CLINICAL IMAGING

Applicability of Abdominal Ultrasonography in Inflammatory Bowel Diseases

Claudia Hagiu, Radu Badea

3rd Medical Clinic, University of Medicine and Pharmacy Cluj Napoca

Abstract

Inflammatory bowel diseases (IBD) are chronic diseases of the digestive system, comprising ulcerative colitis (UC) and Crohn's disease (CD). Diagnosis is based on the endoscopic, contrast radiological and histopathological examinations. Ultrasonography is a noninvasive, repetitive, low cost imaging method and at present it is considered that its use can be a first intention examination in patients with symptoms of IBD, having the role to direct to subsequent investigations.

The method has many advantages: it can evaluate the affected intestinal segment, it can indicate the structural details useful for the diagnosis such as: dehaustration, presence of inflammatory pseudopolyps and mucosal ulcerations, and the extension of the intestinal lesions. It can also give useful ultrasonographical elements which, connected to other investigations, can be used for the differential diagnosis between these two entities.

Using the Doppler ultrasonography at the level of the superior and inferior mesenteric arteries and at the inflamed intestinal wall, we can assess the activity of the inflammatory process and also the evolution under treatment.

Abdominal ultrasound is a complementary investigation and it cannot replace the conventional methods of diagnosis.

Key words

Inflammatory bowel diseases - abdominal ultrasound - diagnosis - activity

Introduction

The diagnosis in ulcerative colitis (UC) and Crohn's disease (CD) is based on the endoscopic, contrast radiological and histopathological examinations.

Abdominal ultrasonography is an imaging method which gives information mainly about the parenchymatous abdominal organs and which, until recently, was not considered a useful method to examine the digestive tract, because of its gas content.

Over the last 20 years, a growing interest has been observed in the literature to find a place for the abdominal ultrasound in the protocol of colon disease investigation.

The ultrasonographical assessment of the digestive tract requires high performance equipment, experience in the field, and being familiar with the method limits, caused by the error sources: operator dependence, areas of low acces-sibility for ultrasonographical exploration (recto-sigmoidian junction, colonic flexures).

In patients with symptoms suggesting IBD, abdominal ultrasonography could be the first investigation, useful to direct onwards to subsequent investigations such as to determine the involved intestinal segment, the extension of the inflammation, the activity phase and the evolution under treatment.

The protocol of ultrasonographic investigation of the digestive tract

In order to remove the error sources caused by intestinal contents, it is necessary to clean the intestine. This can be done orally through a preparation similar to that for colonoscopy, with 4000 ml polyethilenglycol 6.4% which acts through osmotic mechanism or by using a retrograde route, namely the evacuatory enemas. Ultrasonographic investigation is done preprandially.

In the first phase, using the conventional grey-scale ultrasonography, the intestine is scanned with the 2.5-3.5 MHz convex transducer, which allows the identification of the involved intestinal segments. Then the intestinal exploration can be done accurately both by using high resolution ultrasonography at high frequency transducers

J Gastrointestin Liver Dis
June 2007 Vol.16 No 2, 205-209
Address for correspondence: Claudia Hagiu
Dept. Ultrasonography
3rd Medical Clinic
Croitorilor Str., no.19-21
Cluj-Napoca, Romania
E-mail: claudiahagiu@yahoo.com

(7-12 MHz) and by improving the image through endoluminal contrast with 1000-1500 ml lukewarm water introduced transrectally: hydrosonography. This allows also the evaluation of some structural details (ulcerations, polyps, haustration) (1-3).

The normal semiological aspect of the colon comprises 5 layers visible at high resolution ultrasonography, three hyperechogenic: the lumen-mucosa interface, the submucosa and the serosa, and two hypoechogenic: the mucosa and the muscularis (Fig.1).

The thickness of the colonic wall is 3-4 mm (Fig.2) during the relaxation phase and increases by 1 mm during contraction; the thickness of the mucosa is up to 1.5 mm and of the submucosa is up to 1.8 mm; the intestinal lumen during contraction is represented by a hyperechogenic line, and during relaxation it is distended with a mixed content at the enteral level and gas/solid at the colonic level. The mucosal folds are represented by the valvulae conniventes in the intestine and by the haustra in the colon. These appear as hyperecogenic structures, thin, numerous and not too ample – the valvulae conniventes, or rare and ample – the haustrae (Figs.3,4).

