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Spontaneous non-aortic retroperitoneal hemorrhage: etiology, imaging characterization and impact of MDCT on management. A multicentric study

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Abstract
Purpose The purpose of this multicentric study is to assess the usefulness of multiphasic Computed tomography in the identification of spontaneous non-traumatic retroperitoneal hematoma (SRH) and its management, with references to the role of interventional radiology.
Materials and methods From January 2011 to June 2014, 27 patients with SRH were selected. Patients with aortic, traumatic, or iatrogenic source of bleeding were excluded. All the patients were studied with multiphasic MDCT after injection of intravenous contrast. Digital Subtraction angiography and percutaneous embolization treatment were performed.
Results CT identified SRH in all cases (100 %), showing the source of bleeding in 11 cases (40 %) and pointing out the source of bleeding in 15 cases (55 %). In one case (5 %), the bleeding origin was recognized only at surgery as adrenal source. CT has identified a contrast medium extravasation in the arterial phase in 17 patients (63 %), treated successfully by percutaneous embolization in 13 and by open-surgery in two cases. Two patients died before undergoing intervention and surgery, respectively. Ten patients (37 %) were non-operatively treated successfully with clinical, laboratory, and imaging follow-up.
Conclusions Multiphasic CT is the gold standard for the identification of a SRH. Recognition of CT signs of active bleeding is the crucial feature influencing the timing of therapeutic treatment. Urgent embolization should be performed in cases of arterial bleeding or contained vascular injuries supplying the retroperitoneal hematoma. Surgery is to be addressed in cases of actively bleeding hematomas associated with complication. Finally, an initial more conservative approach can be adopted in patients without signs of contrast extravasation or low-flow active bleeding. Technical skill, expertise, and recognition of CT signs of arterial active bleeding are critical features influencing patients management.

Keywords Spontaneous retroperitoneal hemorrhage · Computed tomography (CT) · Computed tomography angiography (CTA) · Digital subtraction angiography (DSA) · Retroperitoneal hemorrhage management

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Introduction

Spontaneous retroperitoneal hemorrhage (SRH) without aortic rupture, trauma, or iatrogenic causes represents a

Table 1 Correlation between CT imaging, treatment and final diagnosis

Case	Age	Anticoagulant	CT diagnosis of bleeding	CT arterial active bleeding	Emergency treatment	Final diagnosis
1	75	Yes	Pancreatico-duodenal artery	Yes	Angiography	Confirmed
2	81	Yes	Pancreatico-duodenal artery aneurism	Yes	Angiography	Confirmed/exitus before DSA
3	51	No	Pancreatico-duodenal artery	No/venous	Conservative	Confirmed
4	53	Yes	Pancreatico-duodenal artery	Yes	Angiography	Confirmed
5	62	Yes	Pancreatico-duodenal artery	No	Conservative	Confirmed
6	77	Yes	Right subphrenic artery	Yes	Angiography	Confirmed
7	67	Yes	Left subphrenic artery	Yes	Angiography	Confirmed
8	73	Yes	Sacral artery	Yes	Angiography	Confirmed
9	70	No	Renal artery aneurysm	Yes	Surgery	Confirmed/exitus during surgery
10	54	No	Renal artery aneurysm-MAV	Yes	Angiography	Confirmed
11	64	Yes	Obturator artery	Yes	Angiography	Confirmed
12	59	No	Obturator artery	Yes	Angiography	Confirmed
13	50	No	Right testicular artery	Yes	Angiography	Confirmed
14	91	Yes	Lumbar artery	Yes	Angiography	Confirmed
15	85	Yes	Lumbar/ileo-lumbar artery	Yes	Angiography	Confirmed
16	78	Yes	Lumbar artery	No	Conservative	Confirmed
17	79	Yes	Ileo-lumbar artery	Yes	Angiography	Confirmed
18	84	Yes	Ileo-lumbar artery	No/venous	Conservative	Confirmed
19	51	No	Renal cystic lesion	No	Conservative	Confirmed
20	54	No	Renal cystic lesion, polycystic kidney	No	Conservative	Confirmed
21	72	No	Renal malignant neoplasm	Yes	Surgery	Confirmed
22	85	Yes	Renal malignant neoplasm	No/venous	Conservative	Confirmed
23	67	No	Renal malignant neoplasm	No	Conservative	Confirmed
24	45	No	Renal angiomyolipoma	No	Conservative	Confirmed
25	67	No	Left subphrenic space, uncertain origin	Yes	Surgery	Adrenal metastasis
26	78	Yes	Adrenal metastasis	Yes	Angiography	Confirmed
27	76	No	Adrenal carcinoma	No	Conservative	Confirmed

rare and insidious condition that recognizes different etiologies [1]. Most frequent causes are parenchymal diseases related to vascular rupture of retroperitoneal organ expansive lesions, most often spontaneous rupture of renal carcinomas and angiomyolipomas [2] and adrenal expansive lesions [3]; further causes include vascular diseases related to the rupture of splanchnic artery aneurysms or small vessels injuries [4–6]. According to the etiology, symptoms may vary from mild abdominal pain to acute abdomen until cardiovascular collapse [1].

Ultrasound (US) and plain film of the abdomen provide insufficient and often non-specific diagnostic information. Multidetector Computed tomography (MDCT) plays a primary role because of its ability to identify, with high sensitivity and specificity, the presence and cause of hematomas into the retroperitoneal space, significantly influencing the subsequent management [7].

Current literature is mainly focused on classification of etiologies and clinical management of the disease. The current multicentric study has the primary purpose to assess the usefulness of MDCT in the diagnosis of SRH, pointing out how CT can influence patients management approach.

Materials and methods

From January 2011 to June 2014, we retrospectively evaluated data of four emergency radiology departments, selecting patients who performed a CT examination for suspected retroperitoneal hemorrhage. We excluded patients with aortic rupture, and traumatic or iatrogenic retroperitoneal hemorrhage, selecting a total of 27 patients (16 males and 11 females aged between 45 and 91 years) with SRH from different causes.

