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Correlation Between Findings of Multislice Helical Computed Tomography (CT), Endoscopic Examinations, Endovascular Procedures, and Surgery in Patients with Symptoms of Acute Gastrointestinal Bleeding

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The study is part of the scientific work of the 2nd Department of Clinical Radiology Medical University of Warsaw

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Summary

Background: Endoscopic methods (gastroscopy and colonoscopy) are considered fundamental for the diagnosis of gastrointestinal bleeding. In recent years, multidetector computed tomography (MDCT) has also gained importance in diagnosing gastrointestinal bleeding, particularly in hemodynamically unstable patients and in cases with suspected lower gastrointestinal tract bleeding. CT can detect both the source and the cause of active gastrointestinal bleeding, thereby expediting treatment initiation.

Material/Methods: The study group consisted of 16 patients with clinical symptoms of gastrointestinal bleeding in whom features of active bleeding were observed on CT. In all patients, bleeding was verified by means of other methods such as endoscopic examinations, endovascular procedures, or surgery.

Results: The bleeding source was identified on CT in all 16 patients. In 14 cases (87.5%), bleeding was confirmed by other methods.

Conclusions: CT is an efficient, fast, and readily available tool for detecting the location of acute gastrointestinal bleeding.

MeSH Keywords: Endoscopes, Gastrointestinal • Endovascular Procedures • Gastrointestinal Hemorrhage • Multidetector Computed Tomography

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Background

Gastrointestinal bleeding poses significant diagnostic and clinical problems. The classification system based on anatomical location of the bleeding source divides gastrointestinal bleeding into upper gastrointestinal bleeding (UGIB), with bleeding source located above the level of the ligament of Treitz, and lower gastrointestinal bleeding (LGIB), with bleeding sources located below the ligament of Treitz.

As demonstrated in epidemiological studies, the incidence of UGIB is 40-150cases/100,000 individuals/year, and it is about four times more common than LGIB [1]. The mortality rates due to UGIB and LGIB are 8–14% and 3.6–18%, respectively. The mortality rates increase to 21–40% in cases of massive bleeding, defined as bleeding that leads to hemodynamic instability of the patient, necessitating transfusion of at least 4 units of packed red blood within 24 hours [2]. Diagnostic methods used to detect the source of bleeding or to determine its cause include:

– endoscopic methods: gastroscopy, colonoscopy, capsule endoscopy;
– radiological methods: computed tomography, endovascular procedures;

– Tc-99m-labeled RBC scintigraphy.

Material and Methods

Between December 2006 and June 2014, CT angiography (CTA) examinations were performed in 16 patients with clinical symptoms of gastrointestinal bleeding.

The main inclusion criterion in this retrospective study was active gastrointestinal bleeding detected and localized on CTA.

Additional criteria were also considered, including:
- reduction in hemoglobin levels by at least 2 g/dL;
- hematemesis;
- bloody and/or tarry stools;
- symptoms of hemorrhagic shock.

