CT Findings of Rupture, Impending Rupture, and Contained Rupture of Abdominal Aortic Aneurysms

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OBJECTIVE. With the increasing use of cross-sectional imaging for a variety of medical and surgical conditions affecting the abdomen and pelvis, familiarity with the imaging features of aneurysm rupture—and the findings suspicious for impending or contained aneurysm rupture—is crucial for all radiologists. This pictorial essay will review the imaging findings of rupture of abdominal aortic aneurysms and of complicated aneurysms.

CONCLUSION. Prompt detection of abdominal aortic aneurysm rupture or impending rupture is critical because emergent surgery may be required and patient survival may be at stake.

Abdominal aortic aneurysm rupture is the 13th leading cause of death in the United States [1]. The classic clinical triad of aneurysm rupture is present in up to 50% of patients and includes abdominal pain, pulsatile abdominal mass, and shock [2].

The risk of abdominal aortic aneurysm rupture relates to the maximum cross-sectional diameter of the aneurysm [1]. For aneurysms less than 4 cm in diameter, a 6-year cumulative incidence of rupture of 1% has been reported [2]. The risk of rupture for 4- to 5-cm aneurysms is estimated to be 1–3% per year, increasing to 6–11% per year for 5- to 7-cm aneurysms. Aneurysms with a cross-sectional diameter greater than 7 cm have a risk of rupture approximating 20% per year [1].

Rupture most commonly involves the posterolateral aorta with hemorrhage into the retroperitoneum (Fig. 1). Intraperitoneal rupture may also occur, originating from the anterior or anterolateral aspect of the aneurysm [2].

Abdominal aortic aneurysm rupture into the bowel usually involves the duodenum and is uncommon. Death due to exsanguination is the usual result, but slow leaks may present with melena and mimic peptic ulcer disease [2].

Rupture into the inferior vena cava is rare (Fig. 2). The clinical presentation of acute aortocaval fistula usually includes high-output cardiac failure, lower extremity swelling, and engorged veins [2].

Although the imaging findings of abdominal aortic aneurysm rupture are usually obvious, small ruptures can be mistaken for unopacified bowel, lymph node enlargement, or perianeurysmal fibrosis. Careful examination of the morphology of the aneurysm may aid in detecting subtle ruptures.

In a retrospective study, Siegel et al. [3] evaluated CT scans of patients with ruptured and nonruptured abdominal aortic aneurysms to determine whether a number of morphologic features were associated with rupture. The length of the aneurysm was not significantly different between the rupture and control groups. The ruptured aneurysms had significantly larger anteroposterior and transverse dimensions. The two groups had similar rates of lumen irregularity. Ruptured aneurysms contained a lesser amount of thrombus than aneurysms that were not ruptured. Thrombus calcification was seen more commonly in nonruptured aneurysms, which was thought to be related to the greater amount of thrombus in the nonruptured aneurysms.

Attenuation characteristics of the thrombus that were not associated with rupture included the homogeneous, diffusely heterogeneous, and low-attenuation periluminal halo patterns [3]. High-attenuation crescents within the mural thrombus were seen only in ruptured aneurysms in the study by Siegel et al [3]. Mural calcification patterns were also evaluated, and a focal discontinuity in otherwise circumferential calcification was rare and seen only in ruptured aneurysms. It was noted, however, that mural calcification was often discontinuous, and the discontinuity was most useful when shown to be new compared with a prior scan [3].

Keywords: abdominal aortic aneurysm, aorta, CT angiography, MRI

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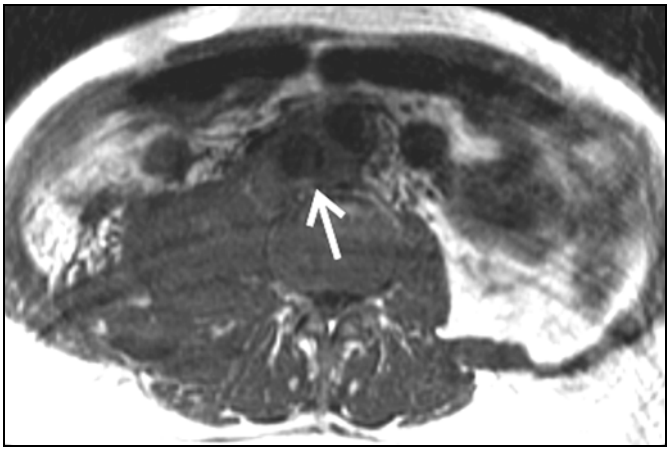

