

Received: 2010.03.18
Accepted: 2010.03.31

CT enteroclysis in the diagnostics of small bowel diseases

Marian Kołodziej¹, Abdulhabib Annabhani^{2,3}, Marek Szaśiadek^{1,3}

¹ Department of General Radiology, Interventional Radiology and Neuroradiology of the Academic Hospital in Wrocław, Wrocław, Poland

² Department of Gastroenterology and Hepatology, Wrocław Medical University, Wrocław, Poland

³ Department of Radiology, Wrocław Medical University, Wrocław, Poland

Author's address: Marek Szaśiadek, Department of General Radiology, Interventional Radiology and Neuroradiology of the Academic Hospital in Wrocław, Borowska 213 Str., 50-556 Wrocław, Poland, e-mail mareks@rad.am.wroc.pl

Summary

Background:

The role of CT enteroclysis is gaining on importance in the diagnostics of small bowel diseases. The aim of the study was to present own experiences in CT enteroclysis application, with the use of a 64-detector CT unit.

Material/Methods:

CT enteroclyses were performed in 60 patients: 53 with the suspicion of the Crohn's disease, 2 suspected for carcinoid, 1 with suspicion of the fistula between the small bowel and the bladder, 2 suspected for the tumor of the ileo-caecal region, and in 1 case, the aim of examination was to carry out an evaluation of the postsurgical state of the bowel-bowel anastomosis.

We used own endoscopic technique of catheter insertion into the bowel, which shortens the examination time and improves patient's comfort.

Results:

The catheter was correctly introduced into the small bowel in 58 patients (endoscopy had to be repeated in 4 cases). Only 2 examinations failed, because patients refused repeated endoscopy.

Radiological signs of the Crohn's disease were found in 50 out of 53 patients. In the 3 remaining patients, the appearance of the small bowel was normal. In 5 non-Crohn's disease patients, CT enteroclysis enabled a good visualization of the pathology (tumors, fistula).

Conclusions:

CT enteroclysis with the use of the 64-detector CT unit is a valuable method in the diagnostics of small bowel diseases. It could supplement or precede capsule endoscopy.

Key words:

CT • enteroclysis • small bowel diseases

PDF file:

<http://www.polradiol.com/fulltxt.php?ICID=878519>

Background

The small intestine is a difficult organ to assess in imaging tests. A conventional contrast passage of the small bowel or a conventional X-ray enteroclysis have limited diagnostic possibilities. For that reason, the role of CT enteroclysis has been gaining on importance for the last few years, and this method is now becoming the basic tool of small intestine imaging, used to detect its diseases [1]. This has been the case especially since the widely recognised introduction of the multiple-detector (multi-slice) computed tomography units (MDCT/MSCT) to radiological diagnostics [2-5].

The aim of the work was to evaluate the CT enteroclysis based on own experience.

Material and Methods

At the Department of General Radiology, Interventional Radiology and Neuroradiology of the Academic Clinical Hospital in Wrocław, CT enteroclysis was performed in 60 patients from the Gastroenterology and Hepatology Department in Wrocław.

In most cases, the aim of the examination was to evaluate the small intestine with respect to the Crohn's disease

Table 1. Clinical indications for enteroclysis.

Clinical diagnosis	Number of patients
Crohn's disease	53
Evaluation of the bowel-bowel anastomosis	2
Carcinoid syndrome	2
Bowel-bladder fistula	1
Tumour of the ileo-caecal region	2
Total	60

lesions. In two cases, the indications for the examination included clinical symptoms of the carcinoid syndrome. In one case, an attempt was made to visualise a fistula between the small bowel and the bladder; in two cases, a tumour of the ileo-caecal area was suspected, and in the next two cases, the aim of the examination was to evaluate the existing bowel-bowel anastomosis, after a previous partial removal of the small intestine due to an inflammatory tumour (Table 1.)

An intestinal catheter was introduced by a gastroenterologist using a duodenofibroscope. In the CT laboratory, the location of the probe was checked on the basis of a pilot (topographic) scan. The obtained topogram was also used to determine the examination area. A radiologist, together with the gastroenterologist, assessed the location of the probe. The desired location of the catheter tip was the jejunum, beyond the ligament of Treitz (Figure 1.) In four patients, a repeat probe introduction was required, as the catheter moved to the duodenum when the patient was walking from the endoscopic laboratory to the CT room. Two patients did not give their consent for catheter repositioning, and the examination was not performed.