The peristaltics are vivid in the intestine and slower in the colon. They can be followed ultrasonographically by stopping the transducer at the level of the studied intestinal segment. The compressibility is evaluated by pushing the transducer and moving away the intestinal loop (4).

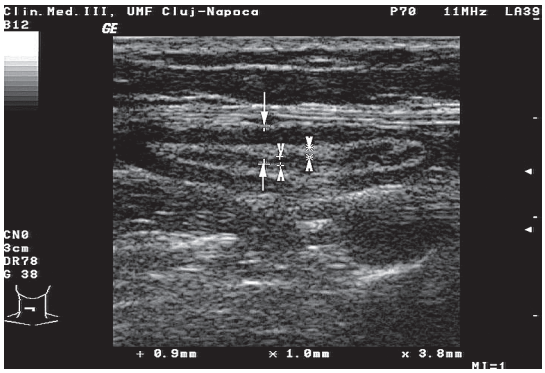

Fig.1 Normal intestinal layers, 0.9 mm: mucosa, 1 mm: submucosa, 3.8 mm: anterior wall.

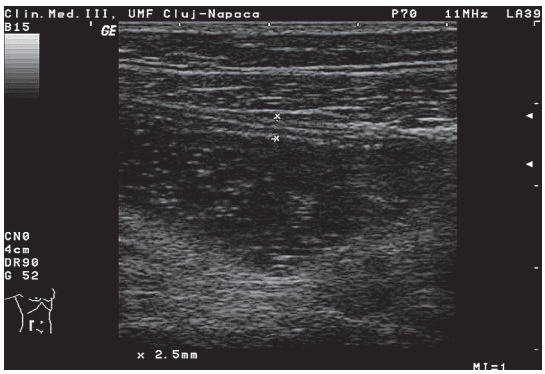

Fig.2 Hydrosonography: normal thickness of the intestinal wall.

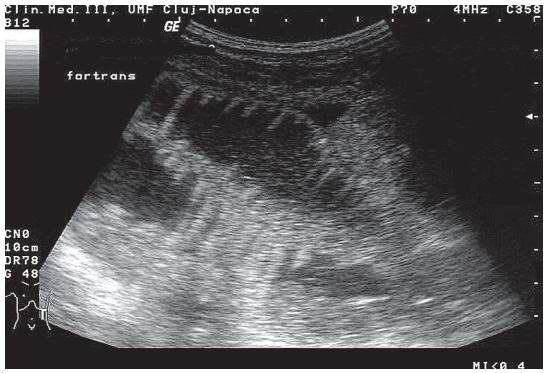

Fig.3 Hydrosonography: valvulae conniventes.

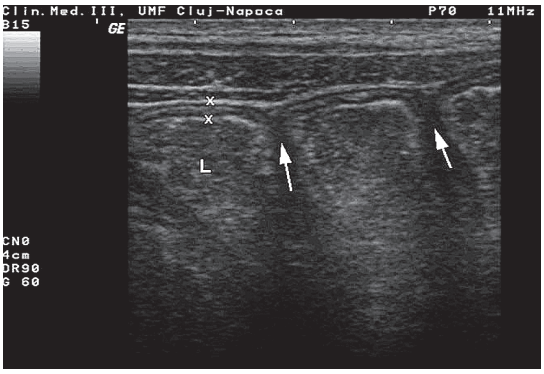

Fig.4 Hydrosonography: the haustrae (arrows).

Assessment of inflammation and disease extention

The main ultrasonographic parameter considered suggestive for the diagnosis of the inflammation in IBD is wall thickness, more than 4 mm, both in transversal and longitudinal section (Fig.5,6). It must have at least 2-3 cm length, is uniform, extended, circumferential and simetric (5-8).

In order to assess the extension of the inflammatory process, the pathological thickening of the intestinal wall (> 4 mm) and the distance on which this extends along the intestine must be sought.

