Oral and IV Contrast Enhanced Ultrasonography of the digestive tract – a useful completion of the B-mode examination: a literature review and an exhaustive illustration through images

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Abstract

Contrast enhanced ultrasonography, using IV and/or oral/rectal contrast agents, represents a technical development of the US method, which has proved its applicability in the qualitative and quantitative assessment of the normal and pathological circulatory bed, as well as of the digestive lumen. The use of microbubbles and harmonics opens a new horizon in the detection and characterization of the inflammatory and tumoral conditions of the digestive tract. The interpretation of the data requires corroboration with the grey scale aspect of the examined lesion/area, as well as with the clinical context of the case and the results of other diagnosis techniques. The purpose of this paper is to review the main applications of CEUS in digestive tract pathology by analyzing the significant literature and guidelines in the light of our personal experience and demonstrating it through suggestive images.

Keywords: contrast enhanced ultrasonography, microbubbles, contrast agent, digestive tract

Introduction

Ultrasonography (US) is one of the most widespread imaging methods used in medical practice. Its accessibility, low cost, real-time and non-invasive characters are all factors that contribute to the popularity of the method.

There are many digestive conditions that can benefit from the US exam. Digestive tract (DT) exploration can be accomplished by using the external, transabdominal approach (using convex 3-5 MHz or linear transducer 7-11 MHz) or the internal, endocavitary approach (using 7.5 MHz and higher frequency transducers).

The US aspect of the DT normal wall is represented by three echoic layers (an interface between lumen content and mucosa, between mucosa and submucosa, and between the serosa and surrounding fat tissue), two hypoechoic layers (mucosa and muscularis) and an echoic lumen (bowel content represented by food and air) [1]. All the DT segments have the same US appearance. During the exam several data are obtained regarding peristalsis (presence, breadth, rhythmicity), topography, symmetry of the examined segment, anatomical landmarks, quality and quantity of the digestive tract, wall vascularity, presence of neighboring fluid collections and lymph nodes [2].

Doppler interrogation is an important component of the investigation as wall vascularity is visualized only in pathological circumstances. Digestive vessels are initially identified using color Doppler (CFM) and afterwards characterized using the spectral technique in large and middle size vessels (mesenteric vessels). The harmonic optimized exploration, using IV contrast agents (CA) (CEUS), has made it possible to evaluate low velocity tissue vascularity (microcirculation) [3].

The European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) has published guidelines of good practice that establish examination protocols with clinical applications practically covering every organ [4,5]. The first guidelines were introduced in 2004 and focused on the applicability of CEUS in liver...
pathology [6]. The guidelines were updated in 2008 [4] and then in 2011, when a section regarding the DT was added [7]. According to the guidelines, CEUS is clearly recommended in inflammatory bowel disease for diagnosis, disease activity assessment, distinction between inflammatory and fibrotic stenosis and abscess, fistulas and fistulous tracts detection [5].

The purpose of this material is to review the main applications of CEUS in the pathology of the DT. It will also briefly cover the utility of oral/rectal administration of the CA. We considered that an approach focusing on the different segments of the DT is the most appropriate.

US examination of the DT vascularity. What does CEUS bring to the standard exam?

CEUS consists of a continuous evaluation of the region of interest (ROI) from the moment of the IV administration of the CA until it disappears. The use of a low mechanical index (0.09 – 0.11) prevents the destruction of microbubbles their ‘life-span’ increases to several minutes and consequently the examination time is significantly longer. The analysis of the acquired information is both qualitative (determination of the moment when the echoes are visualized in ROI, the time of stagnation inside ROI, the moment the echoes disappear, the homogeneous/inhomogeneous distribution of the enhancement) and quantitative (analysis of washout curves – ‘time intensity curves’ – TIC). TIC curves represent a graphic representation of the echoes intensities (dB) over time. The following parameters will be evaluated: the time of CA appearance, time to reach the maximum systolic peak, area under the curve, etc. All these data are reproducible, which represents the procedure’s great advantage. The use of the maximum intensity projection (MIP) techniques allows an optimization of the images and a morphological description of the vessels that is superior to that offered by CT [8].