All patients were studied with multidetector CT scanners (Toshiba Aquilion 128 slices, General Electrics Lightspeed 64 slices, Siemens Somatom S. 64 slices) using a pre-contrast phase followed by a multiphasic study after injection of intravenous contrast agent at high rate (4–5 ml/sec). The multiphasic study consisted of an arterial phase, using the

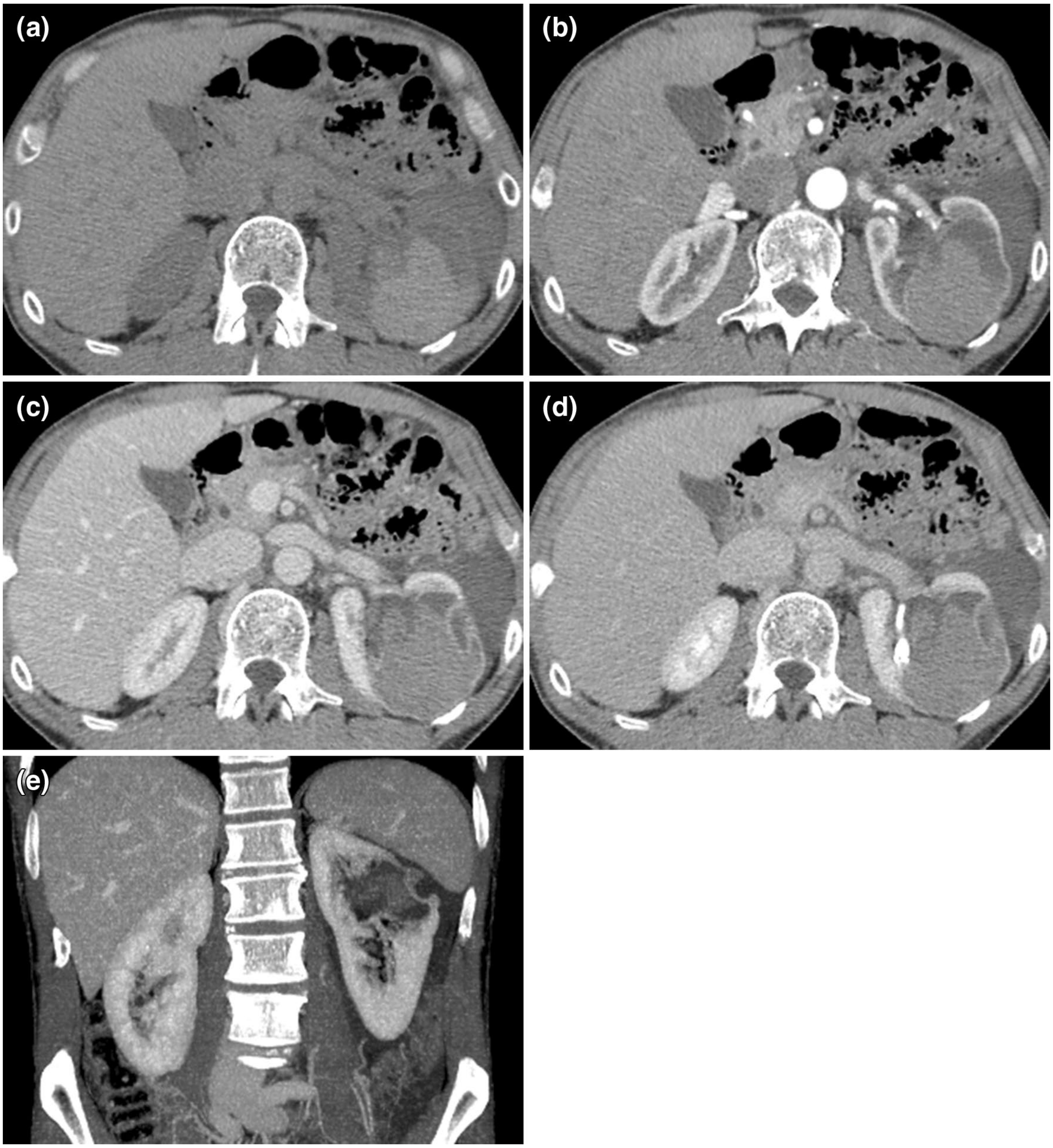


Fig. 1 A 51-year-old man suffering severe left flank pain. Non-contrast enhanced CT scan shows a hyperdense fluid collection, with well-defined margins, in the left kidney **(a)**, associated with fluid in the adjacent perinephric space. The multiphasic CT study after intravenous injection of iodinated contrast material in the arterial **(b)**, portal **(c)**, and delayed phases **(d)** allows classifying the lesion as intraparenchymal hematoma due to the spontaneous rupture of a large cystic lesion. Furthermore, active bleeding and/or urinary leak can be excluded. Coronal reformation images allow excellent visualization of the lesion in the context of the renal parenchyma **(e)**. The patient was treated conservatively and underwent follow-up with CT and US

'bolus tracking' technique, followed by a portal phase at about 70 s from the beginning of the injection of the contrast medium. A delayed phase at 180–300 s has been done in all patients for characterization of vascular lesions or differentiation between vascular and urinary injuries. Post-processing techniques were routinely performed with Multi planar reconstruction (MPR) and Maximum intensity projection (MIP).

Digital subtraction angiography (DSA) was performed using a C-ARM angiography system (Philips Allura Xper FD 20). DSA and percutaneous embolization treatment (PET) were routinely performed using a 0.028-inch lumen microcatheter (Microcatheter System Progreat, Terumo, Tokyo, Japan) with a compatible 0.018-inch guidewire passed through different 5-F angiographic catheters (Cordis, Johnson & Johnson Company, Miami Lakes,

