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The role of computed tomography in the preoperative assessment of gastrointestinal causes of acute abdomen in elderly patients

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ABSTRACT

Gastro-intestinal disorders in older patients is a medical emergency that requires immediate medical care. Chances of recovery improve with an early diagnosis and treatment. It might be caused by a number of different diseases, including perforations by foreign bodies, colon cancer, diverticulitis, ischemia. CT is often the initial modality used to assess patients with acute abdomen, the radiologist may be the first to suggest such a diagnosis. Computed tomography allows to identify the site of gastrointestinal perforations, of ischemia and to determine the most predictive signs in this diagnosis. The purpose of this study was to assess the diagnostic performance of CT gastrointestinal emergency of elderly patients with nontraumatic acute abdominal pain.

The cases of 126 consecutively registered patients 65 years old or older presenting to the emergency department with acute abdominal pain and who underwent CT were retrospectively reviewed by two radiologists. Diagnostic accuracy was calculated according to the level of correctly classified cases in both the entire cohort and a surgical subgroup and was compared between readings. Agreement between each reading and the reference diagnosis and interobserver agreement were assessed with kappa statistics.

In both the entire cohort (87.5% vs 85.3%, $p = 0.07$) and the surgical group (94% vs 91%, $p = 0.15$), there was no significant difference in CT accuracy between diagnoses made by the radiologist. Agreement between the CT diagnosis and the final diagnosis was excellent.

In the care of elderly patients, CT is accurate for diagnosing the cause of acute abdominal pain, particularly when it is of gastrointestinal surgical origin. Thus CT interpretation should not be delayed until complete clinicobiologic data are available, and the images should be quickly transmitted to the emergency physician so that appropriate therapy can be begun.

1. Introduction

Gastrointestinal (GI) diseases are common in older patients, and the clinical presentation, complications, and treatment may be different from those in younger patients. Aging is accompanied by a decline in the healthy function of several organs in response to different mechanisms like oxidative stress and elevated ROS (Reactive oxygen species) overproduction [1–3]. With the marked increase in population aged 65 years and over, the study and care of GI disorders should be a high priority for both clinicians and

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researchers. Both the usual course of aging and the accumulation of multiple disease states can lead to impairments in GI function. Older individuals' propensity to use multiple medications, combined with years of acquired lifestyle choices, can disrupt the integrity and functioning of the GI system. Most problems encountered occur at the proximal and distal ends of the GI tract [4–6]. Acute abdomen in elderly patients poses a difficult challenge for emergency physicians. Elderly patients have a diminished sensorium, allowing pathology to advance to a very dangerous state before developing symptoms. In the presence of serious intra-abdominal pathology, elderly patients are more likely to present with vague symptoms and to have nonspecific findings on examination. The frequently disorders that occurs in elderly patients are: mesenteric ischemia, intestinal perforation by colon rectal cancer, diverticulitis, and foreign bodies [7]. CT with intravenous contrast provides superb anatomical detail and diagnostic specificity by directly imaging of the intestinal wall, detecting primary and secondary signs of bowel disease within the surrounding mesentery and depicting even small amounts of intestinal ischemia and extraluminal air into the peritoneal cavity [8].

2. Material and method

Between February 2012 and September 2013, all patients with symptoms of acute severe abdominal pain (with positive signs on clinical examination most commonly guarding and peritonism) and who were referred for an urgent CT scan as part of their evaluation were included in the study. CT scans performed within a 24-h period of the radiology request were defined as urgent. Patients with acute abdominal pain secondary to trauma (blunt or penetrating) and patients who were referred for a CT of the kidneys, ureter and bladder to establish the clinical diagnosis of renal colic or for abdominal vascular emergencies were excluded. The cases of 126 consecutively registered patients 65 years old or older presenting to the emergency department with acute abdominal pain and who underwent CT were retrospectively reviewed by two radiologists. Diagnostic accuracy was calculated according to the level of correctly classified cases in both the entire cohort and a surgical subgroup and was compared between readings. Agreement between each reading and the reference diagnosis and interobserver agreement were assessed with kappa statistics.