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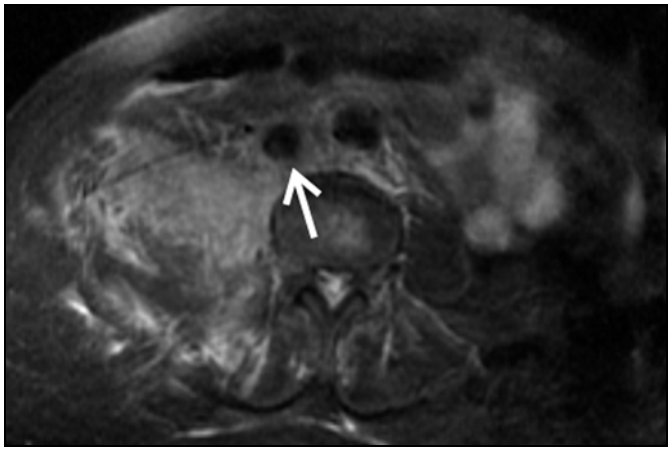

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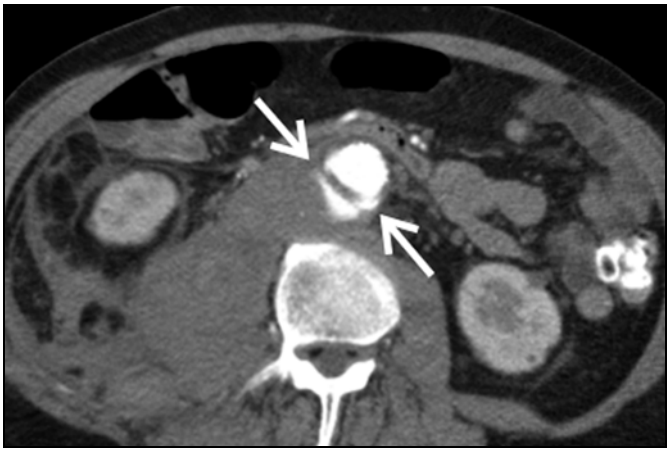

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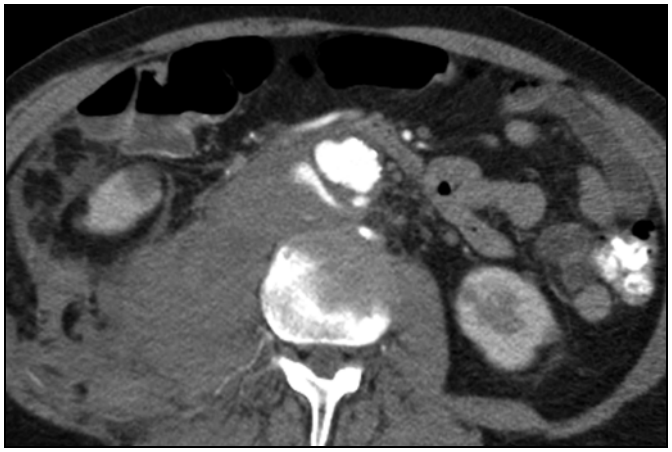

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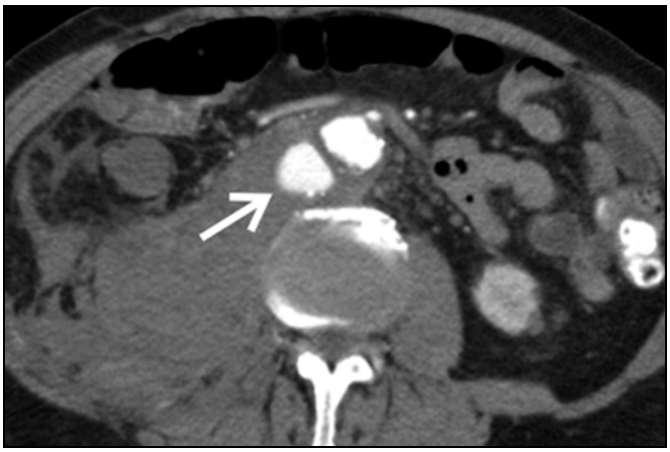

