference was noted compared to EUS-FNB plus ROSE [31]. In a meta-analysis comprising 10 studies that compared EUS-FNB and EUS-FNA, the diagnostic accuracy was greater in patients undergoing FNB sampling (OR, 4.10; 95% CI, 2.48–6.79; P < .0001) with a fewer number of passes and higher rate of optimal core procurement (OR, 3.27; 95% CI, 2.03–5.27; P < .0001) [32]. Because the distal duodenum can be difficult to reach, the sampling from this location is feasible with thinner 25G needles, with a definitive diagnosis in 88% of patients.

5. Conclusions

EUS is essential for evaluating duodenal lesions correctly and completely. EUS can identify if the lesion originates from the mucosa or the deeper layers of the duodenal wall, or if it is extrinsic. Other diagnostic methods lack the resolution to distinguish between them correctly. In addition, EUS can obtain tissue for histological analysis in all cases, as EGD-guided biopsies are not deep enough for SETs. Choice of treatment is also decided following EUS, as benign lesions do not need removal, potential malignant lesions (NETs, GISTs) can be followed or resected and malignant lesions can be resected endoscopically if EUS does not identify invasion of the deeper layers. Given all this, along with the complex surroundings of the duodenum, its thin walls and the difficult anatomical position for surgical interventions, EUS is crucial in lesions of the duodenal wall.

Conflict of interest

The authors declare no conflict of interest.

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