2.1. Imaging protocol

CT scans were performed on a Ge 64 scanner and acquired in double phase at 40 and 60 s after i.v. contrast administration. Oral contrast agent was not administered routinely. The scan was reconstructed to create contiguous 2.5 mm axial sections from the lung bases to the pubic symphysis. Coronal and sagittal reconstructions were also made available.

3. Results

126 consecutive scans fulfilled the inclusion criteria (114 patients; 85 women; mean age 75 years). The correct clinical diagnosis was made in 87.5% of cases based on CT findings. The lack of intravenous contrast limited diagnostic interpretation in 6 of the 15 discrepant cases. CT was unable to define early inflammatory changes in three patients and early caecal carcinoma in one. A right paraduodenal internal hernia was difficult to detect in another patient. Interobserver agreement was 93%, but with a low kappa value of 0.27. A paradox exists due to an imbalance in the positive and negative agreement of 96% and 31%, respectively. In both the entire cohort (87.4% vs 85.3%, $p = 0.07$) and the surgical group (94% vs 91%, $p = 0.15$), there was no significant difference in CT accuracy between diagnoses made by the radiologist. Agreement between the CT diagnosis and the final diagnosis was excellent.

4. Discussion

Imaging is playing an increasingly important role in the assessment of the acute surgical patient with plain radiography, ultrasonography, CT and magnetic resonance imaging (MRI) all being used in this situation. While plain abdominal X-rays and erect chest X-rays are useful screening tools, their findings are often non-specific. Ultrasonography is inexpensive and free from ionising radiation or contrast. However, it is of reduced accuracy in obese patients or those with low mobility and can be unpleasant in patients with a very tender abdomen. CT provides greater accuracy than ultrasonography together with a greater detection of alternative diagnoses, especially with regards to retroperitoneal, bone and bowel pathology and detecting free gas. On the other hand it comes at the cost of exposure to radiation and contrast media as well as being far more expensive. The usefulness of CT in the diagnosis and management of acute gastrointestinal emergencies is well established, and confirmed by the results of this study, in which the CT diagnosis correlated with the final diagnosis in very high rate.

4.1. Intestinal ischemia

Mesenteric ischemia leading to bowel infarction is a relatively common catastrophic occurrence in the elderly. In this condition the diagnosis may be difficult, but time is of the essence for survival, because the prognosis is poor, and the treatment is almost inconsequential if performed too late [9–11]. Acute mesenteric ischemia is a true surgical emergency. Risk factors for acute mesenteric ischemia in patients of advanced age include atherosclerosis, arrhythmias, hypovolemia, congestive heart failure, recent myocardial infarction, valvular disease, deep venous thrombosis, intra-abdominal malignancy, and the use of medications with vasoconstrictive effect on the splanchnic vascular district, such as digitalis, beta-blockers, somatostatin, and vasoactive amines. The diagnosis of acute mesenteric ischemia may be overlooked because of the vague nature of the patient's symptoms [12–15]. Patients may present with recurrent episodes of postprandial abdominal pain (intestinal angina), but often the clinical presentation consists of vomiting or diarrhoea with occasional blood in the stool and localized or generalized abdominal pain of either acute or sub-acute onset. The characteristic of this disease is that symptoms typically are out of proportion to findings. Acute mesenteric ischemia is a syndrome in which inadequate blood flow through the mesenteric circulation causes ischemia and eventual gangrene of the bowel wall. The aetiology could be arterial or venous; the arterial disease can be subdivided into non-occlusive and occlusive ischemia [16,17]. Occlusion of the superior mesenteric artery may be caused by embolism or thrombosis. Emboli may occlude the proximal portion or one of the distal branches of the superior mesenteric artery, whereas thrombosis more frequently involves the origin of superior mesenteric artery, where wall aortic atheromatous apposition may cause partial obstruction of the orifice. When the superior mesenteric artery is obstructed at the origin by an embolus, most of the small intestine and the right colon are subject to ischemia [18,19]. Non-occlusive mesenteric ischemia, most frequent in the elderly, results from decreased arterial perfusion that is not related to the presence of endovascular obstruction but rather is caused by an insufficient cardiac output from congestive heart failure, from myocardial infarction, or from a decreased blood pressure with a low-flow state caused by hypovolemia or shock. Occlusion of the superior mesenteric vein may be