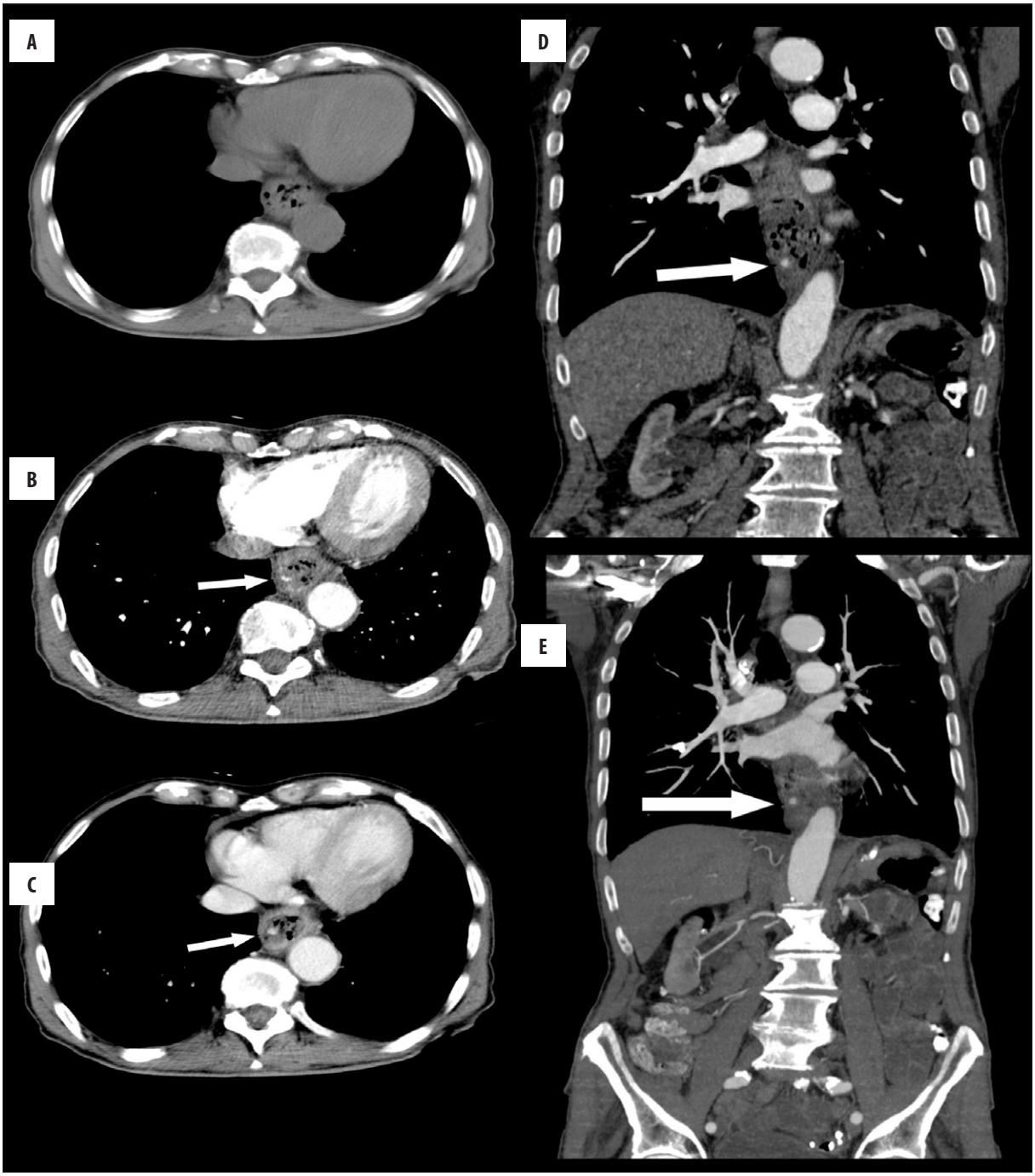

Figure 1. An 83-year-old male patient. Hematemesis was observed 19 days after gastrectomy due to cancer. CT scan revealed extravasation of contrast-enhanced blood at the esophagogastric junction (marked with arrows). (**A**) Axial plane, unenhanced CT image; (**B**) axial plane, arterial phase; (**C**) axial plane, venous phase; (**D**) MPR, coronal image, (**E**) MIP-reconstructed coronal image. Bleeding features were confirmed on gastroscopic examination.

Table 1. Study group characteristics.

Age median(years), range (years)	65, 24–93
Male/female (No. of patients)	8/8
Reduction in hemoglobin levels (fall of, medianhemoglobin level)	3 g/dL, 7.5 g/dL,
Range of lowest hemoglobin levels	5.5–9.5 g/dL
Blood vomiting (No. of patients)	5
Bloody and/or tarry stools (No. of patients)	5
Tarry stools (No. of patients)	4
Bloody stools (No. of patients)	2
Symptoms of hemorrhagic shock (No. of patients)	2

Bleeding features observed on CTA included contrast extravasation within the gastrointestinal lumen in the arterial or portal venous phase (Figure 1). In all patients, bleeding was verified by means of other methods such as endoscopic examinations, endovascular procedures, or surgery (Table 1).

CT scans were acquired using a CT scanner (GE, CT Optima CT 660 n=5 or Light Speed 16 PRO n=11).

Contrast agent (370 mg iodine/ml) was administered via the basilic vein in an amount of 80–120 mL (1–1.5 ml/kg), with an automatic syringe at a rate of 3–4 mL/s, followed by injection of 30 mL of normal saline. The scans were acquired in multiple phases: without contrast administration (unenhanced phase), arterial phase, and portal venous phase. No delayed phase scans were acquired. No negative oral contrast (water) was used.