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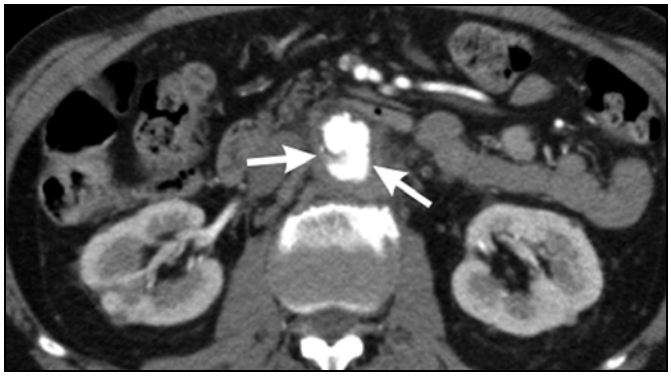
Fig. 1—67-year-old man with known abdominal aortic aneurysm who had 3-month history of lower back and right groin pain. Patient underwent MRI of lumbar spine and pelvis.
A and **B,** Axial T1- and T2-weighted MR images show large right retroperitoneal hematoma containing flow void (*arrows*).
C–**E,** Contiguous axial CT angiograms obtained immediately after MRI reveal large right retroperitoneal hematoma with contrast extravasation from posterolateral aorta (*arrows*, **C** and **E**). Operatively, large right retroperitoneal hematoma was seen, and pathologic evaluation revealed area of aortic wall discontinuity and associated organized hematoma.
(Fig. 1 continues on next page)

Fig. 1 (continued)—67-year-old man with known abdominal aortic aneurysm who had 3-month history of lower back and right groin pain. Patient underwent MRI of lumbar spine and pelvis.
F–H, CT angiograms obtained 3 months before MRI show irregular contour of posterolateral aorta (*arrows,* **G**) with surrounding soft-tissue density (*arrows,* **H**), compatible with unrecognized contained rupture.

F



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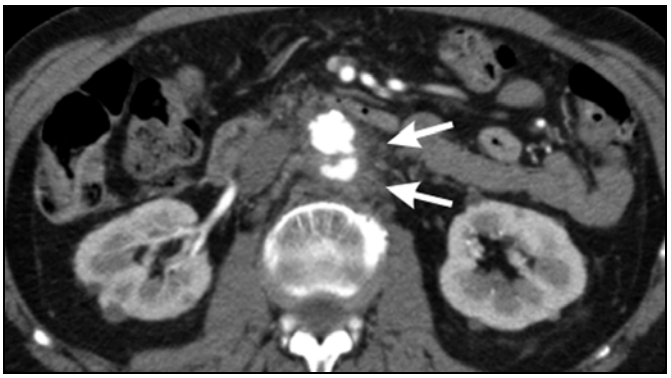

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Hyperattenuating Crescents: A Sign of Impending Rupture

Pillari et al. [4] described the concept of thrombus transformation with contrast extravasation into the thrombus and lumen irregularity as findings that may signify impending rupture. High-attenuating crescents in the wall of abdominal aortic aneurysms on unenhanced CT scans were initially described as a sign of impending rupture by Mehard et al. [5] (Figs. 3 and 4). In that retrospective study, the high-attenuating crescents were present in 77% of patients with complicated aneurysms, with complications including intramural hematoma, contained rupture, and frank rupture. The specificity of the "high-attenuating crescent" sign was 93%.

For a crescent to be considered high attenuation by Siegel et al. [3], the crescent needed to be well defined and of higher attenuation than the psoas muscle on enhanced scans or of higher attenuation than that of the patent lumen on unenhanced scans. In that study, crescents of increased attenuation were present in 21% of ruptured aneurysms and in none of the patients with intact aneurysms.

Hyperattenuating crescents have been attributed histopathologically to hemorrhage into the mural thrombus or into the aneurysm wall, with clefts of blood seeping from the lumen into the thrombus. The hemorrhage later penetrates the aneurysm wall, which weakens the wall. This places the aneurysm at risk for frank rupture, and prompt surgical consultation should be obtained [6].