Next, 1.5 to 2.0 litres of water was introduced to the small intestine. Before scanning, every patient received 1 amp. of i.v. buscolysin.

Scanning was performed with a 64-detector computed tomography unit LightSpeed VCT (General Electric) and covered the area from the diaphragm to the pubic symphysis.

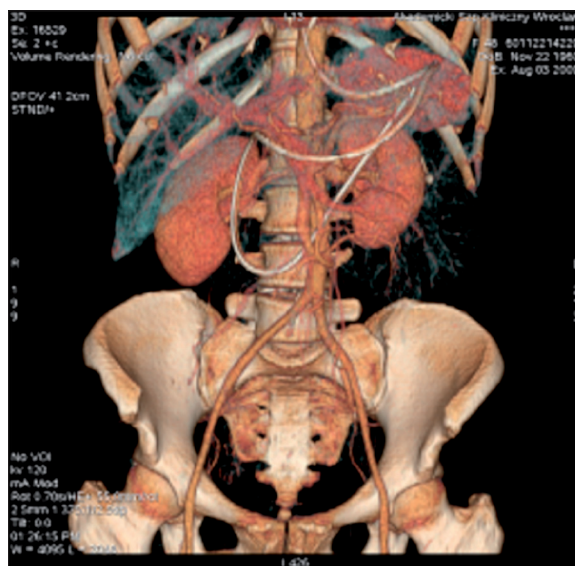
Two scanning cycles were performed, after the administration of 80 ml of an intravenous contrast medium:

- with the delay of 25 s and
- with the delay of 70 s.

Results

The evaluation of the small intestine was performed based on transverse scans and MIP reconstructions (frontal, sagittal and axial planes.) Vessels and parenchymatous organs of the abdominal cavity were evaluated as well. Volume rendering was used to assess the vessels.

In 58 patients with a properly placed catheter, the filling of the intestines provide good or very good results.

**Figure 1.** Volume Rendering (VR) technique; evaluation of intestinal probe position.

We were looking for the following radiological lesions of the small intestine:

- thickened intestinal wall:
 - >0.8 cm in the jejunum and
 - >0.5 cm in the ileum,
- segmental narrowing and dilation of the intestinal lumen,
- segmental contrast enhancement of the walls of a pathological intestinal segment,
- bowel-bowel or bowel-organ fistulas,
- enlarged lymph nodes.

Radiological symptoms were observed in 48 patients with suspicion of Crohn's disease. In 3 patients suspected for this condition, the appearance of the small intestine was normal.

Moreover, one vesicointestinal fistula was found. There was also a tumour of the ileo-caecal region in 2 cases and carcinoid in two cases.

Clinical cases

1.

D.S., a 57-year-old woman with arterial hypertension and multiple sclerosis was diagnosed with Crohn's disease in the year 2007. In the same year, she underwent a partial resection of the sigmoid, due to an inflammatory tumour, and in March 2009 she was surgically treated for an intestino-cutaneous fistula. She was admitted to the Department of Gastroenterology and Hepatology due to recurrent pain of the meso- and epigastrium, persisting for several months, and intensifying after meals, accompanied by flatulence, tendency for constipation, significant weakening and peripheral oedemas. On admission, she was in a severe general condition. Laboratory tests revealed a significant normocytic anaemia, low serum iron, hypoprotrombinaemia, hypoalbuminaemia and leucocytosis, as well as elevated levels of the inflammatory markers (ESR, CRP, fibrinogen). As