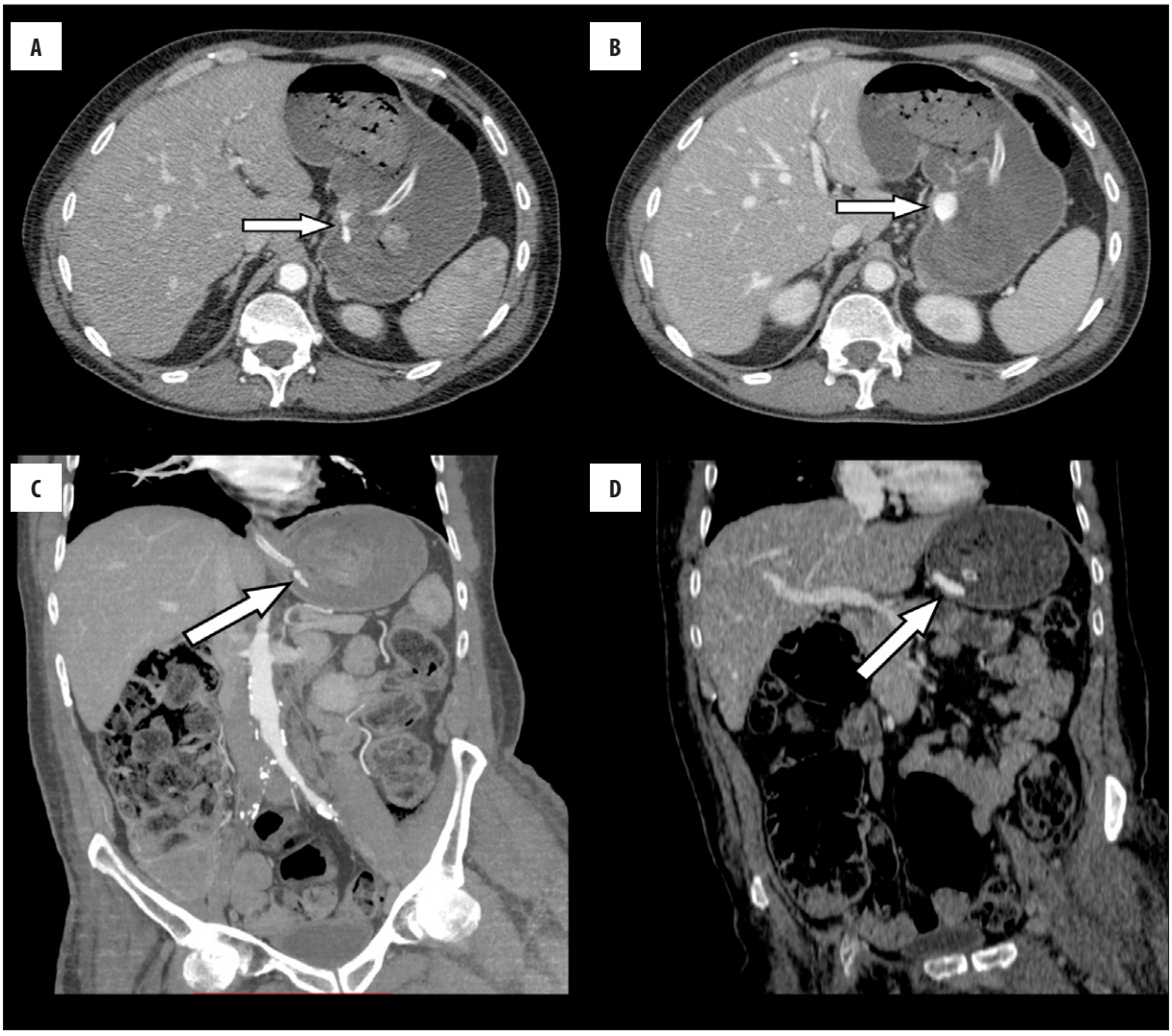

Figure 2. A 51-year-old patient presenting with hematemesis 2 days after Y-graft implantation. CT scan revealed extravasation of contrast-enhanced blood into the stomach (arrows). (**A**) Axial plane, arterial phase; (**B**) axial plane, venous phase; (**C**) MIP reconstruction, arterial phase; (**D**) MPR, coronal reconstruction, venous phase. Features of gastritis were seen on gastroscopy. The patient was received conservative treatment.

For the arterial phase, the use of an automated bolus triggering technique is preferred. Optimal timing of the arterial phase is 8–10 s after the attenuation coefficient in the proximal portion of the abdominal aorta reaches 150 HU. This additional 8–10 s delay allows contrast-enhanced blood to accumulate in the bowel lumen, if a focus of active bleeding is present. Portal venous phase images are then obtained 50s after the start of the arterial phase acquisition.

Scan parameters: 120kV, 250–280mA·s, slice thickness 1.25 mm, pitch 1.375: 1. Scans were assessed in the axial plane, with MIP, MPR, or 3D imaging used for more precise visualization of the bleeding source.

The goal of CTA with multiphasic imaging in GI hemorrhage is to identify the presence and location of active bleeding, indicated by the presence and accumulation of contrast material in the bowel lumen (active extravasation). Extravasated blood typically appears as a hyperattenuating focus of variable sizes in the arterial phase (Figure 2). Thus, the highest sensitivity for detecting and localizing the bleeding site is achieved by carefully evaluating both unenhanced and arterial phase series side by side. Active bleeding is confirmed, if the hyperattenuating focus is not present in the unenhanced series.

The presence of hyperattenuating material within the bowel lumen, without associated active bleeding, is usually a sign of intraluminal clot from recent hemorrhage.

Results

Bleeding location could be determined on CT scans in all patients. Six patients (37.5%) presented with upper gastrointestinal bleeding, while 10 patients (62.5%) presented with lower gastrointestinal bleeding (Table 2).