Chronic Contained Rupture

Several reports in the literature have described abdominal aortic aneurysms associated with retroperitoneal hemorrhage in patients who are hemodynamically stable. The reported cases have variable histories of back pain or clinical symptoms atypical for aneurysm rupture including obstructive jaundice, femoral neuropathy, and symptomatic inguinal hernia. The duration and severity of symptoms, and the hemodynamic status of the patient, are used to differentiate acute from chronic rupture [7]. According to Jones et al. [7], chronic contained ruptures should meet the following criteria: known abdominal aortic aneurysm, previous pain symptoms that may have resolved, stable hemodynamic status with a normal hematocrit, CT scans

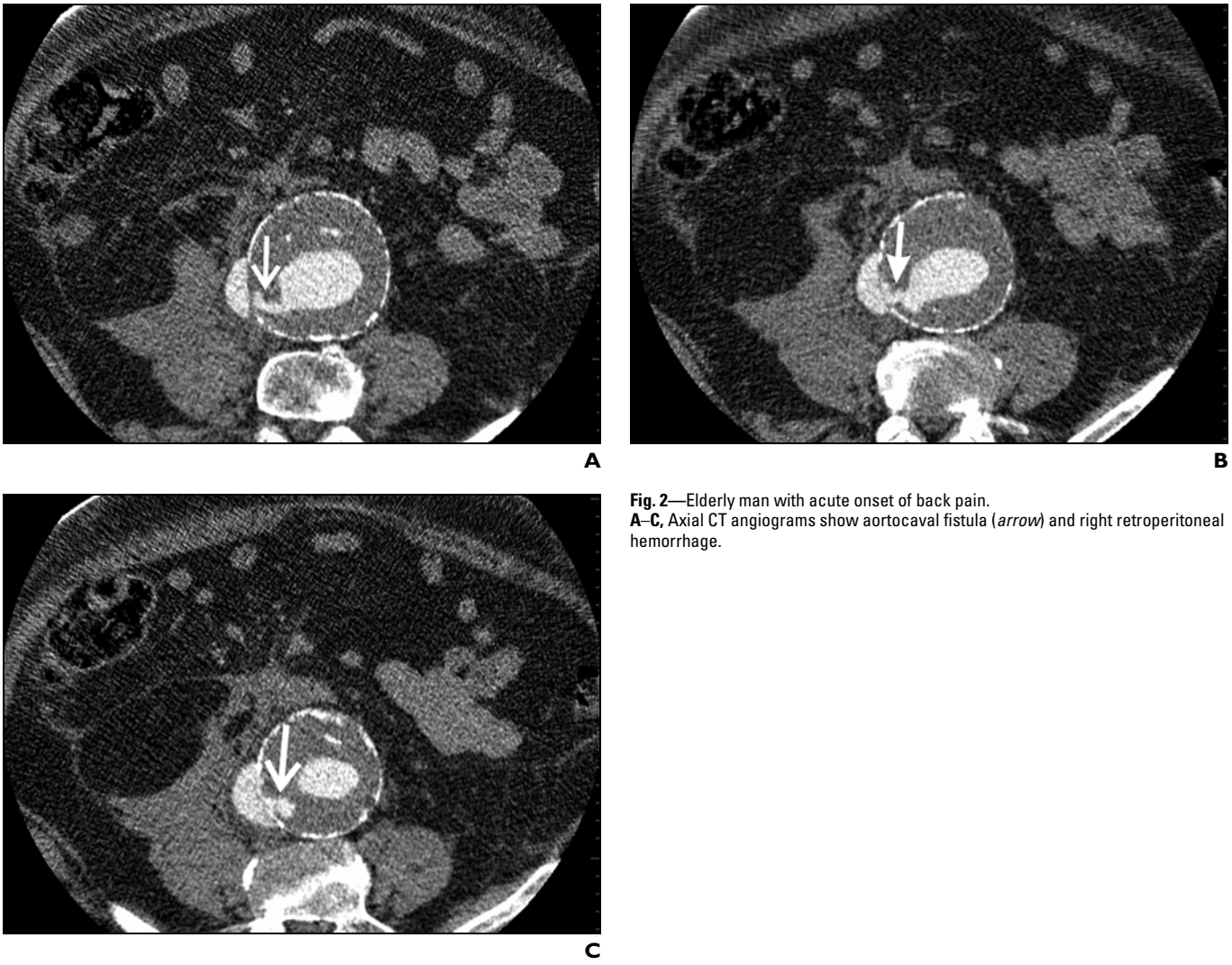

Fig. 2—Elderly man with acute onset of back pain.
A–C, Axial CT angiograms show aortocaval fistula (*arrow*) and right retroperitoneal hemorrhage.

showing retroperitoneal hemorrhage, and pathologic confirmation of organized hematoma (Fig. 1).