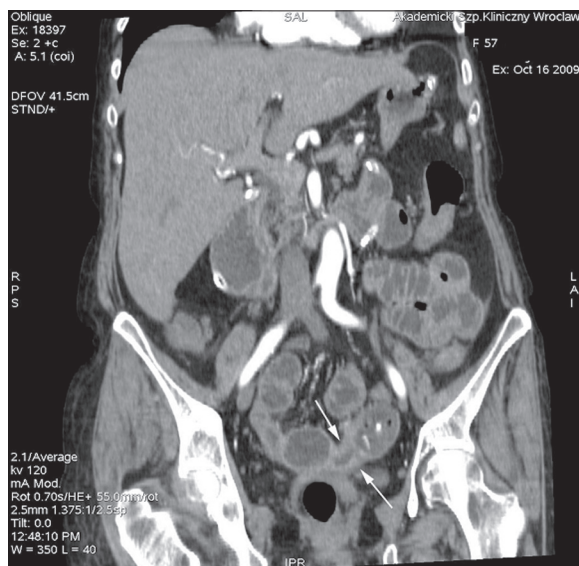


Figure 2A. CT enteroclysis, coronal plane. A marked segmental narrowing of the small intestine (arrows); the tablets visible before the narrowed segment.

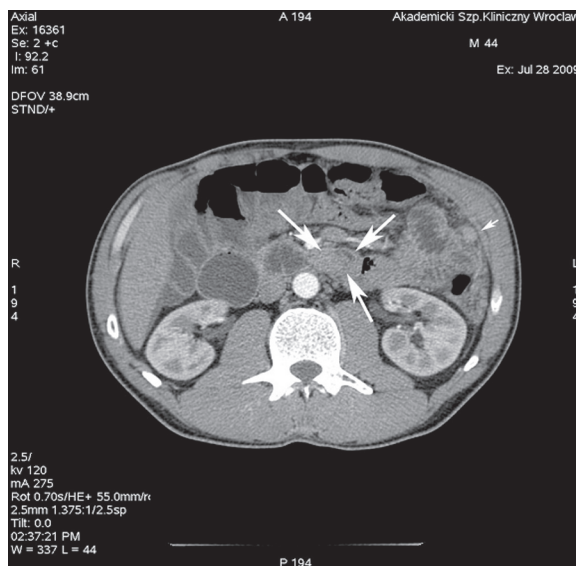


Figure 3A. Tumor in the lumen of the ileum (large arrows). Metastasis to the lymph node (small arrow).

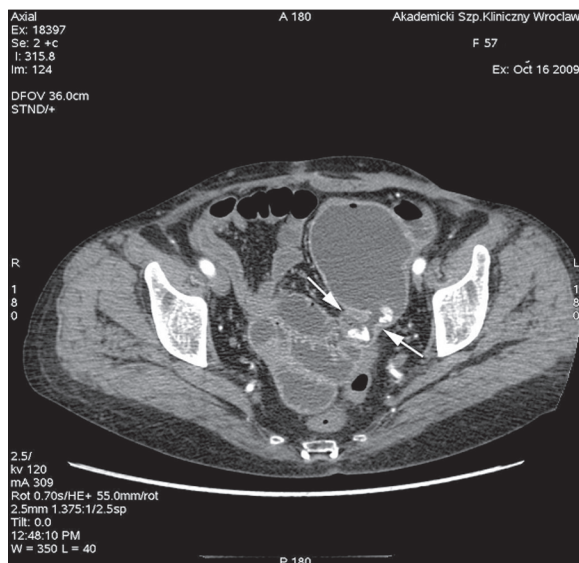


Figure 2B. The same case – transverse plane. The narrowed fragment (arrows) containing tablets.

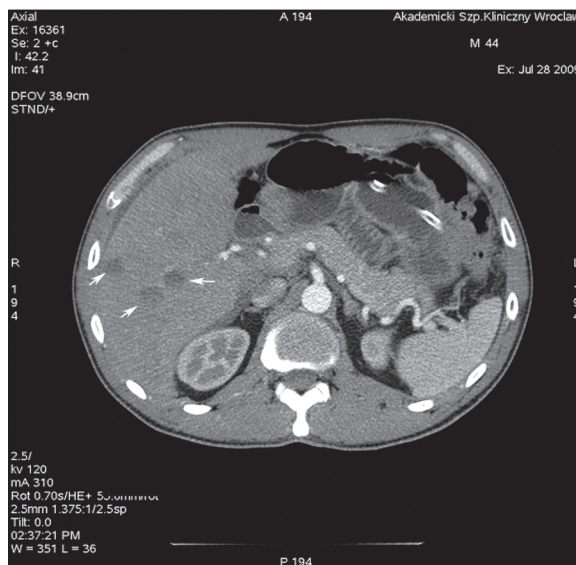


Figure 3B. The same case. Metastases to the liver (arrows).

a result of the applied treatment, there was a slight clinical improvement and a reduction of the inflammatory markers. The enteroclysis revealed a normal intestino-sigmoid anastomosis. In the ileum, there was a segment with inflammatory lesions with its wall thickened up to 1.0 cm. The involved segment was 3.5 cm long. The intestinal lumen of this segment was significantly narrowed. Before the narrowing, the small intestine loop was dilated and included the tablets having been administered orally (Figure 2A,B).