The cause of bleeding was identified on CT in 5 patients (31.2%). These included postoperative bleeding from pancreatic enteric anastomosis (n=2) (Figure 3), iatrogenic arteriobiliary fistula (n=2), and angiodysplasia (n=1). In 11 cases (68.7%), the cause of bleeding was not identified. The results of confirmatory examinations and procedures were

Table 2. Locations of bleeding sources in CT.

Bleeding source	No. of patients
Upper GI tract	**6**
Esophagus	2
Stomach	1
Duodenum	1
Bile ducts	2
Lower GI tract	**10**
Small bowel	8
Large bowel	2
Total	**16**

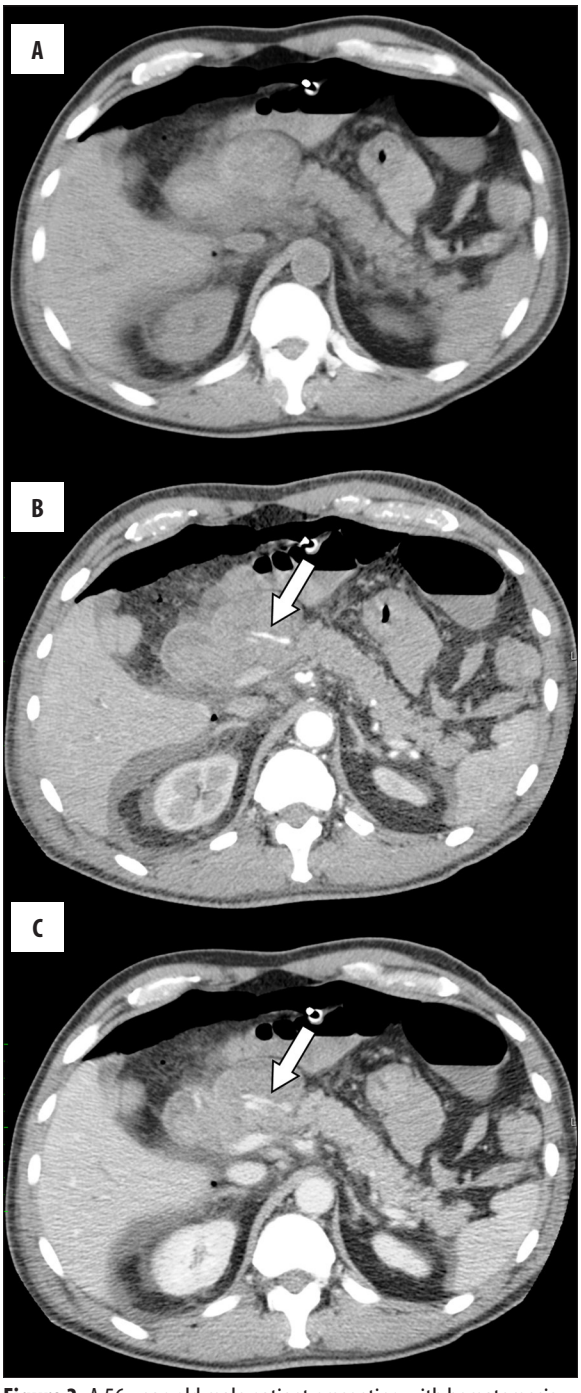

Figure 3. A 56-year-old male patient presenting with hematemesis 3 days after pancreatoduodenectomy. CT scan revealed postoperative bleeding from a pancreatic-enteric anastomosis. (**A**) axial plane, unenhanced CT image; (**B**) axial plane, arterial phase; (**C**) axial plane, venous phase. Active bleeding is marked with arrows. Bleeding features were confirmed during surgery.

as follows: overall, bleeding was confirmed in 14 out of 16 patients in the study group (87.5%)

In 13 endoscopic procedures (8 gastroscopies, 5 colonoscopies), bleeding was diagnosed in 4 patients (30.7%), including 2 cases diagnosed on gastroscopy (25%) and 2 cases diagnosed on colonoscopy (40%). The cause of bleeding could be observed in both gastroscopic examinations (inflammatory lesions and erosion within the esophagus n=1, hemorrhagic gastritis n=1).

No cause of bleeding could be identified in either of the colonoscopic examinations. Due to the presence of blood within the large bowel and the observed outflow of blood via the ileocecal valve, the small bowel was suggested as the source of bleeding.

Out of the total 9 endovascular procedures, bleeding was confirmed in 8 patients (88.8%). The bleeding causes were identified in 5 out of these 8 cases (62.5%) and included perforation of the descending aorta (n=1), pseudoaneurysm of the hepatic artery with arteriobiliary fistula (n=2), and intestinal angiodysplasia (n=2). No cause could be diagnosed in 3 patients (37.5%).