Contrast agents

CA are stabilized gas microbubbles, with a very small diameter (about 2-6 μm), enveloped in a rigid (denatured albumin) or elastic (organic biocompatible material) membrane [9]. The microbubbles reflect the ultrasounds by increasing acoustic impedance with about 20-25 dB, giving a hyperechoic aspect to the blood stream during the exam. The bubbles are visualized in the circulatory bed for about 4-5 minutes, which corresponds to several cardiac cycles. Unlike the contrast agents used in CT and MRI exams, the CA used in CEUS do not penetrate the interstitium; their distribution is strictly vascular. The administration of the contrast agents is either in an IV bolus injection or through a slow IV catheter.

The fast administration is efficient because it realizes a high blood concentration, but the resulting artifacts sometimes may affect the image. The slow administration ensures a moderate concentration, with a ‘plateau’ aspect, which allows for extra details to be visualized. The gas is eliminated through respiration after about 15 minutes after administration and its coating, depending on its nature, is metabolized through the liver or filtered by the kidneys. A part of the CA may become fixed by the sinusoids or the reticulo-histiocytic system of the spleen or liver, which creates a tissular time of the exploration. The microbubbles are well tolerated by the body, in very rare cases mild allergic reactions being noted. The administration is forbidden in patients with severe heart disease, but there are no risks for patients with renal failure or for those with iodine hypersensitivity (this represents an advantage compared with the CA used for CT). Administration to children and pregnant or nursing women is also unacceptable, even though studies performed on pregnant animals did not show any adverse reactions or accidents, and the microbubbles seem not to pass the placental barrier [10,11]. A feature of gas contrast agents is that they are suitable for oral or rectal administration in water dilution. The oral administration combined with the ‘contrast mode’ examination allows a better visualization of the digestive lumen [12].

Esophagus

The esophagus is accessible for transabdominal examination only on its distal segment, under the diaphragm, at the level of the esogastric junction.

Studies performed to determine the utility of CEUS are focused on circulatory anomalies, such as the porto-systemic shunts. These may also be visualized by using Doppler interrogation, during the transabdominal US or through endoscopic ultrasonography and the oral and/or IV administration of a CA is meant to enhance the quality

Fig 1. Esophagus. Oral contrast exploration. Achalasia. A dilatation of the esophageal lumen is observed, in the shape of an “hourglass” (asterisk) upstream of an axial stenosis. The stratification of the anterior esophageal wall can be seen (arrows).
of the images. During the endoscopic US examination, the CA is introduced through the endoscope after it was diluted with plain water. Another application of the method is represented by the assessment of sclerotherapy efficiency. The oral administration also allows a better evaluation of the esophageal lumen, and it is useful in studying esophageal stenosis regardless of their etiology (fig 1).

**Stomach**

The US exam of the stomach is possible for the evaluation of the gastric body (where the anterior wall and the antral region are easily visualized). The fundus is usually obstructed by the air content and the high position under the thoracic wall. When the patient drinks plain water the quality of the image is significantly enhanced and the entire stomach may be examined [13]. By combining a small quantity of CA with plain water, infiltrative gastric lesions become visible because the thickness of the gastric wall is better evaluated, and so are the irregularities of the mucosa. By using the same technique of oral administration of CA the presence and severity of lumen stenosis can be better appreciated (fig 2). This rule is also true for polypoid endoluminal tumors (fig 3).