The succession of the examinations of the intestinal segments in the correct order to evaluate the extension is: the rectosigmoidian segment in transversal and longitudinal suprapubian section, descendent colon in the same sections in the left flank, in dorsal and left lateral decubitus, the transverse colon in transversal section from epigastrum to hypogastrum, ascendent colon and terminal ileum in transversal and longitudinal sections in the right flank and lower quadrant, in dorsal and right lateral decubitus.

Comparing the two ultrasonographic methods (high resolution ultrasonography and hydrosonography), the first identifies mainly the pathological thickening of the intestinal wall. The existence of a partially collapsed lumen filled with air or with mucus causes the partial reflection of the ultrasounds, so it does not allow the evaluation of some of the structural details.

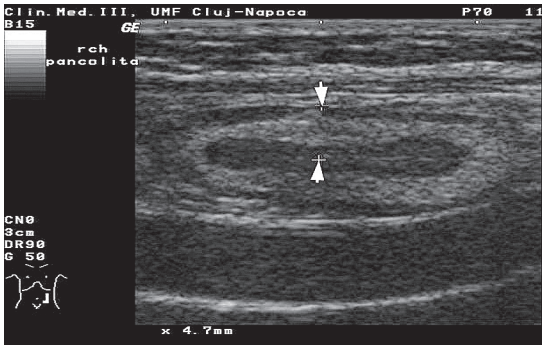

Fig.5 High resolution sonography, transversal section: increased parietal thickness in a case of ulcerative colitis (arrows).

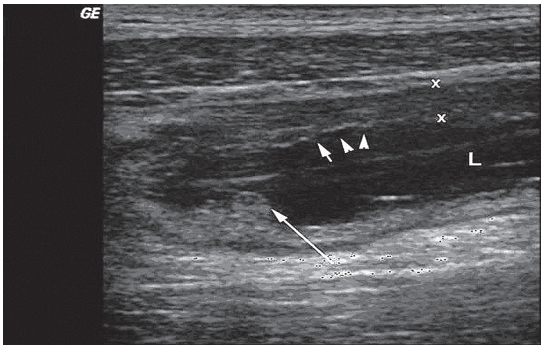

Fig.8 Hydrosonography in a case of ulcerative colitis: L: lumen, x: colonic wall, small arrows: irregular mucosa (ulcerations), big arrow: pseudopolyp.

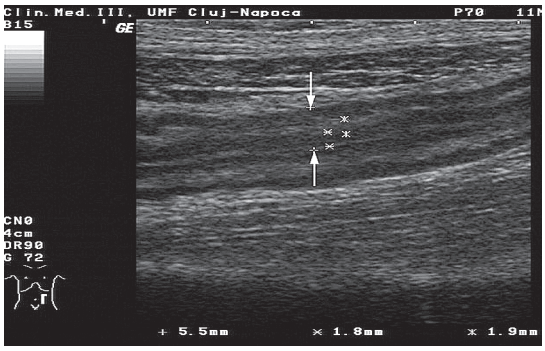

Fig.6 High resolution sonography, longitudinal section: increased parietal thickness in a case of ulcerative colitis (arrows).

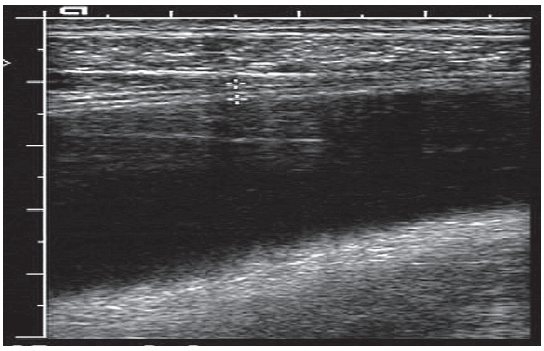

Fig.9 Hydrosonography in a case of ulcerative colitis: dehaustration.

Hydrosonography, through the distension of the lumen allows the identification of these details (mucosal ulcerations, inflammatory pseudopolyps, dehaustration) being more performant than intrarectal sonography (9). These details are complementary to the intestinal parietal thickening for the diagnosis of IBD.