Surgical procedures were performed in 5 patients. Gastrointestinal bleeding was confirmed in all 5 patients (100%), while the cause of the bleeding was identified only in 2 patients (40%). The causes included postoperative bleeding from pancreatic enteric anastomosis (n=1) and small intestinal wall angioma (n=1).

No endoscopic confirmation of bleeding could be obtained in two patients with typical CT features (Figures 4, 5) and typical clinical symptoms of gastrointestinal bleeding. In both cases, CT revealed hemorrhage within the small bowel that could not be confirmed on endoscopic examination.

Data illustrating the efficacy of diagnostic and therapeutic methods in detecting gastrointestinal bleeding and localizing its source are listed in Table 3, while the causes of bleeding that were identified in diagnostic examinations and during therapeutic procedures are listed in Table 4.

Discussion

When diagnosing gastrointestinal bleeding, one must keep in mind that in most cases (approximately 75% cases) it may self-limit due to vascular spasm, coagulation, or tamponade of the bleeding source, but recurrence may occur in 25% of cases [3].

This feature of gastrointestinal bleeding may lead to false negative diagnoses based on imaging examinations [4,5].

Radiographic examinations (CT, X-ray angio) performed in hemodynamically unstable patients increase the likelihood of detecting active gastrointestinal bleeding [4,6,7].

Endoscopic methods (gastroscopy and colonoscopy) are considered fundamental methods for the diagnosis of gastrointestinal bleeding. They allow for a relatively safe location of the source of bleeding and often also for establishing the cause of bleeding from the esophagus, stomach, duodenum, or colon. No assessments of the small intestine are possible.

Gastroscopy is the method of choice in diagnosing UGIB. It permits not only the detection but also efficient treatment of such bleeding. The sensitivity and specificity of this method approach 98% [8].

In our study, gastroscopic examinations were performed in 8 out of 16 patients, with bleeding detected in 3 cases.

Colonoscopy is used in patients with suspected LGIB. Colonoscopy requires that the patient is prepared for the procedure for about 3–4 hours, which may be infeasible, particularly in patients with massive bleeding. In case of an acute, massive bleeding within the colon, the method allows for identification of the source of bleeding in about 13–40% of cases [8].

In our study, colonoscopy was performed in 5 patients with bleeding into the small bowel observed on CT (Figures 4–6). The procedure did not allow for identification of the source of bleeding in either of these patients. In 2 cases, fresh blood was observed within the large intestine, flowing into the intestine via the ileocecal valve and therefore the small intestine was suggested as the source of bleeding.

The role of CT in diagnosing gastrointestinal bleeding has been systematically increasing. It is a good, easily available (particularly in ER setting), non-invasive, and safe method that requires no patient preparation, and it is characterized by high sensitivity and specificity in detecting gastrointestinal bleeding. CT allows for adequate therapeutic decisions based on the detected pathology.

The first prospective study on the usefulness of computed tomography in the assessment of gastrointestinal bleeding was published by Yoon et al. in 2006 [9].with angiography as reference standard. Twenty-six consecutive patients (17 men, nine women; age range, 18-89 years The authors estimated that the sensitivity and specificity of CT in detecting gastrointestinal bleeding were 90.9% and 99%, respectively.

In 2013, Garcia-Blasquez et al. published a meta-analysis that summarized a total of 22 studies including 672 patients and assessing the efficacy of computed tomography in detecting gastrointestinal bleeding [10]. The overall sensitivity and specificity were estimated at 85.2% and 92.1%, respectively.

The choice of an appropriate examination protocol is of much importance, particularly with regard to acquisition of images in the two most important phases, i.e., before the administration of contrast (unenhanced) and in the arterial phase [11,12]. A vast majority of bleeding cases can be detected in the arterial phase [6,7,9]. In our study, bleeding could be observed in the arterial phase in 15 out of 16 patients, and it was seen in the venous phase in the remaining 1 patient.

A correct, multiphasic study protocol helps avoid potential diagnostic mistakes due to the presence of hyperdense