Draping of the posterior aspect of the aorta over the adjacent vertebral body is an indicator of aortic wall insufficiency and contained rupture, even in the absence of retroperitoneal hemorrhage (Figs. 5 and 6). Associated vertebral body erosion may be seen [8].

Differentiation of contained rupture from frank rupture of abdominal aortic aneurysms is vital in selecting proper treatment. Stable patients may benefit from preoperative assessment and management. Emergent surgery for aneurysms in stable patients carries an increased mortality rate, whereas urgent repair has mortality rates comparable to those of elective surgery [7].

Conclusion

Prompt detection of abdominal aortic aneurysm rupture is critical because survival is improved by emergent surgery. Identification of impending or contained rupture is equally important because these patients are at risk for frank rupture but can generally benefit from a more thorough preoperative assessment, followed by urgent surgery.

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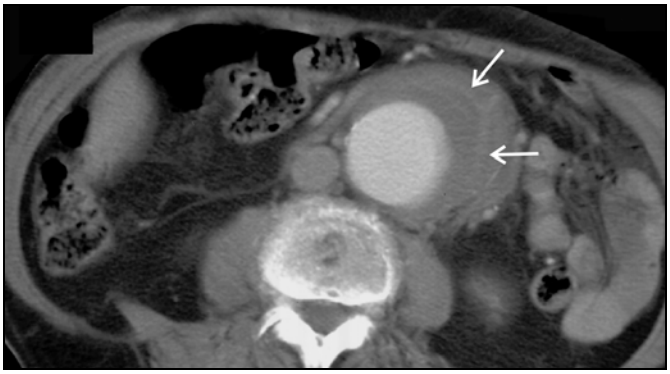

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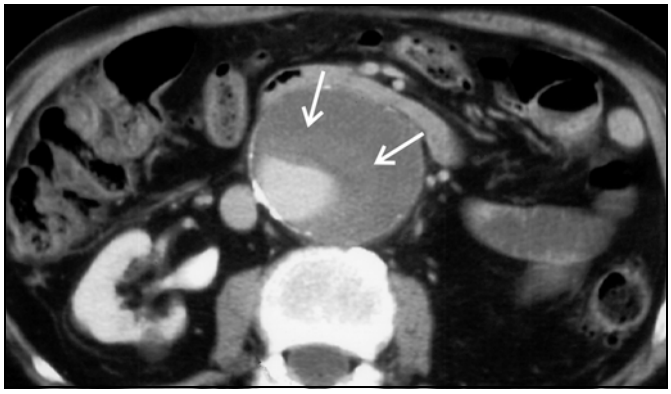
C

Fig. 3—87-year-old man with 12-hour history of severe back pain.
A–**C,** Enhanced axial CT images reveal 7 × 9 cm abdominal aortic aneurysm with high-attenuation crescents within mural thrombus (*thick arrows*, **A** and **B**) and minimal periaortic stranding (*thin arrows*, **C**). Contained rupture was present at surgery.



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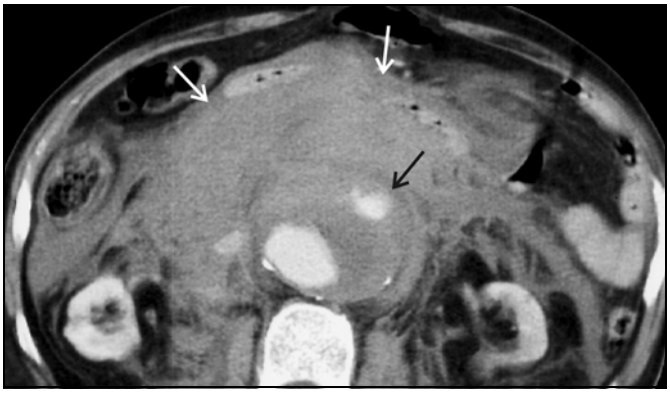

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Fig. 4—87-year-old man with known aneurysm and back pain.
A, Axial enhanced CT image shows 7-cm abdominal aortic aneurysm with faint crescentic area of increased attenuation within mural thrombus (*arrows*). Patient was not surgical candidate due to comorbid conditions.
B, Enhanced CT image obtained 3 months after **A** shows anterior aneurysm rupture (*black arrow*) with associated retroperitoneal hemorrhage (*white arrows*).