The mucosal ulcerations often occur before the parietal thickening. They are suggested ultrasonographically by the existence of hyperechogenic areas attached to the wall, invariable with the mobilization of the patient (Fig.7). A correlation between the localisation of the ulcerations seen at endoscopy and those visualised by ultrasonography cannot be evidenced.

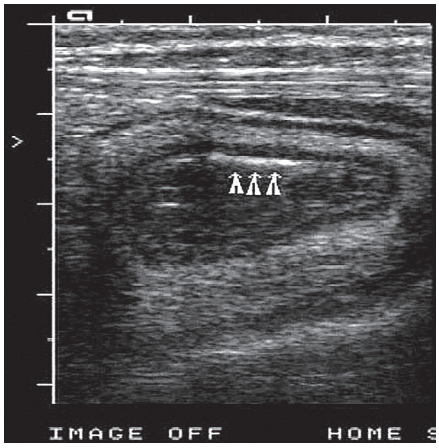

Fig.7 Hydrosonography, transversal section; arrows: mucosal ulcerations in a case of ulcerative colitis.

Pseudopolyps appear as echogenic polypoid masses attached to the wall, sesile or pedunculated (Fig.8) (10,11), and the dehaustration is indicated by the reduced number or disparition of the haustra (Fig.9) (6,12).

Ultrasonographic differential diagnosis between UC and CD

The ultrasonographic parameters which can be considered suggestive for the differential diagnosis between these two diseases are:

1. intestinal wall thickness (considered pathological > 4 mm);
2. mucosal and submucosal thickness;
3. wall echogenicuty: normal or hypoechogenic;
4. periintestinal fibrosis;
5. parietal vascular congestion (colour signals at the Doppler colour ºi Power Doppler examinations) and the number of vessels in the intestinal wall.

In patients with CD the thickness of the whole intestinal wall is frequently superior to 6 mm (Fig.10) in contrast to UC where it rarely exceeds 6 mm (Fig.11), this difference being explained by the transparietal distribution of inflammation in CD and its limitation to the mucosa in UC (13). In CD, the wall thickening evolves in parallel to that of the mucosa and submucosa because of the important parietal edema.

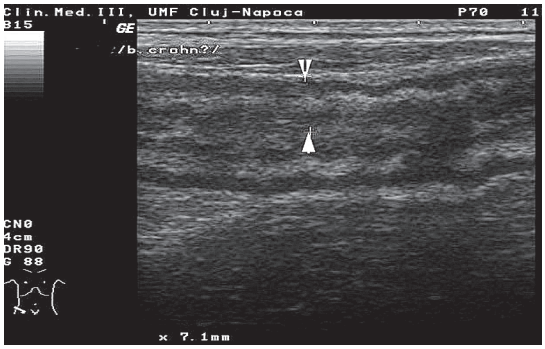

Fig.10 High resolution sonography in a case of Crohn disease: increased parietal thickness > 6 mm (arrows).

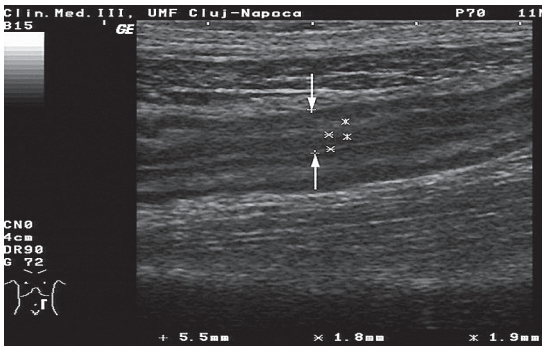

Fig.11 High resolution sonography in a case of ulcerative colitis: parietal thickening < 6 mm (arrows).

In CD, there is a marked hypoechogenicity of the affected intestinal wall secondary to the edema and the inflammation, which are transmural (14).

The ultrasonographic marker suggestive for the periintestinal fibrosis is the irregular external outline of the wall and the hyperechogenicity of the periintestinal fat (Fig.12). These changes are much more often met in CD in correlation with the augmentation of the connective tissue growth factor in this disease.

The rigidity of the intestinal segment at the compression by the transducer and the diminishing of the intestinal peristaltics can also be evidenced (15).