**Gastric tumors.** US may detect gastric tumors in advanced stages. The diagnosis criteria are: thickening of the gastric wall and loss of its stratification, eccentric lumen, loss of peristalsis in the affected area, discontinuity of the serosa, presence of peritumoral lymph nodes, ascites, liver or ovarian mets, etc. CEUS examination of the stomach is performed immediately after the gray-scale exam and it may be approached either by transabdominal US or by endoscopic US (for tumor staging). CEUS can also be used for monitoring the therapy of malignant gastric tumors [14]. Compared to the normal gastric wall, where no vascularity is visible, in adenocarcinomas there are circulatory anomalies represented by the inhomogeneous uptake of the CA within the tumor during the arterial phase, followed by an accelerated wash-out during the venous phase (fig 4). This phenomenon can be easily revealed by analyzing the washout curves (TIC) (fig 5).

Additionally, CEUS allows the visualization of tumor necrosis areas and helps in targeting US-guided biopsy. Tumor size can be measured more accurately by using the CEUS technique, as it clearly demonstrates the size of the viable tumor mass that uptakes the contrast agent [7]. The CEUS examination of gastric tumors should be completed with the evaluation of the

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**Fig 2.** Stomach. Oral contrast exploration. Infiltrative gastric neoplasm (a) at the level of the anterior wall. Neoplastic stenosis (b) at the level of the antral segment.

**Fig 3.** Stomach. Oral contrast exploration. Endoluminal polypoid tumor (asterisk).

**Fig 4.** Stomach. Large adenocarcinoma: Grey scale examination (a); CEUS examination shows accelerated enhancement during the arterial phase (c) compared to the initial moment (b) and CA washout (d).
liver during the late phase, this application serving to detect liver metastases that are not apparent during the grey scale examination.

GIST tumors appear to have a characteristic appearance: accelerated, intense, diffused enhancement during the arterial phase contrast and delayed washout when compared to the venous phase (fig 6).

Gastric lymphoma is characterized by a marked thickening of the gastric wall at the level of the affected area. During CEUS there is an accelerated, diffuse and relatively homogeneous arterial enhancement, followed by slow washout during the venous phase. The combined administration of oral with i.v. CA shows the extent of the parietal hypertrophy by a better visualization of the gastric lumen and the gastric folds (fig 7).

In gastric leiomyoma there is a lack of vascular signal in the tumor compared with the surrounding gastric wall (fig 8). Additional diagnosis criteria may be represented by intratumoral necrosis that is visualized as a lack of enhancement on the CEUS exam.

There are studies that show the usefulness of CEUS in assessing gastric cancer using different surgical approaches and examination techniques. Pan et al showed an overall accuracy of 91.49% of CEUS in the diagnosis and staging of gastric tumors using Bormann criteria for advanced gastric cancer [15]. Cui et al compared the accuracy of CEUS and CT in detecting gastric tumors. The accuracy of CEUS and CT in the T staging was 72.9% and 88.1% respectively [16]. Shi H et al performed 2D and 3D US double contrast (oral and IV-SonoVue) examinations in 46 patients with malignant and benign gastric pathology diagnosed by endoscopy. They found statistically significant differences in the appearance of the normal gastric wall and the malignant lesions but no statistically significant differences between benign lesions and normal gastric wall. The 3D US exploration showed the morphology and vascularity of the lesions through multiplanar and spatial images, superior to 2D examination [17]. Fang Wei et al studied the relationship between the CA enhancement pattern and the clinical and pathological features of the tumors on a group of 552 patients with gastric adenocarcinoma diagnosed by endoscopy and confirmed through biopsy. The homogeneous increased enhancement correlated with well-differentiated adenocarcinomas (72.59%) in the initial T stages, with limited lymphatic invasion, while heterogeneous enhancement correlated with undifferentiated adenocarcinomas in the advanced stages 78.84%). The differences were statistically significant and the chances to benefit from curative surgery proved to be higher. [18].