The consulting surgeon qualified the patient for an emergency surgical treatment, with the diagnosis of a partial obstruction.

During enteroclysis, a developmental abnormality of the coeliac trunk was also found. It was quite long (4.2 cm);

the left hepatic artery branched off from it, whereas the right hepatic artery branched off from the superior mesenteric artery (incomplete hepatomesenteric trunk.) Other branches of the abdominal aorta were normal.

2.

M.R., a 45-year-old male was admitted to the Department of Gastroenterology and Hepatology of the Academic Clinical Hospital in Wrocław for the diagnostic work-up and treatment of a partial intestinal obstruction. During his previous hospitalisations at the Clinical Hospital, he reported face reddening and abdominal pain. The previously performed ultrasound examinations revealed numerous foci in the liver, qualified as metastases. Laboratory tests revealed increased levels of serotonin and 5-hydroxyindoleacetic acid in the urine and of chromogranine A in the serum.

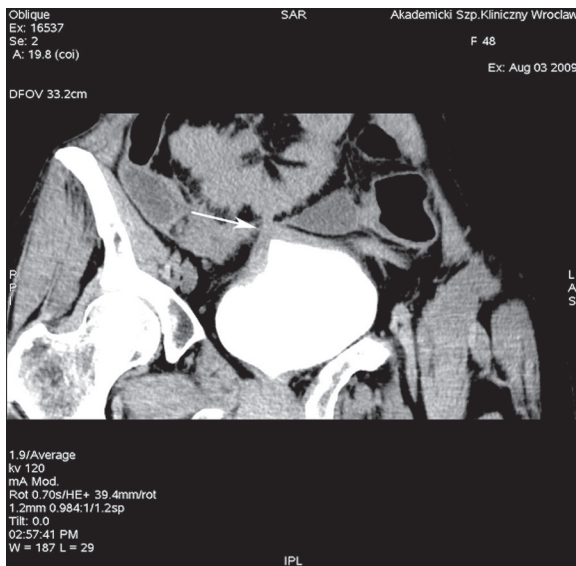


Figure 4A. The late phase of CT enteroclysis, prone position, coronal plane. A visible fistula (arrow) in the wall of the bladder.

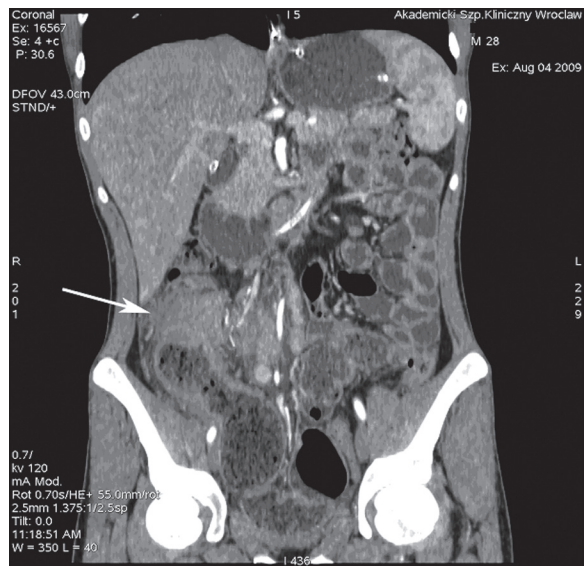


Figure 5A. Tumor of the ileocaecal area (arrow), with retention of faecal masses in the caecum.