The parietal vascular congestion at colour and power Doppler is more exacerbated in CD compared to UC (Fig.13),

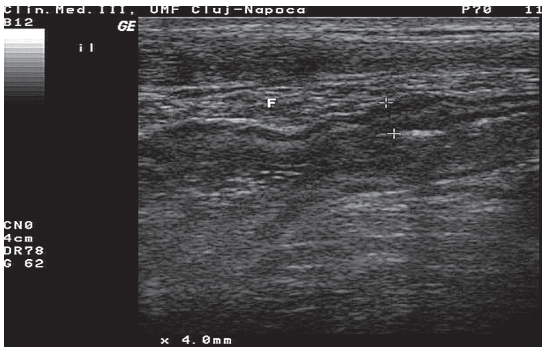

Fig.12 A Crohn's disease: F - periileal fibrosis.

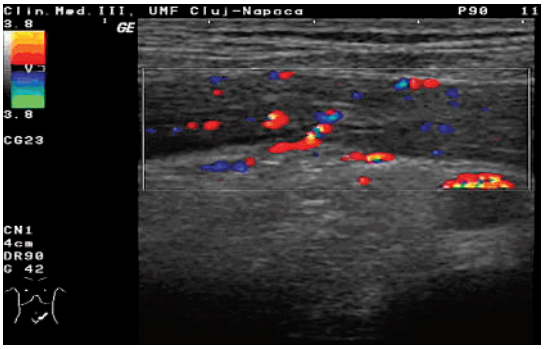

Fig.13 Parietal vascular congestion in Crohn's disease.

and the periintestinal lymph nodes are more numerous and more frequent (16).

Assessment of the inflammatory activity and of the evolution under treatment

The endoscopical and radiological investigations are imaging noninvasive methods to be used during the acute phase in order to assess the evolution phase or repeatedly to monitor the evolution under treatment.

One method to evaluate the activity of IBD and the therapeutic response is Doppler ultrasonography of the superior and inferior mesenteric arteries with dynamic measurement of the haemodynamic parameters. The superior mesenteric artery and its branches irigate the duodenum, jejunum, ileum, ascendent colon and a portion of the transverse colon. The inferior mesenteric artery and its branches irrigate the middle and distal thirds of the transverse colon, the descendent colon and the rectum.

The systolic velocity, the teledyastolic velocity, the mean velocity, the pulsatility index and the resistance index must be quantified.

In active UC, the blood supply, systolic velocity, teledyastolic velocity and mean velocity in the inferior mesenteric artery, increase and they lower towards the normal values during remission (Fig.14). Similar changes of the haemodynamic parameters are also observed in the superior mesenteric artery, particularly in CD (Fig.15) (17,18).

The absence of augmentation of the pulsatility index in the mesenteric arteries when clinical evolution indicates the remission phase, represents an index for early relapse.

Another Doppler technique for assessing the inflammatory process and for monitoring the evolution under medication is the analysis of the wall vascularization of the affected intestinal segment.

During the activity phase there is an exacerbation of the intraparietal vascularization visualised by the presence of the colour signals and quantified by the lowering of the resistance index in arterial vessels (Fig.16). These changes improve when patients enter the remission phase or have a favourable response to the treatment.

Complementary to the Doppler ultrasonography, another ultrasonographical parameter useful for assessing the remission phase or the therapeutic response is the dynamic

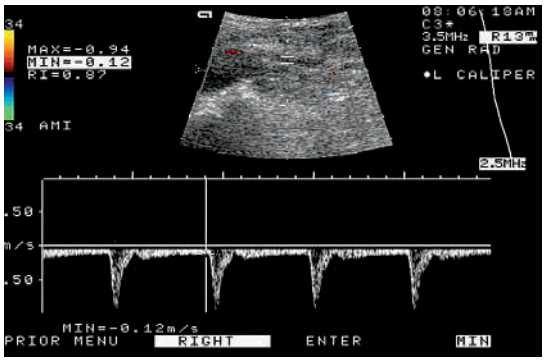

Fig.14 Ulcerative colitis during remission: low velocities and high resistance index in inferior mesenteric artery.