The study of Zheng et al [19] on 162 patients evaluated the preoperative examination of the patients with gastric malignancies using CEUS and endoscopic US (EUS). The overall accuracy for the T staging was 77.2% for CEUS
and 74.4 % for EUS; the overall accuracy for N staging was 78.4% for CEUS compared to 57.4% for EUS. Therefore CEUS is comparable with EUS in appreciating assessment of tumoral depth and its superior in the characterization of lymphatic invasion. In 2012 Ang et al published a study which compared the assessment of gastric cancers by CEUS in comparison with CT in evaluating tumor response to neoadjuvant chemotherapy, using the 1.1 RECIST criteria [20,21]. The global accuracy of CEUS in diagnosing the decrease of tumor perfusion under treatment was 60.5%, compared to that of CT, which was approx. 53.5%.

**Portal gastropathy** is a consequence of the hemodynamic and vascular permeability alterations encountered in portal hypertension. About 6% of patients with esophageal varices also present gastric varices [22]. The study of Sato et al on 41 patients showed a 100% sensitivity of Doppler transabdominal US in visualizing venous blood flow within the gastric wall, but was limited in showing the gastric venous collaterals [23]. As an alternative, CEUS can appreciate the presence of gastric varices by identifying vascular signal in the DT wall during the venous phase.

**Duodenum**

The duodenum is visible by US in direct contact with the pancreatic head, during its peristaltic movements. At that time the lumen is distended due to the fluid transonic content and thus the wall may be more easily analyzed. CEUS exploration may have utility both in describing duodenal tumors (malignant tumors present accelerated wash-out of the contrast) as well as in showing tumor invasion of pancreatic masses (fig 9). Congenital anomalies like cysts can be easily visualized both by oral or IV administration of the CA (fig 10). Duodenal congestion associated with hypertrophic chronic pancreatitis may be detected by using both CFM and CEUS explorations.

**Small intestine**

The small intestine is visible as tubular structures with sinuous distribution and having an echoic center due to the gas and food content. US allows the evaluation of individual segments only one at a time. The normal image is characterized by the visualization of a layered wall and a central lumen with a variable diameter depending on the peristalsis status. The mobility and constant movement of the bowel loops can also be demonstrated, as well as the absence of lymph nodes or fluid between them [24]. The normal intestine contains fluid, has wall thickness of about 3-4 mm and 5 consecutive layers [25]. The CEUS examination has a diagnostic role in inflammatory disease as well as in intestinal tumors but is limited in the following situations: a) diagnosis of the early stages of inflammatory disease; b) excessive abdominal fat or gas; c) clear distinction between wall inflammation and fibrosis; d) the relatively narrow field of view and a focus on a single lesion [26,27].

**Small intestine tumors** are rare, representing about 1-5 % of the DT tumors. The tumors arising at the extremities of the small intestine are accessible to the endoscopic exam, the rest of them being diagnosed through imaging, X-ray exams and trough video capsule endoscopy. The sinuous disposition, the length of the small intestine, the presence of gas inside the lumen...
and the peristalsis are all elements that limit the performance of US in the diagnosis of the small intestine tumors. The gray scale investigation may detect tumors if they show a significant thickening of the intestine wall (with or without lumen stenosis) or if they present as a large intraluminal mass (polypoid tumors). I.v administration of CA increases the trustworthiness of the diagnosis by visualizing the arborescent vascular signal characteristic to neoformation [28]. The CEUS behavior of intestinal tumors is uncharacteristic [29]. The aspect is that of a lesion with arterial phase enhancement followed by venous wash-out (fig 11). Additional investigations to complete the diagnosis are often necessary (fig 12).