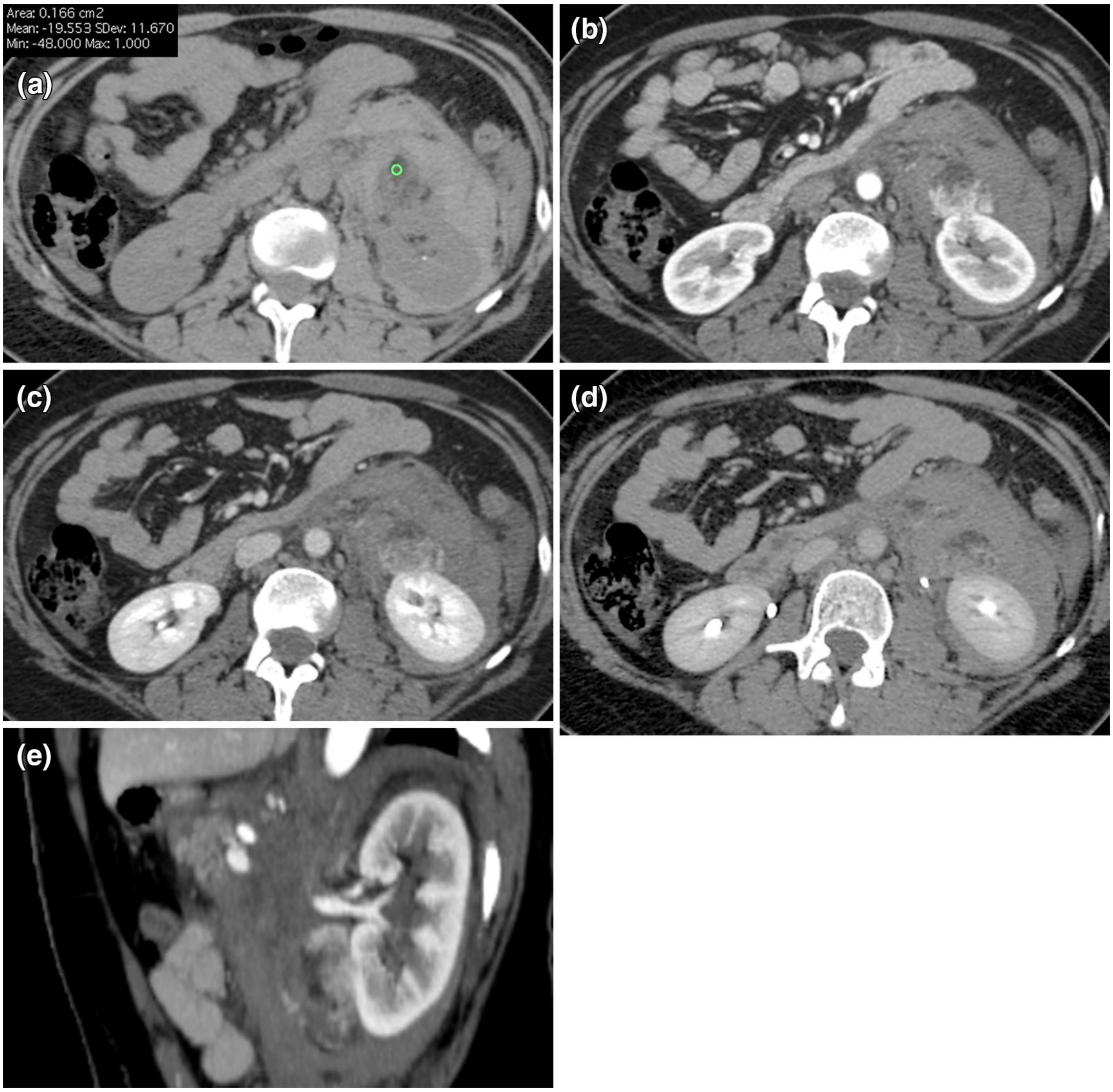


Fig. 2 A good health 45-year-old man admitted with left lumbar pain. CT scan shows a large perirenal hematoma secondary to the rupture of a large, inhomogeneous fatty-like mass within the middle and lower third portion of the left kidney in keeping with an exophytic angiomyolipoma **(a)**. A multiphasic MDCT study in arterial **(b)**, venous **(c)**, and delayed phases **(d)** and an oblique sagittal MPR reformation image **(e)** exclude an active bleeding, thus suggesting a non-operative management

Florida). Diagnostic angiography through the main bleeding vessel was performed to confirm extravasation of contrast medium revealed by CT scan. The microcatheter was advanced as close as possible to the bleeding site in all cases. Different embolic materials were used: microcoils, absorbable gelatin sponge, glue, and polyvinyl alcohol (PVA) microspheres.

DSA was performed at the end of each procedure to confirm the cessation of the bleeding.

All patients were clinically monitored and followed up with a CT scan or ultrasound in an interval period between 2 days and 2 months.

Results

Cause of the bleeding was properly vascular in 18 patients (67 %) and parenchymal in nine cases (33 %) as detailed in Table 1.

CT allowed a rapid diagnosis of retroperitoneal hemorrhage in all cases (100 %). In 11 cases (40 %), CT identified the source of bleeding: two cases from renal cysts (Fig. 1), three cases from a malignant renal tumor, one case from an adrenal carcinoma, adrenal metastasis, and a renal angiomyolipoma (Fig. 2), two cases of aneurysm of segmental renal artery branch, and one case of aneurysm of

Fig. 3 A 81-year-old man admitted to the ER with epigastric flank pain and initial onset of cardiovascular decompensation. The multiphasic CT study demonstrates a large para-duodenal hematoma secondary to the rupture of an aneurysm in the territory of the pancreatic-duodenal arch **(a)**, with signs of active bleeding **(b)**. The scans acquired in the portal phase **(c**, **d)** show progressive and significant increase of iodinated contrast medium extravasation. MIP reconstruction image in the coronal plane **(e)** gives a further perspective of the abovementioned findings, allowing optimal depiction of other smaller aneurysms distributed along the branches of the hepatic artery. Giving the deep hemodynamic instability, the patient died shortly before undergoing embolization

the pancreatic-duodenal artery (Fig. 3). In 15 cases (55 %), CT has identified a retroperitoneal hematoma, pointing out the site of bleeding: four cases from pancreatic-duodenal artery (Figs. 4, 5, 6), one case from sacral artery, one case from right subphrenic artery, one case from left subphrenic artery, three cases from lumbar artery (Fig. 7), two cases from ileo-lumbar artery (Fig. 8), two cases from obturator artery (Fig. 9), and one case from right testicular artery (Fig. 10). However, in one case (5 %), the bleeding origin was not recognized at CT, identified at surgery as small