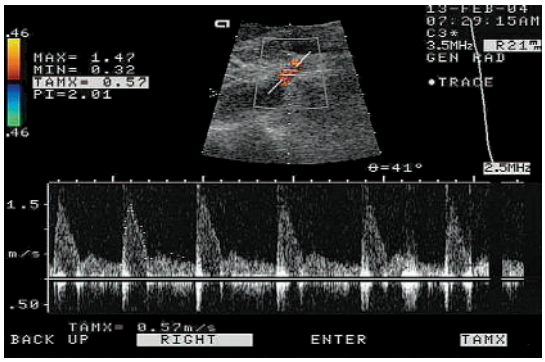

Fig.15 Crohn's disease during active phase: high velocities and low pulsatility index in superior mesenteric artery.

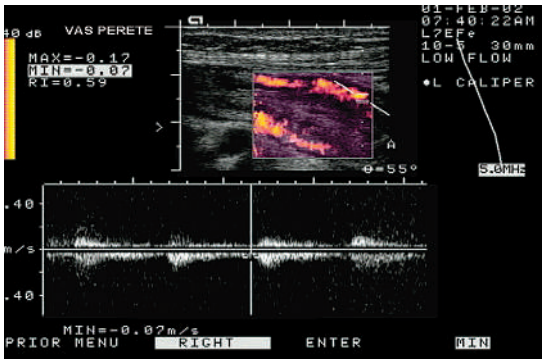

Fig.16 Crohn's disease. exacerbation of intraparietal vascularisation and low resistance index.

evaluation of the thickness of the intestinal wall and of its layers, with their reduction in case of a favourable outcome (19).

Conclusions

Abdominal ultrasonography performed as a first investigation is useful to suggest the presence of IBD. It has a high sensitivity and specificity for the assessment of the inflammatory extension and the measurement of the haemodynamic parameters in mesenteric arteries. Parietal vessel examination has a significant contribution to the assessment of the inflammatory activity and of the treatment response.

References

1. Dixit R, Chowdhury V, Kumar N. Hydrocolonic sonography in the evaluation of colonic lesions. Abdom Imaging 1999; 24:497–505.
2. Hagiu C, Pascu O, Tanþãu M, Iobagiu S, Anton O, Dumitra D. Rolul ecografiei de înaltã rezoluþie ºi al hidrosonografiei în diagnosticul bolilor inflamatorii intestinale. Clujul Med 2004; 76:317-327.
3. Valette PJ, Rioux M, Pilleul F, et al. Ultrasonography of chronic inflammatory bowel diseases. Eur J Radiol 2001; 11:1859-1866.
4. Hagiu C, Pascu O, Badea R. Aportul ecografiei abdominale în diagnosticul rectocolitei ulcero-hemoragice ºi bolii Crohn. Clujul Med 2003; 76:750-760.
5. Maconi G, Parente F, Bollani S, Cesana B, Bianchi Porro G. Abdominal ultrasound in the assessment of extent and activity of Crohn's disease: clinical significance and implication of bowel wall thickening. Am J Gastroenterol 1996;91:1604–1609.
6. Bru C, Sans M, Defelitto MM, et al. Hydrocolonic sonography for evaluating inflammatory bowel disease. AJR Am J Roentgenol 2001; 177:99-105.
7. Hollerbach S, Geissler A, Schiegl H, et al. The accuracy of abdominal ultrasound in the assessment of bowel disorders. Scand J Gastroenterol 1998; 33:1201-1208.
8. Limberg B. Diagnosis of inflammatory and neoplastic colonic disease by sonography. J Clin Gastroenterol 1987;9:607-611.
9. Limberg B. Hydrocolonic sonography—potentials and limitations of ultrasonographic diagnosis of colon diseases. Z Gastroenterol 2001; 39:1007-1015.
10. Ling UP, Chen JY, Hwang CJ, Lin CK, Chang MH. Hydrosonography in the evaluation of colorectal polyps. Arch Dis Child 1995;73:70-73.
11. Chui DW, Gooding GA, McQuaid KR, Griswold V, Grendell JH. Hydrocolonic ultrasonography in the detection of colonic polyps and tumors. N Engl J Med 1994; 331:1685-1688.
12. Puylaert JB. Ultrasonography of the acute abdomen: gastrointestinal conditions. Radiol Clin North Am 2003; 41:1227-1242.
13. Winther KV, Fogh P, Thomsen OO, Brynskov J. Inflammatory bowel disease (ulcerative colitis and Crohn's disease): diagnostic criteria and differential diagnosis. Drugs Today (Barc) 1998; 34: 935-942.
14. Pilleul F, Crombe Ternamian A, Fouque P, Valette PJ. Cross sectional imaging evaluation of the small bowel. J Radiol 2004; 85:517-530.
15. Di Sabatino A, Fulle I, Ciccocioppo R, et al. Doppler enhancement after intravenous levovist injection in Crohn's disease. Inflamm Bowel Dis 2002; 8: 251-257.
16. Sigirci A, Baysal T, Kutlu R, Aladag M, Sarac K, Harputluoglu H. Doppler sonography of the inferior and superior mesenteric arteries in ulcerative colitis. J Clin Ultrasound 2001; 29: 130-139.
17. Byrne MF, Farrell MA, Abass S, et al. Assessment of Crohn's disease activity by Doppler sonography of the superior mesenteric artery, clinical evaluation and the Crohn's disease activity index: a prospective study. Clin Radiol 2001; 56: 973-978.
18. Lukic-Kostic L, Jovic J, Sekulovic S. Significance of ultrasonography of the terminal ileum in moderate Crohn's disease. Vojnosanit Pregl 2006; 63: 787-792.