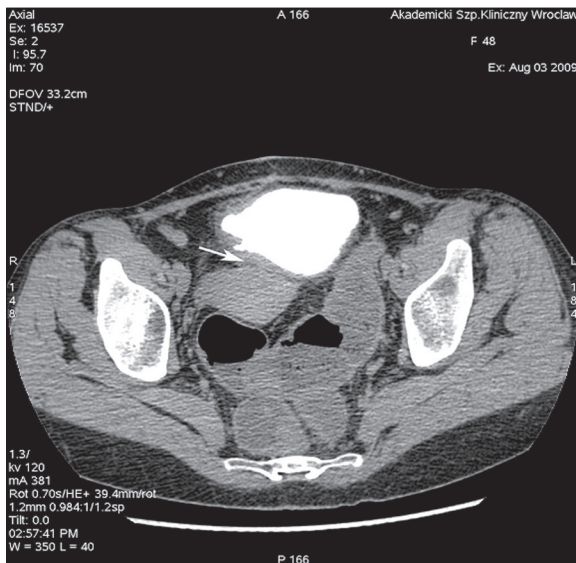


Figure 4B. The same study, transverse plane; fistula marked with an arrow.

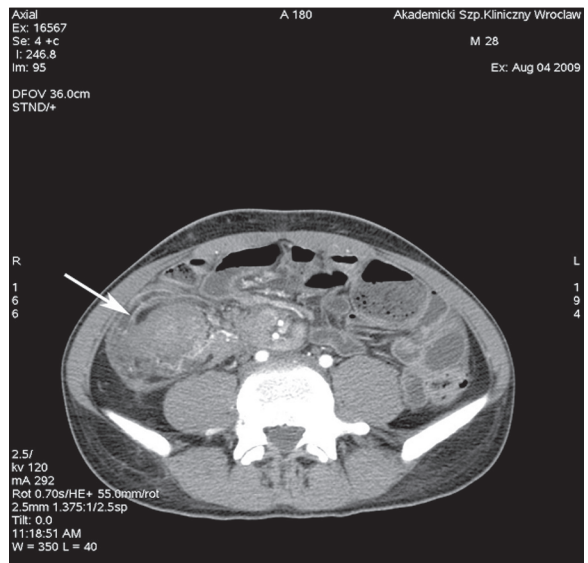


Figure 5B. The same case; transverse scan, arrow indicating tumor.

CT enteroclysis revealed a poorly outlined tumour of 2.0 cm in diameter, strongly enhanced after contrast administration, located in the middle mesogastrium, in the lumen of the jejunum (Figure 3A). In the vicinity of the tumour, numerous enlarged mesenteric lymph nodes were visible, with the largest one measuring 1.4 cm in diameter. Proximally to the tumour, there was a dilated intestinal loop with residual food. Numerous metastatic foci were confirmed in the liver (Figure 3B).

Based on all tests, and on CT enteroclysis results in particular, carcinoid syndrome was diagnosed, with liver metastases.

3.

M.S., a 49-year-old woman, treated at Department of Gastroenterology, suspected for a vesicointestinal fistula

and pyuria after the removal of an inflammatory tumour of the urinary bladder in March of the current year. The patient had had two caesarean sections (in 1981 and 1988) and deep vein thrombosis in the pelvis minor (VI-2008.) She had also been diagnosed with stenosis of the left subclavian artery, with a steal syndrome.

Before hospitalisation, the patient had had colonoscopy that revealed no lesions apart from haemorrhoids.

During hospitalisation, periodical disturbances of gastrointestinal peristalsis were observed, with vomiting and abdominal pain. The performed enteroclysis revealed lesions typical for Crohn's disease in the terminal ileum, spreading for a distance of 15 cm (the intestinal wall thickened up to 1.5 cm and the lumen was deformed and narrowed). In addition, at least 3 enlarged mesenteric lymph nodes were shown. In the initial examination phases

(arterial and venous – delay of 30 and 60 seconds), indirect symptoms of the vesicointestinal fistula were demonstrated. A gas bubble was found in the anterior part of the urinary bladder. The urinary bladder was locally thickened at that site (up to 1.5 cm). In the late phase of the examination, there appeared leakage of the enhanced urine from the urinary bladder to the intestinal loop (Figure 4A,B)

The presence of the fistula was confirmed by cystography (K. Tupikowski, MD).