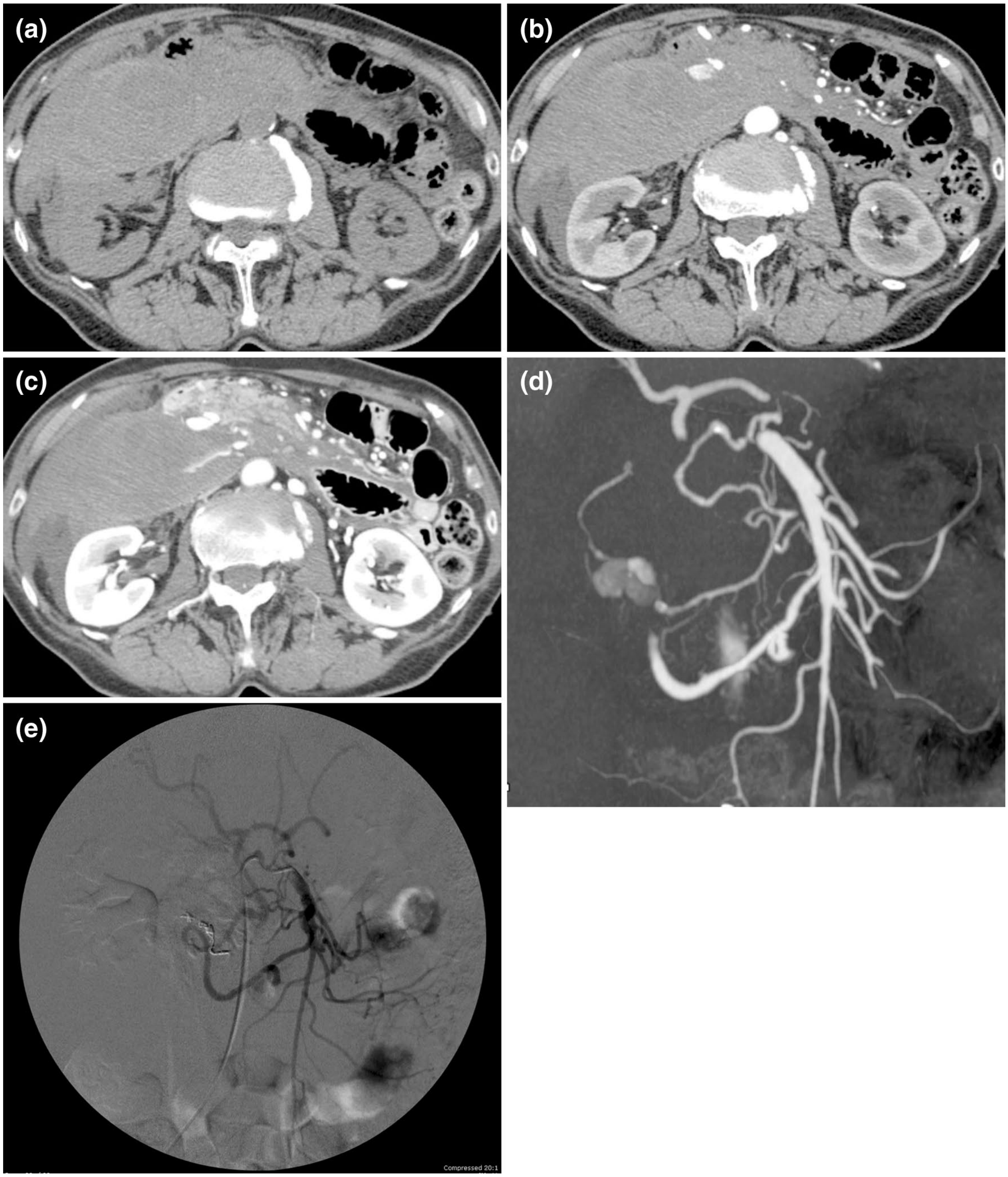


Fig. 4 A 75-year-old woman submitted to chronic antiplatelet treatment suffering severe epigastric and right flank pain. The CT scan shows a heterogeneously hyperdense retroperitoneal collection with contextual fluid–fluid levels **(a)**. The axial CT scan acquired in the arterial phase demonstrates signs of active bleeding **(b)** with evidence of the so called *"signal flare" sign* **(c)**. MIP reformation image depicts that the bleeding originates in the territory of the superior mesenteric artery and also the occlusion of the celiac artery origin **(d)**. Digital subtraction angiography confirms that the bleeding site is at a slender branch of the superior mesenteric artery. Angiography performed after embolization with microcoils and Spongostan demonstrates absence of arterial bleeding **(e)**

bleeding of adrenal metastases into the subphrenic space (Fig. 11).

CT has identified a contrast medium extravasation in the arterial phase in 17 patients (63 %): 13 patients were treated successfully with intervention in the emergency setting. Two patients were treated by open-surgery for sudden worsening of hemodynamic conditions. One patient underwent open-surgery to remove a bleeding adrenal metastasis with nephrectomy. Two patients died before undergoing DSA and surgery for hemodynamic complications.

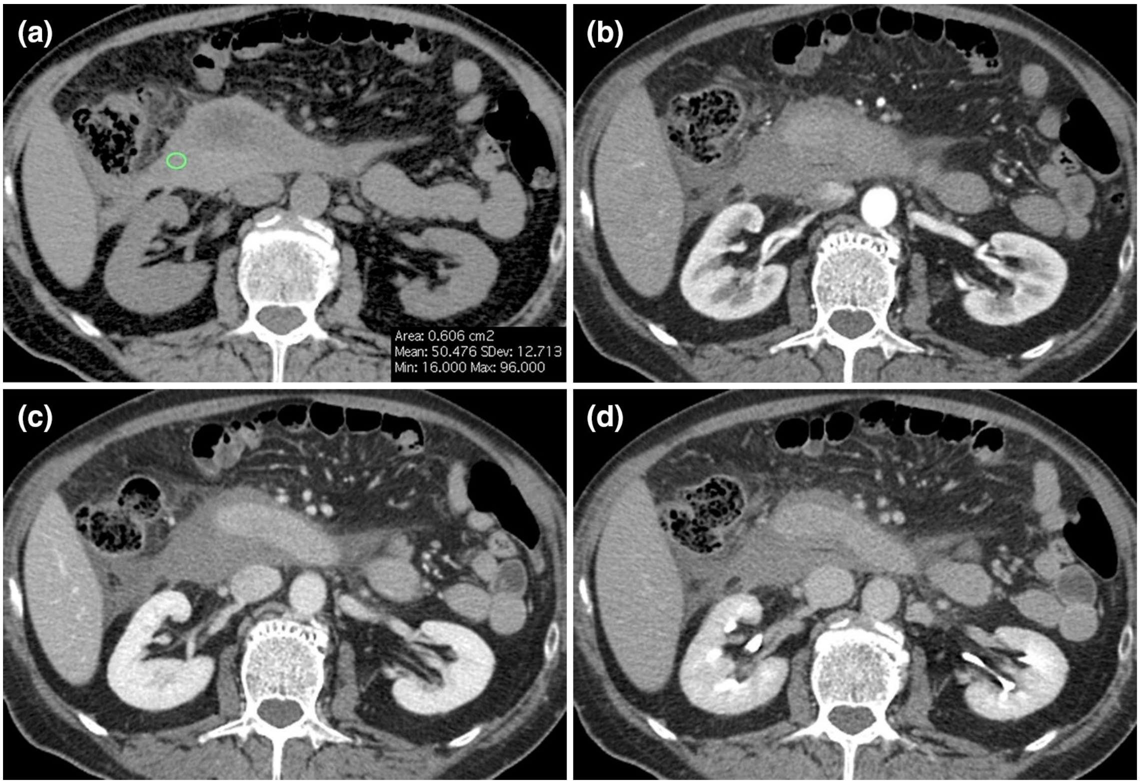


Fig. 5 A 62-year-old man suffering sudden epigastric pain. Non-contrast axial CT scan **(a)** shows a well-defined fluid collection with blood density values (mean 50 HU) adjacent to the second portion of the duodenum. The CT scans in the arterial **(b)**, portal **(c)**, and delayed phases **(d)** show no signs of active bleeding. Therefore, the patient was successfully treated conservatively and underwent clinical and instrumental follow-up

Ten patients (37 %) with SRH were treated non-operatively with clinical and laboratory monitoring and follow-up with CT or ultrasound examinations, until resolution of the hematoma. Particularly, in three cases, CT showed signs of active venous low-flow bleeding, detectable only in the portal phase and, for this reason, patients received a non-operative management. CT revealed retroperitoneal hematomas without active bleeding in remaining seven patients.