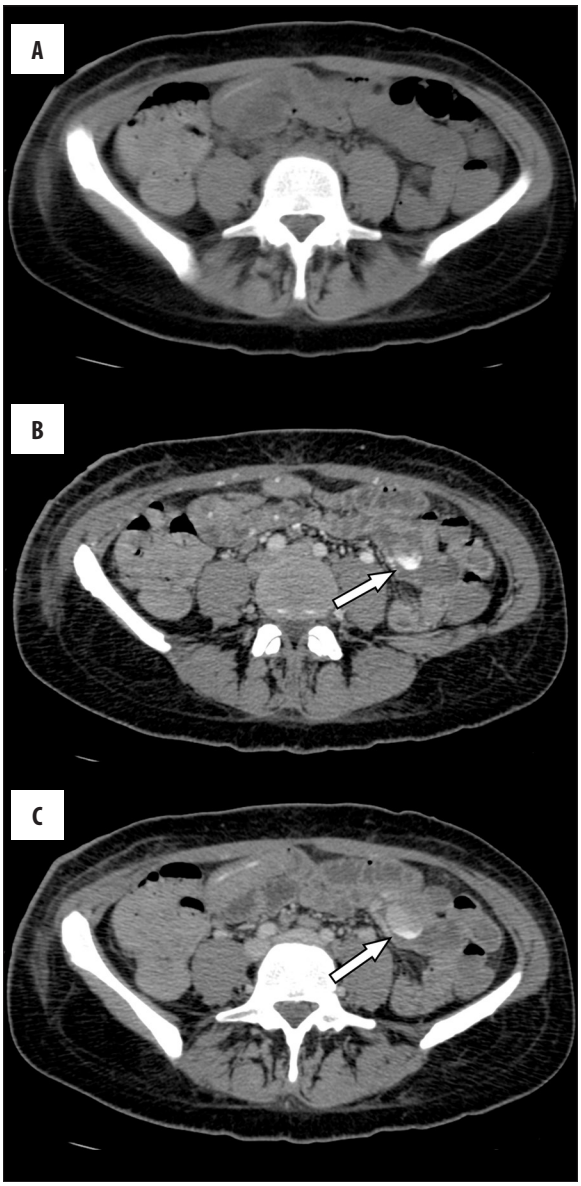

Figure 4. A 40-year-old female patient after surgical resection of an extrahepatic bile duct cyst. On day 11 after the procedure, the Hg level dropped to 5.5 g/dL (the lowest level measured in the entire study group), the patient fainted and had reduced blood pressure and increased heart rate. CT scan. (**A**) unenhanced phase; (**B**) arterial phase; (**C**) venous phase. Arrows mark active bleeding into the jejunal loop within the left epigastrium. No bleeding source could be identified on gastroscopy and colonoscopy. The patient underwent conservative treatment.

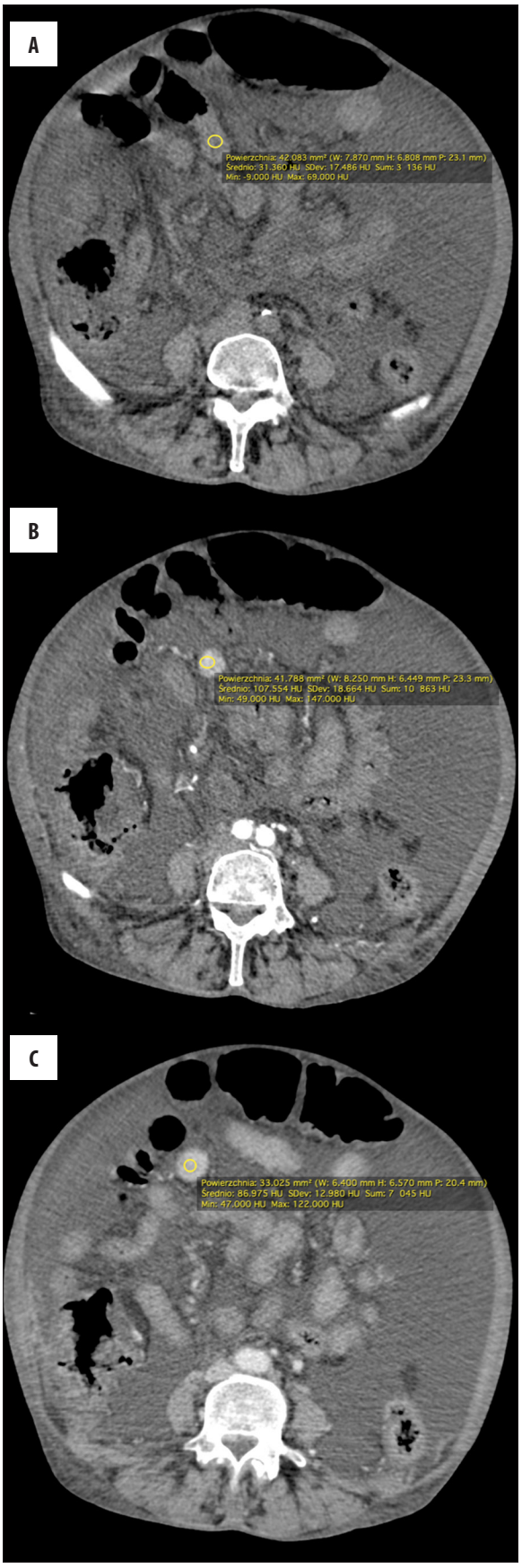

Figure 5. A 65-year-old female patient with a history of liver transplantation 2 years before and inflammatory bowel disease. Her Hb level dropped to 7.9 g/dL, and she had bloody/tarry stools. CT scan. (**A**) Unenhanced phase; (**B**) arterial phase; (**C**) venous phase. Features of contrast enhancement within the lumen of the small intestine during the arterial and venous phases on CT are indicative of active bleeding. No bleeding source could be identified on gastroscopy and colonoscopy. The patient underwent conservative treatment.