The patient was catheterised and the fistula was treated conservatively. The patient was consulted by urologist on 5 August 2009 (A. Kaczmarek, MD) The patient was discharged home in an improved general condition. Urological follow-up (cystoscopy) was recommended in 3 weeks' time.

4.

P.G., a 39-year-old male was admitted to our Hospital for the diagnostics of an atypical abdominal pain, chronic constipation and periodical diarrhoea. The physical examination revealed tenderness on compression in the right hypogastrium, confirmed by ultrasound examination. A tuberos structure was found at this location, together with enlarged lymph nodes along the right iliac axis.

CT enteroclysis revealed a tumour in the ileo-caecal area, measuring: 4.7×4.5×4.7 cm. The tumour was well-vascularised and compressed the ascending colon. In the vicinity of the tumour, there was one mesenteric lymph node with the diameter of 1.0 cm and several lymph nodes along the right iliac axis. Vessels supplying the tumour originated from the ileo-caecal artery (a branch of the superior mesenteric artery.) Other organs, as well as the abdominal aorta and its main branches, were normal (Figure 5A,B).

Inflammatory tumour was confirmed surgically. Afterwards, a bowel-bowel anastomosis was performed.

Discussion

For over 100 years, the contrast passage of the small bowel had been a predominant imaging method in radiological diagnostics, as it was easy to perform, widely available and cost-effective [3]. However, its diagnostic value was extremely limited. Given that the small intestine is also poorly accessible in the endoscopic methods, alternative diagnostic modalities were searched for.

The first European report on the diagnostics of inflammatory conditions of the small intestine using CT enteroclysis, was presented by Kloppel et al. (1992). The first American report concerning the use of CT enteroclysis in the diagnostics of the small intestine occlusion was created by Benderow et al. (1996) [5].

Currently, CT enteroclysis seems to be the method of choice in the diagnostics of small intestine diseases, in particular when performed with multislice computed tomography units (MSCT.) It allows for a simultaneous visualisation of transverse, frontal and sagittal planes, which is of extreme

importance in localisation of small lesions in the intestinal lumen and wall.

Additional data that can be obtained with this examination include: assessment of coexisting pathologies in parenchymateous organs of the abdominal cavity (liver and kidneys in particular, but also the large intestine), and assessment of intra- and extraperitoneal lymph nodes.

The use of an appropriate delay following intravenous contrast medium administration enables (in most of the cases) a proper evaluation of the aorta and its main branches, and of relatively numerous developmental vascular anomalies, being an important piece of information for the operating surgeon.

Enteroclysis consists in filling the intestinal loops with a neutral contrast medium through an intestinal catheter, the end of which is placed in the proximal loop of the jejunum, i.e. behind the duodeno-jejunal ligament of Treitz. The intestinal wall thickness, diameter of the intestinal lumen, stromal tumours (GIST), intraluminal tumours, narrowings of the intestinal loops, lesions outside the intestinal wall (inflammatory infiltrations or abscesses), intestinal and intestinal-cutaneous fistulas are assessed. Good results are achieved in imaging of the inflammatory or neoplastic tumours of the ileo-caecal region.

The literature erroneously uses two terms interchangeably: CT enterography (Mayo Clinic) and enteroclysis [7].

In our opinion, the term CT enterography should be used to describe an examination of the small intestine with intravenous contrast administration, irrespective of the fact whether the intestinal lumen is filled with the positive or with the neutral contrast medium, administered orally.

The term CT enteroclysis should be reserved for the cases where the (positive or neutral) contrast medium is administered directly into the small intestine. Rajesh and Maglinte [7] even call it a hybrid examination, combining CT of the abdominal cavity with conventional enteroclysis (administration of contrast medium through the intestinal catheter.)

In the majority of the diagnostic laboratories, the catheter is placed through the oral cavity, and less frequently through the nose. Its location is radiologically guided [6,8–10]. In some laboratories, the catheter is placed in the duodenum and sealed with a balloon to avoid reflux of the contrast medium.

As already mentioned above, in the cases analysed by us, the intestinal catheter was placed with the help of the fibroduodenoscope in the first loop of the jejunum, beyond the ligament of Treitz, which inhibits the reflux sufficiently. This allows for avoidance of a repeated fluoroscopy and patient's exposition to radiation. Replacing this procedure with a pilot scanning (topogram) in CT, shortens the examination time and reduces patient's discomfort caused by a long-lasting presence of the catheter in his/her GI tract. The pilot scan can also be used to determine the scanning area of the actual enteroclysis.