Discussion

Spontaneous retroperitoneal hemorrhage is a rare disease associated with data limited to case reports and small case series, with a prevalence in elderly patients undergoing chronic antiplatelet or anticoagulant treatment [4] or dialysis [8]. Symptoms often appear fuzzy, non-specific, and difficult to classify in the initial phase. They can be represented by general abdominal pain in the epigastric region, in the region of the hips or radiated to the lumbar region, pelvis, and legs [2–4]. In cases of massive spontaneous bleeding, with initial onset of cardiovascular decompensation, suspicion of bleeding is more suggestive.

Main causes can be essentially divided into parenchymal bleeding and vascular bleeding.

Parenchymal bleeding

Parenchymal bleeding is often related to renal or adrenal injuries.

Wunderlich's syndrome is a clinical condition defined as a spontaneous renal bleeding of non-traumatic origin [9]. Based on the literature, various etiologies have been suggested [10]. Benign and malignant renal neoplasms and cystic disease can be the etiology of bleeding. Renal cell carcinoma [11] and angiomyolipoma [12] seem to be the major etiology. CT scan clearly depicts both the primary tumor and signs of spontaneous rupture [13].

Cases of spontaneous rupture of adrenal masses include pheochromocytoma [14], myelolipoma [15], cortical adenoma, adrenocortical carcinoma, and metastases [16]. CT of adrenal hemorrhage appears as a round solid adrenal mass with attenuation comparable to soft tissue, which decreases

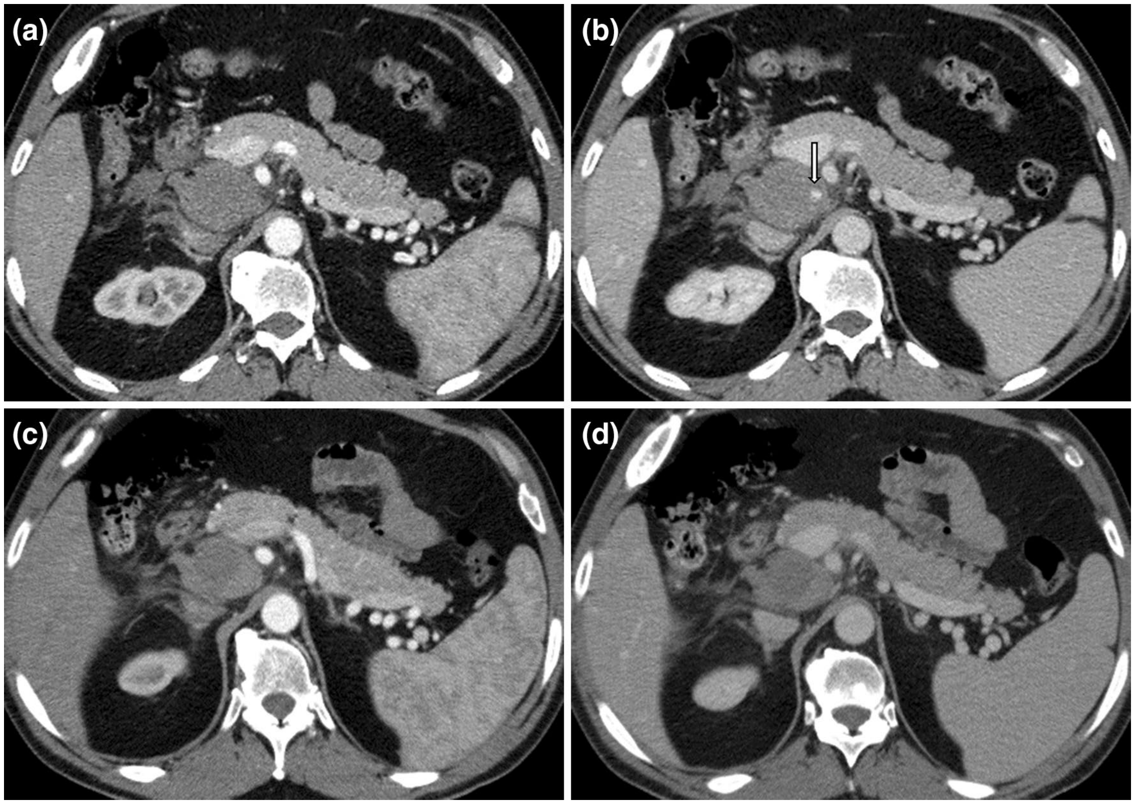


Fig. 6 A 51-year-old man suffering severe left flank pain. Arterial phase CT scan shows a circumscribed high-density fluid collection in peri-pancreatic space without signs of medium contrast extravasation **(a)**. CT scan in the portal phase demonstrates a minimum "jet" of active bleeding in the contest of the hematoma **(b)**. Patient was successfully treated conservatively and underwent clinical and instrumental follow-up. CT scan performed 1 week later in arterial **(c)** and portal **(d)** phases illustrates spontaneous cessation of bleeding

in size during follow-up [17]. MR is very sensitive and specific for diagnosing adrenal hemorrhage and determining if blood is the sole component of the hematoma [18].

"Vascular" bleeding

Primary causes of vessel injuries include rupture of splanchnic arteries aneurysms [19, 20], arteriovenous malformations [21], or disease resulting from atherosclerotic or inflammatory small vessels injuries [22, 23] with a prevalence in patients with antiplatelet agents or anticoagulants [1]. In these patients, CT can identify the presence of aneurysmal dilatation and vascular abnormalities or suggest the origin related to the site of hematoma and of contrast extravasation [19–24].