Table 3. The number of bleedings and their locations as detected by individual diagnostic methods.

	No. of patients	Bleeding confirmation (No. of patients)	Bleeding cause (No. of patients)
MDCT	16	16	5
Endoscopy	13	5	3
Gastroscopy	8	3	3
Colonoscopy	5	2	0
Endovascular procedures	9	8	4
Surgery	5	5	2

Table 4. Causes of bleedings identified in diagnostic examinations and during therapeutic procedures.

Pathology	MDCT		Endoscopy		Endovascular procedures		Surgery	
	Bleeding confirmation	Bleeding cause	Bleeding confirmation	Bleeding cause	Bleeding confirmation	Bleeding cause	Bleeding confirmation	Bleeding cause
Aortoesophageal fistula (n=1)	+ (n=1)	- (n=1)	+ (n=1)	+ (n=1)	+ (n=1)	+ (n=1)	No Procedure	No Procedure
Esophagitis (n=1)	+ (n=1)	- (n=1)	+ (n=1)	+ (n=1)	No Procedure	No Procedure	No Procedure	No Procedure
Gastric mucositis (n=1)	+ (n=1)	- (n=1)	+ (n=1)	+ (n=1)	No Procedure	No Procedure	No Procedure	No Procedure
Arteriobiliary fistula (n=2)	+ (n=2)	+ (n=2)	No Procedure	No Procedure	+ (n=2)	+ (n=2)	No Procedure	No Procedure
Postoperative bleeding from pancreatic enteric anastomosis (n=2)	+ (n=2)	+ (n=2)	- (n=1)	- (n=1)	+ (n=1)	+ (n=1)	+ (n=1)	+ (n=1)
Intestinal wall angioma (n=1)	+ (n=1)	- (n=1)	- (n=1)	- (n=1)	- (n=1)	- (n=1)	+ (n=1)	+ (n=1)
Intestinal angiodysplasia (n=2)	+ (n=2)	+ (n=1)	- (n=1)	- (n=1)	+ (n=2)	+ (n=2)	No Procedure	No Procedure

n – No. of patients.

structures within the intestinal lumen (sutures, tablets, foreign bodies, contrast agent administered during previous examinations, blood clots) that can be mistakenly interpreted as active bleeding.

We did not administered water orally in our study. According to some authors, one may consider oral administration of 1000 mL of water to hemodynamically stable patients in order to extend the intestines and thus possibly facilitate identification of extravasated blood [13]. In addition, this would simplify differentiation between the enhancement of gastrointestinal wall and bleeding in the fully collapsed intestinal lumen. Other authors believe that oral administration of water may reduce the diagnostic value of CT by diluting extravasated, contrast-enhanced blood, leading to false negative results [6,7,14].

Computed tomography facilitates detection of bleeding in patients with blood loss rates of 0.3 mL/min [15].

However, CT has some limitations. To detect contrast extravasation, the patient must be actively bleeding at the time of the scan. In addition, low intensity bleeds may be difficult to detect, when extravasated contrast material dilutes with preexistent intraluminal fluid or clot.

For years, arteriography was considered the gold standard in radiological diagnosis of gastrointestinal bleeding. Today, it is used mainly as a therapeutic method, and its diagnostic role is replaced by MDCT.

Arteriography facilitates detection of bleeding in patients with blood loss rates of 0.5 mL/min [16].

The sensitivity of arteriography is approximately 90% for upper gastrointestinal bleeding and 86% for lower gastrointestinal bleeding, respectively [17].