In order to improve patient's comfort during the examination, some laboratories sedate patients. Such a procedure was not necessary in case of our method.

At the very beginning, CT enteroclysis imaging used oral contrast media and the intravenous contrast media were not applied. The examinations were performed to detect minor obstruction of the small intestine and intestinal fistulas mainly. In the mid-1990s, neutral contrast media were introduced. They allowed for a better assessment of the mucous membrane and of the thickness of the mucous membrane folds. As soon as the intravenous contrast media were introduced, the examination provided the researchers with additional information, as it was now possible to evaluate parenchymateous organs and blood vessels of the abdominal cavity at the same time.

Neutral contrast media used in enteroclysis include water, methylcellulose and 0.1% solution of a barium salt. Positive contrast media include 4–15% barium solutions and 12% iodine contrast media, soluble in water [7].

In our laboratory, we prefer to use water, as this is the cheapest and a tasteless contrast medium. As a result, we may use a narrower intestinal probe, which leads to an improved comfort of the patient and allows us to apply a higher pressure and a shorter filling time. Since recently, water has been administered in our laboratory with a water pump, KMP 2000, made by Guerbet I (Germany). We apply constant pressure of 150 to 200 ml/min. This also improves patient's comfort and makes it possible to avoid additional sedation.

The introduction of an endoscopic capsule into the diagnostics of small intestine diseases allowed for a detailed visualisation of the mucous membrane of the whole gastrointestinal tract, non-invasively. Video Capsule Endoscopy (VCE) was invented in 1981 by an engineer, Gavriel Iddan, from Israel, a specialist in electronic optics. However, the first animal test with a prototype of that capsule was performed by Paul Swain from Great Britain as late as in 1996. In 2001, Food and Drug Administration (FDA) approved capsule endoscopy as a new mode of small intestine examination.

Numerous reports showed high efficacy of that method in the diagnostics of gastrointestinal bleeding (50–67%) and Crohn's disease (43–71%) [4,11].

However, in many cases, introduction of the endoscopic capsule is impossible.

Contraindications for the endoscopic capsule imaging include:

- a) gastrointestinal stenosis and obstruction,
- b) disturbed swallowing,
- c) disturbed intestinal peristalsis,
- d) intestinal fistula,
- e) numerous or large gastrointestinal diverticuli,
- f) history of abdominal surgeries,
- g) pregnancy,
- h) implanted cardiac pacemaker.

It can be assumed, with a high likelihood, that all these contraindications can pose indications for CT enteroclysis

at the same time; obviously, except for pregnancy, which is a contraindication for all diagnostic methods using X-rays.

There are no doubts that capsule endoscopy is connected with better results of mucous membrane imaging. Nonetheless, CT enteroclysis will remain the best diagnostic modality in the evaluation of intestinal walls and extraintestinal structures, providing us with a great deal of information on organs, lymph nodes and vessels of the abdominal cavity.

In many cases, CT enteroclysis should be performed prior to capsule endoscopy, especially in patients with the risk of intestinal lumen stenosis and clinical symptoms of a partial obstruction. Sensitivity and specificity of CT enteroclysis in the assessment of high-grade obstructions is assessed to be above 90%. However, as for the assessment of low-grade obstructions of the small intestine, it is less precise and its sensitivity is assessed for 50%, while the specificity for 94% [3].

On the other hand, sensitivity of CT enteroclysis in detecting wall thickness is 89%; 79% in detecting the non-physiological contrast enhancement of the walls, and 64% in detecting adenopathy [3].

Maglinte et al. [3] clearly stated that according to the review of the American literature, MR enteroclysis is significantly less sensitive in comparison to CT enteroclysis, and its value in detecting wall thickness is 60%, in detecting non-physiological contrast-enhancement of the intestinal walls – 56%, and in detecting adenopathy – 14%.

CT enteroclysis is also favoured due to the fact that peritoneal adhesions are the reason for as many as 60–80% of cases of intestinal obstruction. They include parietal and visceral adhesions. The first ones form between the intestine and the peritoneal cavity wall, whereas the latter spread between the small intestine loops or between the loops and their adjacent organs, e.g. colon or uterus.