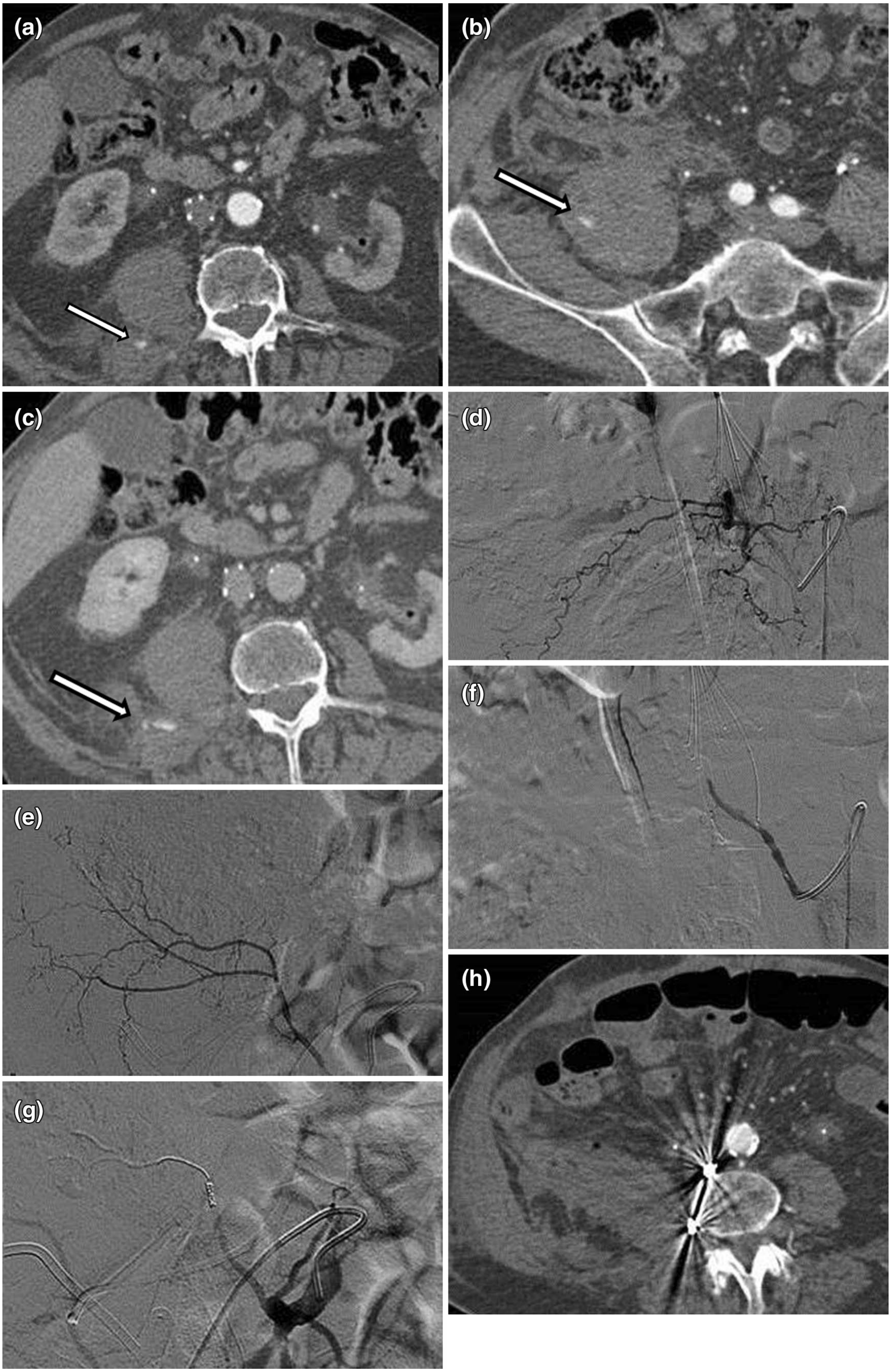
Current literature reports more frequently rupture of aneurysms and pseudo-aneurysms of the superior mesenteric artery branches, renal artery aneurysms, and pancreatic-duodenal artery aneurysms, the latter often associated with stenosis of the celiac artery [25–31].

Lumbar, ileo-lumbar and obturator artery were identified as source of bleeding in six patients; these sites represent other sources of non-traumatic retroperitoneal hematoma frequently described in the literature [25–27].

Fig. 7 A 85-year-old man submitted to anticoagulant and antiplatelet therapy due to venous deep thrombosis and pulmonary embolism. Arterial (**a**, **b**) and venous **(c)** phase scans show active bleeding in more than one area (*arrows*). Digital substraction angiography confirmed the active bleeding from a lumbar artery and from a branch of the ilio-lumbar artery (**d**, **e**). Angiographic scans after positioning of two microcoils of 3-mm injection of spongeal and a 4-mm vascular plug **(f)** and one microcoil of 2-mm injection of spongeal showing the stoppage of bleeding **(g)**. Axial CT **(h)**, coronal **(i)**, and sagittal **(j)** images performed after 2 weeks before patient's discharge confirmed the evidence of organized hematoma, without blushing or signs of infection ▶

Imaging

X-ray and ultrasound examination are often the first imaging examination for patients with mild to moderate symptoms as pain in the epigastric region, hips, and back. Their role is currently confined to the preliminary exclusion of G.I. tract perforation and for identification of other more common causes of acute abdomen, especially if related to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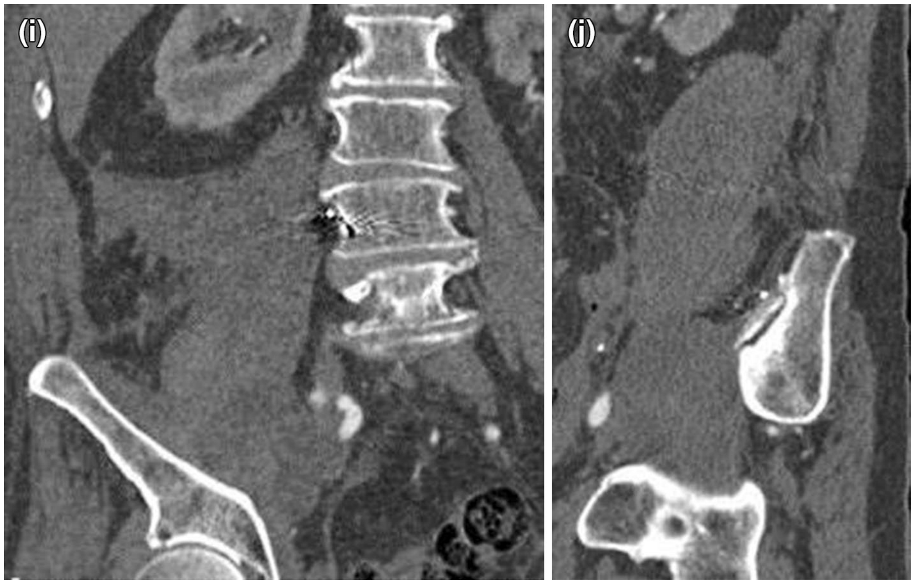

Fig. 7 continued

intra-peritoneal origin or of the urogenital tract. Known limits of US in the evaluation of the retroperitoneum are generally related to meteoric distension of the intestinal loops and poor patients cooperation in the majority of cases [7–35].

CT scan is usually performed in patients with drug-resistant pain symptoms or in case of uncertain ultrasound diagnosis; more often, a CT scan is performed as the first exam to quickly get the correct diagnosis of any intra and/or retroperitoneal disease in patients with severe symptoms, worsening of hemodynamic conditions, or clinical suspicion of an abdominal bleeding source. For this reason, CT plays a primary role in the detection of retroperitoneal bleeding, its location, size, and source, with high sensitivity and specificity [1, 3, 7, 34]. Some authors have highlighted the importance of a deep knowledge of the anatomy of the retroperitoneal fascial planes [36].

The execution of CT with injection of intravenous contrast with multiphase acquisitions is an essential issue both for early diagnosis and management of patients with suspected abdominal and/or retroperitoneal bleeding, allowing optimal detection and characterization of vascular structures [36–39].