**Crohn’s Disease.** The diagnosis of Crohn’s disease is based on the endoscopic evaluation. The length of the small bowel as well as its mobility makes it impossible to entirely examine it. Considering the fact that the terminal ileum is the main location for Crohn’s disease, an area easily examined by US, the utility of the method is obvious in the monitoring of these patients [30]. The US exploration may bring information in both the subclinical and clinical stages of the disease and it can also identify various complications. The most important sonographic finding is represented by the segmental wall thickening. The sensitivity of US is 75-94% and the specificity is 67-100% [26,31,32]. In the early activity phase of the disease a process of angiogenesis takes place in the mucosa and submucosa [33]. Vascular proliferation leads to an increase of the blood flow in the intestine wall, an alteration that represents the basis for CEUS and other contrast imaging methods ability to demonstrate wall inflammation [34]. The CEUS signal is always visualized when there is intestinal congestion. The strength of the signal reaches a maximum during the arterial phase and has a transmural pattern. During the venous phase there is a slow, progressive wash-out of the CA (fig 13).

CEUS can differentiate inflammatory from fibrotic lesions when they are not simultaneous. In patients with a long standing condition, inflammation and fibrosis may coexist in the same area. In these situations CEUS shows wall thickening, but it cannot differentiate between their pathological mechanisms [34].

Quaia et al published a study on 28 patients with Crohn’s disease who underwent CEUS examinations for the differential diagnosis between inflammatory and fibrotic stenosis. The TIC curves obtained at the site of the stenosis were compared and enhancement differences registered (45.86±5.32 vs. 37.33±16.24%), the same
thing being observed for the area under the enhancement curve (1168.25±437.65 vs. 570.47±323.08). The differences for the maximum enhancement time were insignificant (9.25±4.21 vs. 12.01±7.34 s). It was concluded that the quantitative analysis of the CEUS data may differentiate between inflammatory and fibrotic stenosis in patients with Crohn’s disease [35].

Nylund et al studied the differences of vascularity in inflammatory and fibrotic tissue in patients with Crohn’s disease using CEUS on a group of 37 patients (18 with fibrotic disease and 19 with inflammatory disease). CEUS proved useful in the quantification of intestinal wall perfusion and showed that in the fibrotic tissue the blood flow and the blood volume is lower compared with the inflammatory tissue [36].

Girlich et al compared the activity index, the biochemical inflammatory markers and the quantitative assessment of bowel vascularity using CEUS in 41 patients with Crohn’s disease. A correlation between C-reactive protein (CRP), Harvey-Bradshaw index (HBI) and TTP (“time to peak”) was registered. Associations between HBI and TTP and between HBI and the peak of the TTP were noted. The analysis of the 34 patients with Peak (%) ≥ 25 showed an important correlation between HBI and CRP and a strong negative correlation between HBI and TTP (r=-0.645, p<0.01). The authors concluded that, by calculating TTP in patients with a maximum systolic time ≥25%, CEUS becomes a method that can easily quantify the inflammatory response in Crohn’s disease [37].

Malago et al evaluated the accuracy of CEUS versus MRI in defining disease activity in 30 patients with Crohn’s disease [38]. The correlation between the activity index of Crohn’s disease (CDAI) [39] and MRI was low, as was the correlation between CDAI and CEUS. However the correlation between the two imaging methods proved to be very good (r=0.791). The conclusion was that MRI remains the best method to define the activity of Crohn’s disease, CEUS being indicated in cases where there are discrepancies between the clinical aspect, laboratory results, and MRI.

In the study of Bialecki et al, CEUS results perfectly overlap the CT exam conclusions. There was a moderate positive correlation between PE and CDAI (r=0.65, p<0.001), but there was no correlation between the CEUS perfusion parameters and the laboratory markers of inflammation [40].

Ischemia and bowel infarction. Theoretically, CEUS can identify circulatory anomalies suggestive for these conditions. In practice the situation is a little more complicated due to interobserver variability, the multiple sites of vascular stenosis, intestinal aeration as well as collateral vascularity. Hata et al published a study about the performance of CEUS in diagnosing intestinal ischemia in a group of 51 patients with a radiological suspicion of mesenteric infarction. The results were: sensitivity 85%, specificity 100%, positive predictive value 100%, and negative predictive value 91.2% [41]. Hamada et al studied the value of CEUS on a group of 50 patients with symptoms of intestinal ischemia and compared these to the intraoperative findings. It was found that the method has a sensitivity, specificity, positive predictive value and a negative predictive value of de 94.1%, 100%, 100% and 97.1% respectively in detecting intestinal ischemia [42]. In 2010 Giannetti showed evidence in a case report, of occlusion of the superior mesenteric artery and of intestinal infarction through the use of CEUS [43].