All such lesions can be assessed with CT enteroclysis: deformation and adhesion of the small intestine to the peritoneal cavity wall, significant bending of the intestinal loops, asymmetric thickening of the intestinal wall [3,4,11].

CT enteroclysis can be also successfully used to assess post-operative intestinal anastomoses.

Based on our experience and the presented material, we believe that CT enteroclysis is an irreplaceable tool in the diagnostics of neoplastic diseases of the small intestine. It is equally true for tumours growing into the intestinal lumen as well as those that proliferate within the intestinal wall. The value of this method is mainly associated with its possibility to assess the periintestinal space. It allows for the assessment of regional and distant lymph nodes.

An experienced radiologist is highly probable to detect fistulas between the intestine and other organs, e.g. the vesicointestinal fistulas.

On the other hand, CT enteroclysis is assessed as rather ineffective in the diagnostics of bleedings of unknown

aetiology, with its value ranging from 10 to 20%, according to the literature [4,11].

Conclusions

1. CT enteroclysis performed with a multirow-detector computed tomography unit is a valuable tool for small intestine diagnostics, eliminating the defects of enterography.
2. CT enteroclysis should supplement and sometimes precede capsule endoscopy.
3. In patients with Crohn's disease, CT enteroclysis makes it possible to confirm or rule out pathologic involvement of the small intestine (if clinical symptoms of partial obstruction are present).
4. CT enteroclysis is a useful tool in the detection of tumours of the small intestine, intestinal fistulas and adhesions.
5. CT enteroclysis allows for a simultaneous evaluation of parenchymateous organs and vessels of the abdominal cavity.

References:

1. Walecki J, Furmanek M: Postępy w diagnostyce obrazowej w 2004 roku. *Medycyna Praktyczna*, 2005; 3: 51-63
2. Maglinte DDT, Sandrasegaran K, Lappas JC, Chiorean M: CT Enteroclysis. *Radiology*, 2007; 245(3): 661-71K
3. Maglinte DDT, Bender GN, Heitkamp DE et al: Multidetector-row helical CT enteroclysis. *Radiol Clin N Am*, 2003; 41: 249-62
4. Sailer J, Peloschek P, Schober E et al: Diagnostic value of CT enteroclysis compared with conventional enteroclysis in patients with Crohn's disease. *AJR*, 2005; 185: 1575-81
5. Boudiaf M, Jaff A, Foyer P et al: Small-Bowel Diseases: Prospective Evaluation of Multi-Detector Row Helical CT Enteroclysis in 107 Consecutive Patients. *Radiology*, 2004; 233: 338-44
6. Cieszanowski A, Wojciechowski K, Pacho R et al: Tomografia komputerowa całego jelita u pacjentów z podejrzeniem choroby Crohna. Doniesienie wstępne – ocena techniki badania i jakości uzyskanych obrazów. *Pol J Radiol*, 2004; 69(4): 12-18
7. Rajesh A, Maglinte DDT: Multislice CT enteroclysis technique and clinical applications. *Clin Radiol*, 2006; 1: 31-39
8. Cieszanowski A, Gołębiowski M: Zastosowanie tomografii komputerowej w diagnostyce niektórych ostrych schorzeń jamy brzusznej. *Pol J Radiol*, 2005; 70(2): 54-61
9. Chrupek M, Prokurat AI, Mierzwa G et al: Zastosowanie modyfikacji badania tomografem komputerowym w chorobie Leśniowskiego-Crohna. Alternatywa czy uzupełnienie diagnostyki w kwalifikacji do leczenia operacyjnego. *Pediatrica Współczesna. Gastroenterologia, Hepatologia i Żywnienie dziecka*, 2007; 9(3): 221-24
10. Gil J, Jałocha Ł, Wojtuś S: Metody obrazowania w nieswoistych chorobach zapalnych jelit. *Pol Merk Lek*, 2007; XXII(131): 442-45
11. Schmidt S, Felley C, Meuwly J-Y et al: CT enteroclysis: technique and clinical applications. *Eur Radiol*, 2006; 16: 648-60