At baseline acquisition, a recent hematoma appears as a soft tissue density mass (30–50 HU) that sometimes displaces the adjacent structures. In the first hour after bleeding, an area of higher density surrounded by serum of relatively lower density, "the sentinel clot sign," may suggest the bleeding site [37, 38]. In the next phases, a fluid–fluid level in the context of the hematoma, known as *'hematocrit effect'*, can be visible (Fig. 4). This sign is generated by the stratification of cellular elements heavier and serous fluid supernatant [39, 40].

If active bleeding is present in the context of a hematoma with fluid–fluid level, it is possible to identify the '*signal flare sign*' (Fig. 4), generated by the different gravitational weight that determines layering of the contrast medium between cellular and fluid component [40].

The multiphasic CT acquisition requires high flow injection of contrast medium (4–5 ml/sec) to differentiate hematomas actively supplied in the arterial phase from venous bleeding. Furthermore, CT can help detection of contained vascular lesions such as aneurysms or pseudo-aneurysms within a hematoma.

A technically correct CT exam allows, with high diagnostic confidence, to exclude significant arterial supply in the context of a hematoma. This distinction is essential from a management view-point [41].

On CT-angiography imaging, *hemorrhage* is defined as free extravasation of contrast media that persist and enlarge on delayed images and *pseudoaneurysm* as a round or ovoid cavity, communicating with an injured vessel wall, that shows wash out on delayed phase. *Arteriovenous fistula* is defined as early, simultaneous vessel enhancement of both artery and vein. From a therapeutic view-point, arterial active bleeding lesions can be safely treated with angiographic embolization. On the other way, exclusion of a significant arterial supply in the context of a hematoma initially addresses the patient toward a non-operative management, with laboratory and instrumental

Fig. 8 A 79-year-old man submitted to anticoagulant and antiplatelet therapy, with lumbar pain from 2 weeks. Non-contrast CT scan demonstrates a large retroperitoneal hematoma in the context of the iliopsoas muscle, with excellent representation of the "*hematocrit effect*," a blood-plasma level seen with acute re-bleeding into an older blood collection **(a)**. Arterial phase CT scan shows an active bleeding in more than one area (**b**, *arrows*), with *"signal flare,"* corresponding to the layering of the contrast medium between cellular and fluid component. Digital substraction angiography confirmed the active bleeding from a branch of the ilio-lumbar artery **(c)**. Angiographic scan after injection of spongeal showing the cessation of bleeding **(d)**

follow-up. Existence of intermittent bleeding can be supposed, when CT-angiography does not demonstrate any source of active bleeding and the hematoma increases in size. Actually, in these patients, DSA is recommended [42–44].

Several studies on vascular traumas support the notion that a rigorous multiphase CT technique can address patients to a tailored management—i.e., intervention, surgical or conservative—[45–48]. This management approach can be safely extended to non-traumatic conditions. In all our cases, CT has appropriately directed patients to the proper management, confirming to be the cornerstone for a fast and correct diagnosis and treatment. Our data also show a high prevalence of active arterial bleeding among patients with retroperitoneal hematoma with source of vascular origin. This finding supports the relationship that exists between this event and a small vessels chronic disease [4–7].

Conclusions

Spontaneous retroperitoneal bleeding represents a pathological entity of difficult clinical classification, in which early diagnosis is crucial to prevent a severe involvement of clinical conditions.