caused by thrombosis at the origin or in its distal branches. It can be primary, or it can be observed in cirrhotic patients who have portal hypertension or in patients who have coagulation disorders. Occlusion of the superior mesenteric vein leads to intramural haemorrhage from impaired venous drainage of the bowel wall. Chronic mesenteric ischemia may be the precursor of any of these conditions. When the arterial lumen is narrowed secondary to atherosclerosis, an increased metabolic demand (e.g., in digestion) exceeds the possible blood supply and can result in severe abdominal pain and possibly infarction. The superior mesenteric vessels are involved more frequently than the inferior mesenteric vessels, but blockage of the latter often is silent because of better collateral circulation. Damage to the affected bowel portion may range from reversible ischemia to trans-mural infarction with necrosis and perforation.

4.2. Gastrointestinal perforation

Gastro intestinal perforation is a medical emergency that requires immediate medical care. The condition is life threatening. Chances of recovery improve with an early diagnosis and treatment.

Gastrointestinal perforation (GP) occurs when a hole forms all the way through the stomach, small intestine and large intestine. It might be caused by a number of different diseases, including foreign bodies, colon cancer, diverticulitis, ischemia. Intestinal perforation is an emergency medical situation presented as an acute abdomen, and it's only rarely diagnosed clinically. CT is often the initial modality used to assess patients with acute abdomen, the radiologist may be the first to suggest such a diagnosis 15. CT provides superb anatomical detail and diagnostic specificity by directly imaging of the intestinal wall, detecting secondary signs of bowel disease within the surrounding mesentery and depicting even small amounts of extraluminal air or oral contrast leakage into the peritoneal cavity [20–24].

4.3. Foreign bodies

The ingestion of foreign bodies occurs involuntarily while eating; meat boluses are the most common foreign bodies ingested in western countries, fish bones in oriental countries [25–27]. However, in 1% of cases, it causes complications such as acute abdomen due to intestinal perforation [21]. In some cases, it can cause severe complications and even death; in the USA,1,500 people die annually from foreign body ingestion [28]. In the early patients this condition is more frequent because persisted two predisposing risk factor for foreign body ingestion: co-morbid condition and the use of dentures, because they reduce the sensitivity of the palate [29,30]. Bowel perforation by a foreign body is less common, as the majority of foreign bodies uneventfully pass to the feces and only 1% of them (the sharper and more elongated objects) will perforate the gastrointestinal tract, usually at the level of the ileum [31]. The complications of foreign bodies ingestion with perforation include the formation of localized abdominal abscesses, colorectal, and entero-vascular fistulas, inflammatory masses or omental pseudotumors, and endocarditis.

The intestinal tract, where perforations by foreign bodies are most frequent, include the ileocecal and rectosigmoid regions, because the intestinal lumen narrows and the digestive tract is angulated in these sites. Sites where impaction is most likely, include zones with adhesions, areas containing a diverticular process, or surgical anastomoses. Treatment consists of surgery (from primary suture to rectosigmoid resection with colostomy, removal of the foreign body, and abdominal cavity lavage), and antibiotics.

The patient presented, at the emergency department with diffuse abdominal pain with peritoneal irritation and vomiting of 24 h' duration. Laboratory tests showed generally leukocytosis and increased C-reactive protein. The supine plain abdominal radiograph demonstrated signs of small bowel obstruction but do not always shows a radiopaque foreign body or pneumoperitoneum. This finding is not surprising because for example fish bones have variable radio-opacity depending on the fish species; in general, the foreign bodies are minimally radiopaque and can rarely be detected on plain films, especially if they are masse by coexistent inflammatory tissue, fluid or abscesses [32,33]. Moreover, signs of pneumoperitoneum are not usually observed in plain films because impaction of the foreign body into the intestinal wall is gradual, allowing the perforation site to seal with omentum or adjacent loops and limiting the amount of gas or fluid in the peritoneal cavity. MDCT is currently considered the method of choice for the evaluation of patients with acute abdominal pain and the depiction of foreign bodies due to MDCT's ability to generate high-resolution, thin-collimation, multi-planar reconstructions, which allow the GI tract to be examined in all projections.