Acute appendicitis. The utility of CEUS is related to the demonstration of the circulatory signal in the appendicular wall and in proving periappendicular congestion. The method also shows periappendicular fluid collections and the peritoneal congestion (fig 14).

Intestinal pseudo-obstruction. Pathological dilatation of the bowel loops associated with stagnation may mimic, in rare situations, abdominal tumors. CEUS is significantly helpful in reaching the diagnosis (fig 15).
**Graft versus Host Disease (GVHD)** represents a complication of marrow transplantation which affects about 25-30% of the patients. It presents in different degrees of severity, from a mild inflammatory reaction without any clinical manifestation to a systemic major reaction with potentially lethal consequences. The early diagnosis of GVHD is very important for the early introduction of an adequate treatment which leads to a quick remission of the disease with «restitutio ad integrum» of the intestinal structure and function. CEUS’s potential to determine and quantify the inflammatory changes of the bowel and ‘friendly’ character of the method, with the possibility of performing a bedside examination, has brought this method to the attention of researchers in this field [44].

The study conducted by Benedetti et al in 30 patients with GVHD proved the presence of the disease in the intestine in 14 cases and in the stomach in 16 cases. The patients underwent abdominal US and CEUS. Abdominal US showed parietal thickening of the affected bowel segments and CEUS additionally demonstrated alterations of the microcirculation in the affected areas, which correlated with the activity of the disease and the therapeutic response. These findings were not detected in the control group [45].

Schryer et al examined 9 patients with intestinal GVHD proved by histology and a control group consisting of 6 patients with Crohn’s disease and 4 healthy volunteers by CEUS. ROI were manually selected at the level of the mesenteric fat, intestinal wall, and intestinal lumen. The maximum intensity of the signal was calculated for each compartment. The patients with GVHD and Crohn’s disease presented significantly increased enhancement compared with the healthy volunteers. The patients with GVHD specifically showed enhancement in the intestinal lumen due to the transmural penetration of the microbubbles. This fact was interpreted as a consequence of the involvement of the mucosa barrier, thus serving as diagnosis criteria for GVHD [46].

**Large intestine**

**Pseudomembranous colitis.** The US aspect of this condition is characterized by a marked, circumferential thickening of the colon wall associated with unaltered stratification. It often associates dilated bowel loops that simulate intestinal occlusion. CEUS examination usually reveals a dissociated enhancement of the walls of the colon, with areas that enhance early and also with some areas that enhance in the late phase. This stage is crucial for excluding ischemia. Contrast washout is relatively accelerated in relation to the inflammatory process (fig 16).

**Ulcerative colitis (UC).** UC is a chronic inflammatory condition of the large intestine, which usually affects young adults. The etiology of the disease is unknown and the evolution is characterized by periods of exacerbation followed by variable periods of remission. CEUS was used in the diagnosis and monitoring of UC. The appearance is similar with that of the small intestine, but a clear CEUS differential diagnosis with other colitis is not possible. The findings are represented by an accelerated, linear enhancement of the mucosa during the arterial phase, followed by a slow washout during the venous phase.

Romanini et al evaluated the accuracy of the quantitative uptake of the intestinal wall in 33 patients suspected of having inflammatory bowel disease who underwent colonoscopy. The biopsied material underwent histology analysis and the number of vessels/microscopic field was determined. High vascular density (>265 vessels per field) was significantly correlated with the characteristic aspect of the active disease, as found by colonoscopy, and with parietal inflammatory signs found by US and CEUS. TIC analysis demonstrated a high enhancement peak, with a reduced time to enhancement peak, localized increase of the blood flow and congestion in the affected wall. The quantitative determination of the CEUS data is correlated with the disease activity demonstrated through vascular density [47].