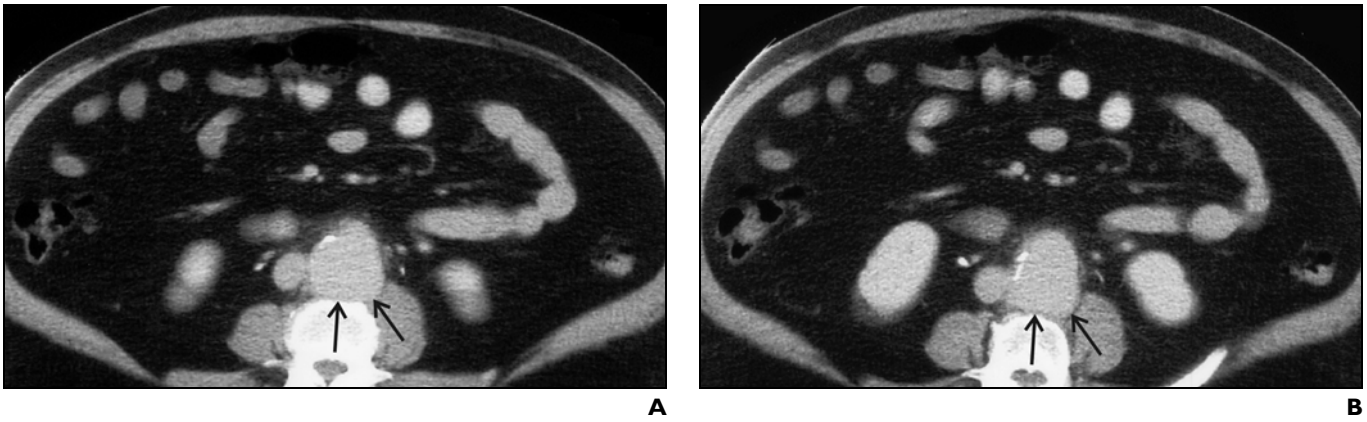

Fig. 5—Elderly man with 3-day history of back pain.
A and **B,** Enhanced CT images show 5-cm abdominal aortic aneurysm with draping of posterior wall over vertebral body (*arrows*). Contained rupture was found at surgery, with vertebral body visible through aortic lumen.

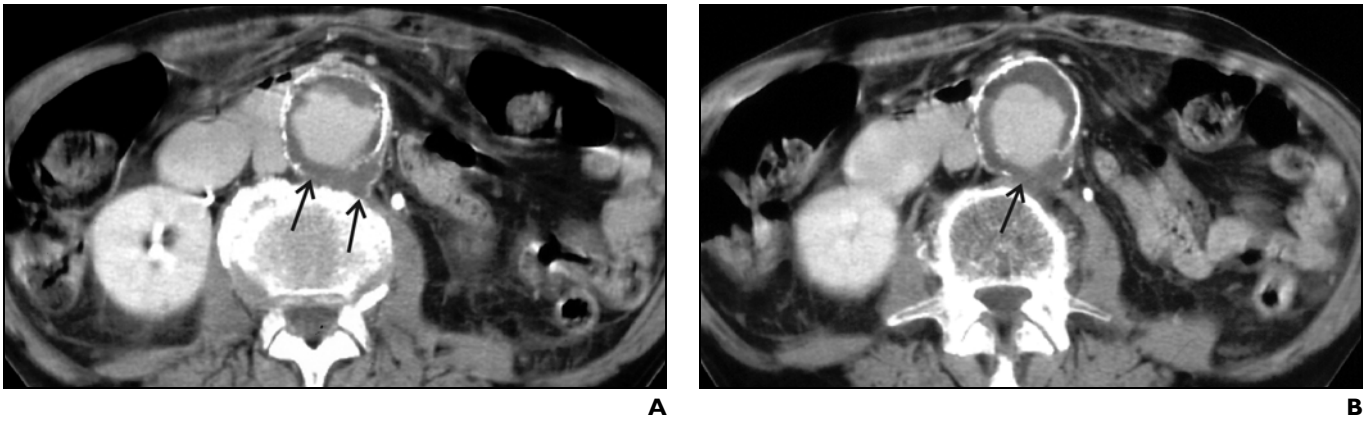

Fig. 6—Elderly man with abdominal pain.
A and **B,** Enhanced CT images show 5-cm abdominal aortic aneurysm with irregular posterior aortic contour and draping of aorta over vertebral body (*arrows*). Patient suffered cardiac arrest shortly after CT. Autopsy revealed pneumonia as cause of death, but aortic wall was paper thin and adherent to vertebral body.

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