Quiz HQ 37, pag.187 Answer

Intramural protrudig polypoid adenoma of the ampulla with high-grade dysplasia

Ampullary neoplastic lesions can be found at intraampullary or periampullary sites, or they can be mixed, intra/periampullary. Three macrotypes of ampullary tumors, based on their appearance from the duodenum, were described (1):

- intramural protruding (intraampullary) tumors: polypoid tumors of the common chanel without duodenal luminal component;
- extramural protruding (periampullary) tumors: polypoid tumors protruding through the papilla into the duodenum;
- ulcerating ampullary tumors/carcinomas.

Intramural protruding type represents almost 30% of all ampullary tumors (2). Obscure overt bleeding is an unusual manifestation of intraampullary tumors. The specific approach to diagnostic evaluation of the patient with obscure overt GI bleeding varies with the clinical presentation, prior work-up, and local expertise (2). Based on the literature, the algorithm comprises upper endoscopy, followed by colonoscopy and small bowel examination by push enteroscopy or videocapsule (3).

Until recent years, surgery was considered the standard treatment for neoplastic diseases of the papilla. Especially in cases of proven or suspected malignancy, radical resection procedures are considered. On the other hand, pure adenomas, without high-grade dysplastic changes or carcinoma, could benefit from less-invasive treatment options such as local surgical resection procedures (ampullectomy) or endoscopic resection. Endoscopic resection was advised for ampullary tumors less than 4 cm in diameter, without severe dysplastic/malignant component. For dysplastic tumors larger than 4 cm or ampullary carcinoma, surgical resection should be considered (4). In the present patient, a 7 cm papillary adenoma with high-grade dysplasia was found (Fig.3). The mortality from pancreaticoduodenectomy performed for ampullary tumors generally varies between 0 and 10%, although not all these studies distinguished between benign and malignant papillary tumors (4).

Capsule endoscopy has a high diagnostic yield for obscure GI bleeding and may facilitate clinical decision-making (3).

References

1. Fischer HP, Zhou H. Pathogenesis of carcinoma of the papillaof Vater. J Hepatobiliary Pancreas Surg 2004; 11: 301-309
2. Charton JP, Deinert K, Schumacher B, Neuhaus H. Endoscopic resection for neoplastic diseases of the papilla of Vater. J Hepatobiliary Pancreas Surg 2004; 11: 245-251
3. Dulai GS, Jensen DM. Severe gastrointestinal bleeding of obscure origin. Gastrointest Endoscopy Clin N Am 2004; 14: 101-113
4. ASGE Guideline. The role of endoscopy in ampullary and duodenal adenomas. Gastrointest Endosc 2006; 64: 849-854