Swift et al published preliminary results of a study regarding intraoperative evaluation of the large intestine
vascularity, using CEUS with the purpose of determining the areas with decreased vascularity in order to prevent anastomosis in those areas. The aim of this technique was to improve the postoperative prognosis and reduce fistula complication. CEUS was practiced in 8 patients who underwent intestinal resections of the colon and rectum. The patients were administered 5 ml SonoVue in bolus injection before and after vascular ligation, the transducer being positioned without compression, directly on the large bowel. The method proved to be feasible and with a good interobserver agreement [48].

**Colon tumors.** The US diagnosis of colon tumors has been known for a long time. The use of hydrosonography brings real diagnosis benefits even though it is laborious and examiner dependent [12]. Experience is limited regarding CEUS in the diagnosis and characterization of the colon tumor. Performance is conditioned by the visualization of the tumor in grey scale US (fig 17).

Badea et al successfully used CEUS in the diagnosis and vascularity characterization of a polypoid colon tumor in a patient with Peutz-Jeghers syndrome. The benign character determined by the CEUS exam was confirmed afterwards by the histology exam of the lesion [49].

**Colon diverticulosis.** IV contrast exploration is useful in differentiating colon wall abscesses from pericolonic perforations (fig 18). The use of microenemas combined with the microbubbles reveals the luminal stenosis area and may suggest the presence of fibrosis (fig 19).

**Ischemic colitis.** The US diagnosis is difficult and cannot be separated from the clinical situation. Often US represents an intermediate phase between the clinical exam and other diagnosis techniques, especially colonoscopy. Identifying wall thickening with colon dehausturation and upstream dilatation of the lumen represent elements that define the colonic involvement without suggesting the infections, ischemic or inflammatory character. IV administration of CA allows the identification of circulatory anomalies within the intestinal wall and strengthens the diagnosis of ischemia/necrosis with or without collateral circulation (fig 20).
Rectum

Rectal tumors. The CEUS examination of the rectum is possible by using the endocavitary approach (endorectal or endovaginal). A previous administration of a small quantity of water allows the distension of the rectal ampulla and reveals the mass (fig 21).

Zhuangsi et al studied the characteristics of rectal adenocarcinoma vascularity by using CEUS in order to describe the anarchic pattern of the vascular proliferation [50]. Lu et al performed a research on a group of 227 patients with malignant and benign rectal lesions. The patients received the CA through rectal and IV administration. The CEUS exam was performed both through transabdominal and rectal approach. The behavior of adenocarcinomas was variable, adenomas showed homogeneous decreased uptake, inflammatory lesion revealed increased uptake in the periphery and showed no central enhancement [51]. The parameters that characterize the TIC curves of adenocarcinomas, adenomas and inflammatory lesion were statically different compared with those of the normal rectal tissue. These conclusions are supported by other studies as well [52]. The administration of plain water, with or without CA, brings real benefits in tumor visualization.

Inflammatory rectal disease. The administration of the microbubbles in microenemas allows a better visualization of the rectal ampulla, surface of the mucosa and presence of discontinuities. The injection of a solution combined with a CA in the fistulas helps identify fistulas and may become an alternative to CT or MRI.

Conclusions

The CEUS exploration of DT pathology offers real benefits in the consolidation of the diagnosis in circumstances when US proves to be insufficient. It permits the distinction between inflammatory and tumoral conditions, and helps identify complications in which the circulatory component is involved. Additionally, CEUS permits a more accurate evaluation of the digestive lumen and fistulas. Therefore CEUS is a complementary exploration that can be used alongside other imaging investigations to increase diagnosis accuracy. Its value resides in the manner in which the examiner is able to integrate the information into its clinical context and at the same time corroborate it with conventional US or other imaging techniques findings.

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