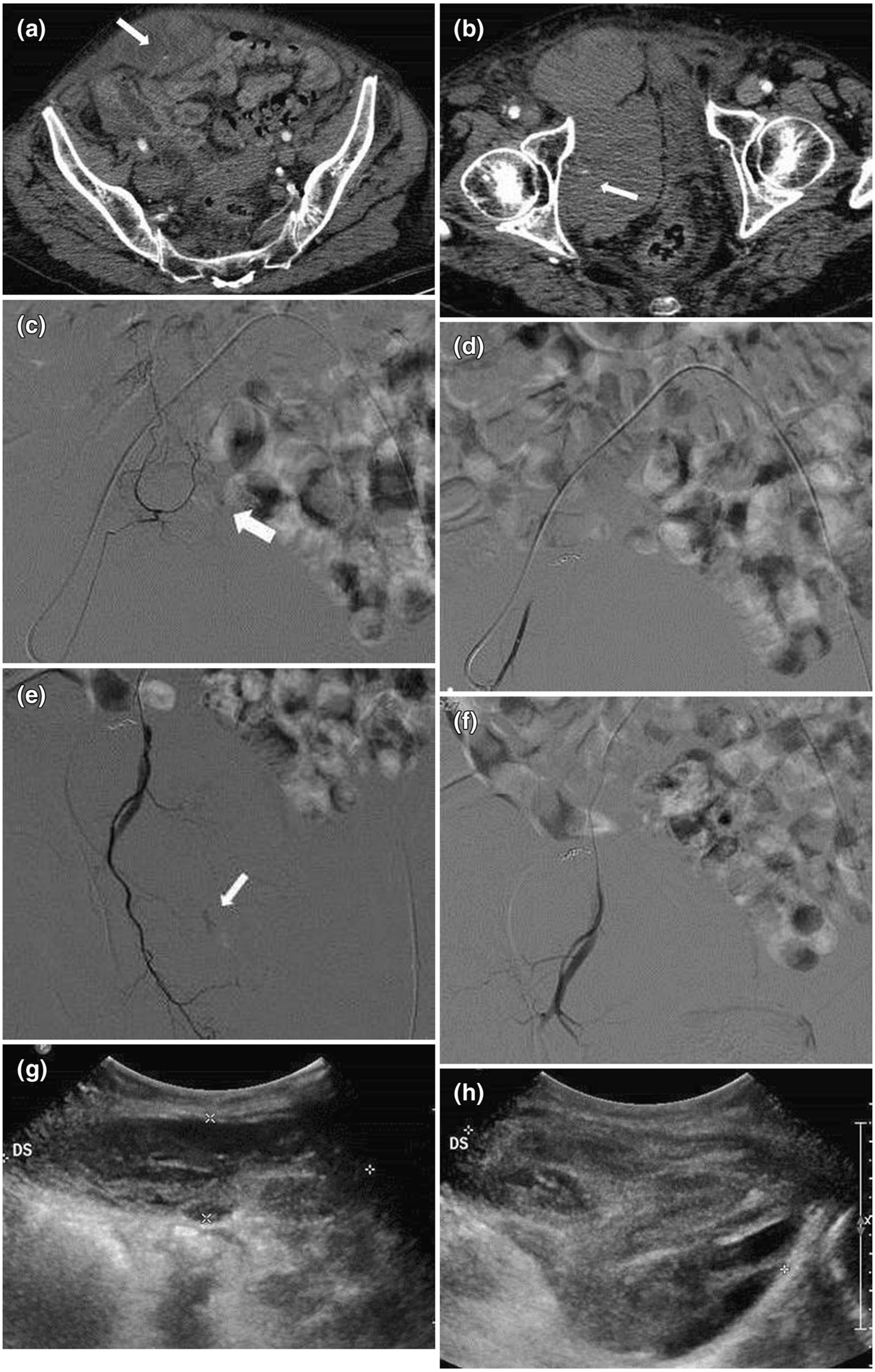

Fig. 9 A 64-year-old man submitted to anticoagulant and antiplatelet therapy. Axial CT scans show active bleeding in the context of the right rectal muscle (**a**, *arrow*) and the obturator muscle (**b**, *arrow*), respectively. Digital substraction angiography confirms the presence of active bleeding from right inferior epigastric artery (**c**) and from a branch of the right obturator artery (**d**) respectively. Angiography performed after embolization with one 3-mm microcoil and spongeal (**e**) and spongeal (**f**), respectively, showing the absence of active bleeding. Ultrasonography performed after 1 month illustrates organized hematomas of the right rectus muscle (**g**) and of the obturator muscle (**h**), respectively

Fig. 10 A 50-year-old man affected by HIV and acute renal failure with acute severe right back pain. Non-contrast axial CT scan shows a large high-density fluid collection in the anterior right para-renal space (**a**). CT scan in the arterial phase shows a "jet" of active bleeding in the contest of the hematoma (**b**). Maximum intensity projection images on axial (**c**) an coronal (**d**) planes suggest the territory of gonadal artery as the possible bleeding site. The selective catheterization of the right testicular artery documented the presence of at least 2 minute areas of contrast medium leakage at the level of the proximal third of the artery (**e**). Embolization of the proximal tract of the artery with metallic coils and Spongostan results in vessel occlusion with absence of persistent signs of arterial bleeding (**f**)

Multiphasic CT is the gold standard for the identification of a spontaneous retroperitoneal hematoma. Recognition of CT signs of active bleeding is the most important element influencing the timing of therapeutic treatment. Urgent embolization should be performed in cases of arterial bleeding or contained vascular injuries supplying the

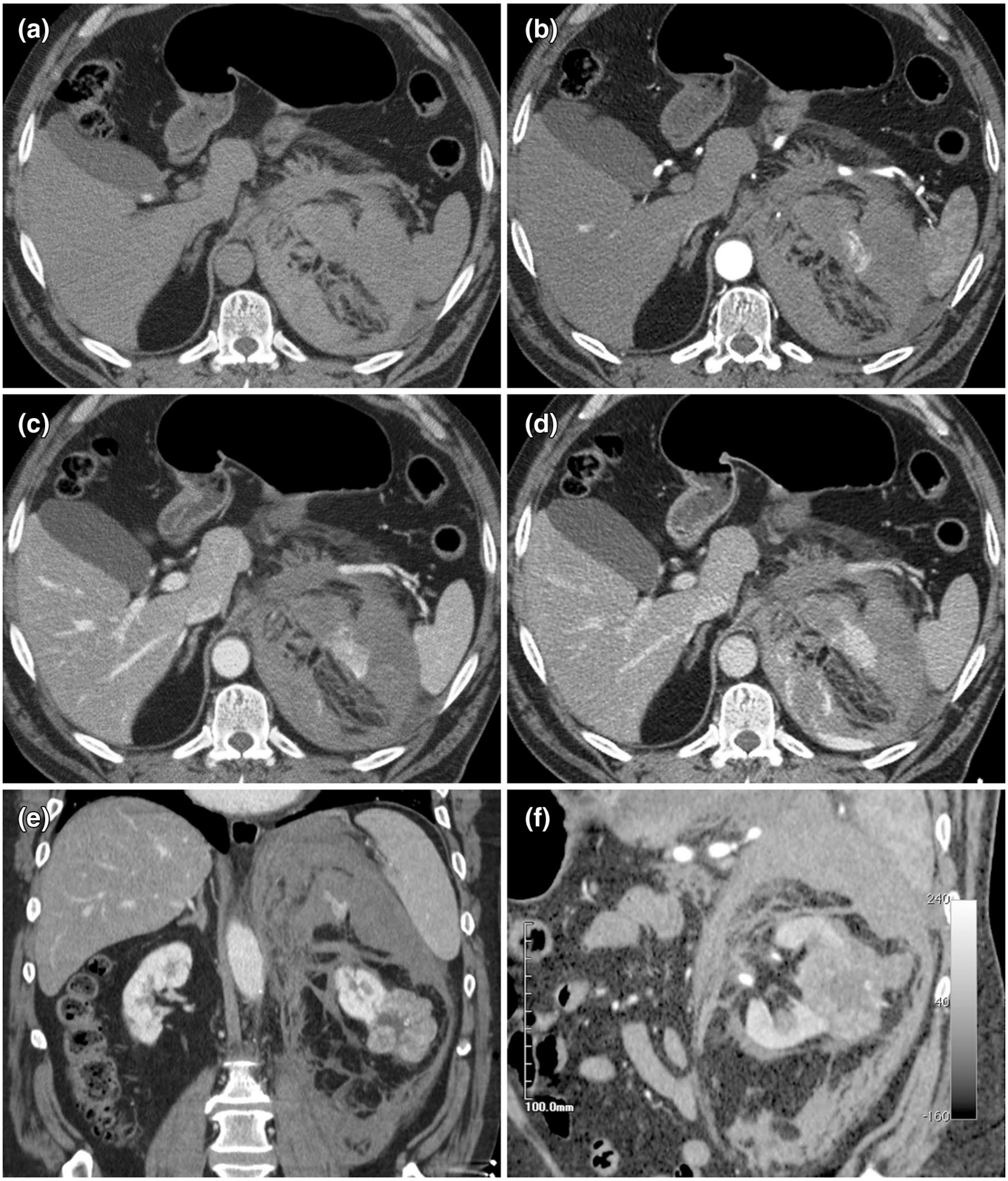

Fig. 11 A 67-year-old man admitted to the ER with dyspnea and acute back pain. Multiphasic CT scans at baseline (**a**), arterial (**b**), portal (**c**), and delayed phases (**d**) depict the presence of a large retroperitoneal hematoma spreading toward the subphrenic space with signs of contrast medium active extravasation. The MPR reconstruction images in the coronal (**d**) and sagittal (**e**) planes also demonstrate the presence of an unsuspected, large exophytic neoplastic lesion at the middle third of the left kidney. An emergency surgical treatment to control the bleeding and a left nephrectomy were performed at the same time. A small bleeding adrenal metastasis was finally diagnosed

retroperitoneal hematoma. Surgery is to be addressed in cases of actively bleeding hematomas associated with complication. Finally, an initial more conservative approach can be adopted in patients without signs of contrast extravasation or low-flow active bleeding.

Conflict of interest The authors declare no conflict of interest

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