Abdominal CT showed generally a foreign body in the small bowel, with pneumoperitoneum and fluid within the abdominal cavity.

4.4. Colorectal cancer

There are many hereditary pathologies, such as genetic factors, that predispose onset of colorectal carcinoma, among these the syndromes characterized by the occurrence of polyps [34–36]. Bowel obstruction is the most commonly observed complication of colon cancer. The reported frequency of patients with obstructive colon cancer has ranged from 8% to 29% [37]. Left-sided colon malignancies are more prone to obstruct the colon lumen than are the right-sided malignancies. This is because the diameter of the left colon is smaller than that of the right colon. CT is a sensitive imaging modality for detecting bowel obstruction, and the multiplanar reconstruction images can provide additional information on the transition point in problematic cases [37]. Identifying the transitional zones and an obstructing lesion on CT, and these usually appear as irregular circumferential thickening of the colon, is important to differentiate this entity from other benign conditions such as adynamic ileus, colonic pseudoobstruction and stercoral colitis, and all these maladies can present with colonic dilatation. Because of the relatively larger diameter of the cecal lumen, cecal adenocarcinomas have a tendency to grow without displaying clinical manifestations for a long time [38]. Therefore, cecal cancer only infrequently presents as bowel obstruction; as the initial manifestation, distal small bowel obstruction has been reported to occur in 1.5–8.1% of the patients with cecal cancer [39]. Additionally, adenocarcinoma developing near the ileocecal valve area can cause distal small bowel obstruction even though the tumor is small. CT is also useful for examining cecal cancer patients who present with small bowel obstruction. Careful inspection of the cecum on the CT, and especially the ileocecal valve area, is needed to diagnose this rare condition. Closed-loop obstruction is a unique form of mechanical obstruction in which two points of a bowel segment are occluded, and this most frequently occurs in the small bowel [40,41]. On rare occasion an obstructing colon cancer with a competent ileocecal valve can lead to the condition in which the intraluminal pressure of the colon proximal to the obstructing mass increases due to failure of decompression through the ileocecal valve; this produces effects that are similar to those of a closed-loop obstruction in the small bowel [42]. On CT, this condition can be identified as an obstructive colon mass that causes severe dilatation of the proximal colon. The affected colon is usually filled with fecal

material, and the small bowel is not dilated due to a competent ileocecal valve. Radiologists and surgeons should be aware of a closed-loop obstruction associated with colon cancer because this is an urgent surgical situation that can lead to a perforated colon [43]. Common presenting symptoms of CRC include abdominal pain, change in bowel habits, rectal bleeding, anaemia and weight loss [44]. A less frequent presentation is perforation and abscess formation, which is usually intraperitoneal, but may occasionally be located in extraperitoneal spaces. With contained perforation and abscess formation, the clinical picture can closely resemble complicated diverticulitis, whether on clinical examination or on radiological imaging such as Computed Tomography (CT) scans. Patients typically present fever, abdominal pain and leukocytosis, and CT scans show a pericolic or intra-abdominal abscess. Perforation in association with a colonic tumour is uncommon as a primary presentation, with incidences ranging from 2.6%4–10% [45]. Perforation of the colon can be diagnosed by CT with the demonstration of a focal defect in the colon wall that may be accompanied by a fluid-density abscess, free air or stranding of the pericolic fat. Abscess formation occurs in 0.3%–0.4% of colonic carcinomas and it's the second most common complication of perforated lesions. Abscesses commonly remain localised in the paracolic region or may develop into a pelvic abscess, but they can also track along various tissue planes and have been reported to present as a flank abscess, psoas abscess [46], or even a subcutaneous abscess on the trunk. Perforations can also occur proximally to an obstructing primary lesion, for example, a perforated caecum secondary to a closed loop obstruction with a competent ileocecal valve in an obstructed carcinoma of the sigmoid or descending colon [47,48]. It is important that the diagnosis of perforated colonic carcinoma is considered as a differential diagnosis whenever a patient presents with an intra-abdominal abscess with the presumptive diagnosis of perforated diverticular disease. All patients who present with complicated “diverticular disease” and intra-abdominal abscess—especially those that do not respond to conservative treatment—should be offered surgery with resection of the involved colon and removal of the abscess for histological evaluation [40–49].