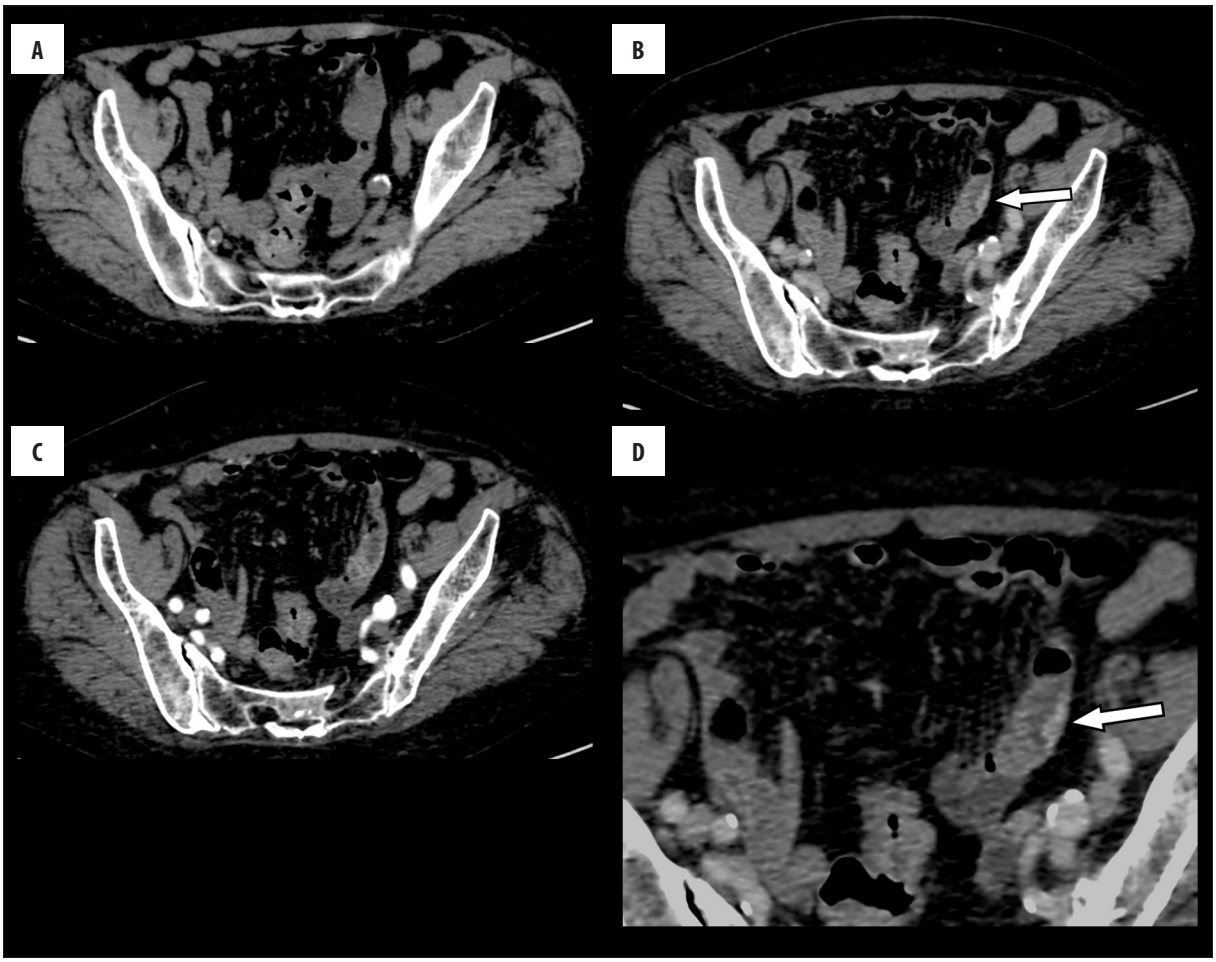

Figure 6. An 85-year-old patient with recurring gastrointestinal bleeding. CT scan. (**A**) Unenhanced phase; (**B**) arterial phase, no bleeding observed; (**C, D**) venous phase, linear bleeding into the small intestine is marked with an arrow within the left epigastric region. Bleeding was undetectable on gastroscopy. Colonoscopy revealed a large amount of blood within the large bowel; due to that, the bleeding source was not found, and the small intestine was suspected to be the origin of bleeding. No bleeding was revealed during endovascular examination. Surgery involved resection of a 40-cm segment of the small intestine with two nodular lesions with morphology suggestive of vascular malformation. Histological examination revealed an angioma. The patient received transfusion of a total of 31 packed red blood cells during hospitalization.

The efficacy of embolization of the bleeding source during an endovascular procedure is estimated at 91–100%, while the clinical success of the procedure (defined as no recurrence of bleeding within 30 days) is estimated at 68–82.5% for UGIB and 81–91% for LGIB, respectively [18–21].

Radiographic methods (computed tomography, endovascular procedures) are most commonly used for detection and/or treatment of gastrointestinal bleeding, when identification of the bleeding source with endoscopic methods is impossible.

Tc-99m-labeled RBC scintigraphy is characterized by high sensitivity in the detection of bleeding. However, the method is time-consuming, unavailable in the ER setting, and it is anatomically imprecise and thus should not be used in patients with acute massive bleeding. Tc-99m-labeled RBC scintigraphy facilitates detection of bleeding in patients with blood loss rates of 0.04 mL/min [22].

Our study is retrospective. The main limitation of the study is a small number of patients. For that reason, specificity and sensitivity of CT in the detection of the source of GI bleeding were not calculated.

Conclusions

1 CT is an efficient method for the detection of the source of acute gastrointestinal bleeding.
2. The method is quick, easily available, and requires no patient preparation.
3. Due to the requirements regarding patient preparation and examination times, other methods may be unable to visualize active bleeding which sometimes resolves spontaneously.

Conflicts of interest

There are no conflicts of interest and commercial involvement.

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