4.5. Diverticulitis

Diverticular disease has become more prevalent in Western countries [50,52]. About 10–25% of individuals with diverticulosis will develop symptomatic diverticulitis, and of these, 15% will develop significant complications, such as perforation [53]. Although the absolute prevalence of perforated diverticulitis complicated by generalized peritonitis is low, it's importance lies in the significant postoperative mortality, ranging from 4 to 26% regardless of the surgical strategy selected [53]. Optimal treatment strategies are based on disease severity as classified by Hinchey [54]. The usual management of diverticulitis is based on patients symptomatology as well as CT scan results. Simple diverticulitis can be treated with bowel rest and intravenous antibiotics. Complicated diverticulitis is classified using the Hinchey classification, and management strategies depend on the classification. Hinchey III and IV diverticulitis are indications for laparotomy, washout and resection of the affected colon.

Today, a conservative treatment with antibiotics (and abscess drainage) is advocated for Hinchey 1 and 2 [55]. Patients presenting with perforated diverticulitis with generalized peritonitis (Hinchey 3 and 4) should undergo emergency surgical treatment. Laparoscopic peritoneal lavage without resection of the affected bowel segment in patients with purulent peritonitis (Hinchey 3) appears to diminish the morbidity and improve outcome, whereas acute resection should be performer in patients with gross fecal peritonitis (Hinchey stage 4). The combination of free air and intra-abdominal fluid seen on the CT scan correlated well with Hinchey 3 and 4 perforated diverticulitis, and these are the main findings the radiologists used to for the CT based diagnosis of Hinchey 3 or 4. Preoperative differentiation between Hinchey stage 3 and 4 is not very important, as both need emergency surgical treatment. Nevertheless, it could be useful in deciding on the surgical approach. In case of purulent peritonitis (Hinchey 3), laparoscopic peritoneal lavage and drainage without resection of the affected bowel segment has shown excellent results. In case of fecal peritonitis, laparotomy is recommended for resection of the affected bowel segment.

The preoperative differentiation between Hinchey 3 and Hinchey 4 is not possible with CT scanning. Today, computed tomography is the modality of choice in the assessment and management of diverticulitis with its high sensitivity and specificity [56,57]. With CT-guided percutaneous abscess drainage (PCD), it has also become an important therapeutic modality. In recent years, CT scanning has become the imaging modality of choice to determine the extent of the disease and surgeons tend to rely more frequently on the CT findings to decide upon further treatment [58].

5. Conclusions

Our findings show the CT provides an accurate prediction of final operative findings, validating the usefulness of CT in preoperative diagnosis and planning. It also demonstrates a high degree of accuracy in on-call registrar reporting if there is adequate consultant support. Early review by a second consultant radiologist can further increase the diagnostic accuracy of CT in the acute abdomen.

CT imaging in the diagnosis, management and outcome of patients presenting with acute abdominal pain is well established. In a minority of cases, the usefulness is limited by certain factors; specifically, the use of noncontrast imaging, the inability of CT to define various pathologies, the lack of imaging findings in uncommon conditions and the variability in the interpretation of nonspecific imaging findings. Awareness of these limiting factors is vital to both clinicians and radiologists in the diagnosis and management of these patients.

Ethical approval

Ethical approval was requested and obtained from the “Second University of Naples/AO S.G. Moscati” ethical committee.

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Author contribution

All authors contributed significantly to the present research and reviewed the entire manuscript.

Alfonso Reginelli: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data; also participated substantially in the drafting and editing of the manuscript.

Anna Russo: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data.

Antonio Pinto: Participated substantially in the analysis and interpretation of data; also participated substantially in the drafting and editing of the manuscript.

Francesco Stanzione: Participated substantially in the analysis and interpretation of data.

Ciro Martiniello: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data.

Salvatore Cappabianca: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data.

Luca Brunese: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data.

Ettore Squillaci: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data; also participated substantially in the drafting and editing of the manuscript.

Conflicts of interest

All Authors have no conflict of interests.

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