Rupture of abdominal aortic aneurysm: Computed tomography findings

Poster No.: C-1568
Congress: ECR 2015
Type: Educational Exhibit
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Keywords: Arteries / Aorta, CT, Diagnostic procedure, Aneurysms
DOI: 10.1594/ecr2015/C-1568

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Learning objectives

1. To recognize the computed tomography (CT) findings of abdominal aortic aneurism (AAA) rupture.
2. To illustrate CT findings of contained AAA rupture.
3. To review CT imaging features suggesting imminent AAA rupture.
Background

Abdominal aortic aneurysm rupture is a surgical emergency and prompt diagnosis is essential. Due to its availability and short acquisition time, computed tomography is the imaging method of choice. Chronic contained rupture of AAA is a condition in which rupture occurs but then is stopped by the surrounding tissues. It constitutes a diagnostic challenge and the patient may undergo massive hemorrhage at any time. Since emergency surgery in stable patients carries a poorer prognosis than elective surgery, differentiation of contained rupture from frank rupture of AAA is essential for selecting the appropriate treatment. In this differentiation, not only CT findings should be taken into account, but also clinical findings (such as the duration and severity of symptoms as well as the patient's hemodynamic status).
Findings and procedure details

The presence of an aortic aneurysm and hyperdense fluid in the peritoneal cavity suggest rupture, even in non contrast enhanced CT Fig. 1 on page 6. This fluid can also be limited to the retroperitoneal space, forming a retroperitoneal hematoma adjacent to an AAA, which is the most common imaging finding of AAA rupture Fig. 2 on page 12.

After intravenous contrast administration it might be possible to find contrast outside of the aortic lumen or even identify the location of contrast extravasation Fig. 3 on page 7, both indicating rupture with active bleeding.

A ruptured AAA can, uncommonly, present as an aortoenteric fistula, usually to the duodenum. Imaging findings include intraluminal and periaortic gas, as well as contrast extravasation to the bowel. Still rarer is a rupture to the inferior vena cava with an acute aortocaval fistula.

Contained rupture is usually located to the posterior aortic wall. The draping of the aorta helps differentiate a contained from a frank rupture, the later being characterized by a large AAA with and adjacent higher attenuation retroperitoneal hematoma that dissects between fascial planes. The draped aorta sign is a focal blurring of aorta's posterior wall Fig. 4 on page 8 or when its shape adapts to the contour of the vertebral bodies Fig. 5 on page 6. This sign implies the presence of wall fragility or contained rupture, even in the absence of more obvious features of retroperitoneal hemorrhage.

Blood in direct contact with bone, combined with aortic pulsatility, can lead to bone destruction. As such, in patients with a draped aorta, there may be associated erosion of the vertebral bodies Fig. 6 on page 9 and Fig. 7 on page 10. Vertebral erosion can lead to an initial mistaken diagnosis of paraspinal abscess, primary retroperitoneal tumor and metastatic bone tumor. Magnetic resonance imaging might be helpful in the differential diagnosis. Bone erosion margins are usually smooth in a contained rupture, while irregular and poorly defined margins are seen in infected, mycotic aneurysms. Clinical symptoms or signs of infection, rapid expansion of the aneurysm, the presence of periaortic gas as well as other signs of infection, such as periaortic inflammation or abscess, also suggest a pyogenic infection. Infected aneurysms also have an high risk of rupture but different treatment.

An higher transverse diameter of an aortic aneurysm indicates an higher risk of rupture, particularly when it is superior to 7 cm Fig. 8 on page 14 or when it increases 10 mm or more in one year. Aneurysms with higher thrombosed area have a lower rupture risk - there is an inverse relationship between thickness of the thrombus and risk of rupture. It has been proposed that a circumferential thrombus protects against rupture. On the
other hand, an enlargement of the patent lumen predisposes to rupture. In addition, the presence of an hyperattenuating crescent in the thrombus is a sign of either acute or impending rupture Fig. 9 on page 13 and Fig. 11 on page 11. This crescent should be well defined and higher in attenuation than the patent lumen (on unenhanced scans) or the psoas muscle (on enhanced scans). This crescent has been attributed to hemorrhage into the thrombus or into the aneurysm wall. The hyperattenuating crescent sign is one of the earliest and more specific findings of the rupture process, Fig. 10 on page 15, Fig. 11 on page 11 and Fig. 12 on page 16.

A focal discontinuity in aortic wall calcifications (especially in concentric calcifications) suggests either instability or rupture of the aneurysm Fig. 13 on page 17. However, mural calcification is often discontinuous and, as such, the discontinuity sign is most useful if there was no discontinuity in prior scans.
Fig. 1: Ruptured AAA: peritoneal high density fluid as a sign of rupture

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**Fig. 5:** The draped aorta sign is associated with wall fragility and/or contained rupture. Note that the shape of aorta's posterior wall adapts to the contour of the vertebral bodies. The presence of contrast outside the central lumen of the aorta suggests rupture, apparently still contained but not thrombosed.

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**Fig. 3:** Ruptured AAA: peritoneal high density fluid as a sign of rupture. After contrast administration it is possible, in this case, to identify the local of extravasation

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Fig. 4: The draped aorta sign is associated with wall fragility and/or contained rupture. Note the blurring of aorta’s posterior wall.

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Fig. 6: The draped aorta sign is associated with wall fragility and/or contained rupture. Vertebral erosion may happen (arrow). See Fig 7 for bone window.

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Fig. 7: The draped aorta sign is associated with wall fragility and/or contained rupture. Vertebral erosion may happen (arrow). See Fig 6 for soft tissue window.

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**Fig. 11**: Rupture process (Fig 10 to Fig 12): an hyperattenuating crescent in the thrombus is one of the earliest and more specific findings of the rupture process. There is a small rupture (arrow on Fig 10), frequently not detected on CT, causing hemorrhage into the thrombus or into the aneurysm wall. Note on non-contrast enhanced scans Fig 11 and Fig 12 the presence of an hyperattenuation on the thrombus, outside luminal calcifications and, as such, in the aortic wall (arrow on Fig 12). This may evolve into frank rupture or contained rupture.

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Fig. 2: Ruptured AAA: retroperitoneal high density fluid as a sign of rupture

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**Fig. 9:** An hyperattenuation crescent suggests acute or imminent rupture. It is one of the earliest and more specific findings of the rupture process

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Fig. 8: An higher transverse diameter of an aortic aneurysm indicates an higher risk of rupture, particularly when it is superior to 7 cm. Note the presence of an almost completely thrombosed area of contained rupture on the left aortic border (arrow).

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**Fig. 10:** Rupture process (Fig 10 to Fig 12): an hyperattenuating crescent in the thrombus is one of the earliest and more specific findings of the rupture process. There is a small rupture (arrow on Fig 10), frequently not detected on CT, causing hemorrhage into the thrombus or into the aneurysm wall. Note on non-contrast enhanced scans Fig 11 and Fig 12 the presence of an hyperattenuation on the thrombus, outside luminal calcifications and, as such, in the aortic wall (arrow on Fig 12). This may evolve into frank rupture or contained rupture.

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Fig. 12: Rupture process (Fig 10 to Fig 12): an hyperattenuating crescent in the thrombus is one of the earliest and more specific findings of the rupture process. There is a small rupture (arrow on Fig 10), frequently not detected on CT, causing hemorrhage into the thrombus or into the aneurysm wall. Note on non-contrast enhanced scans Fig 11 and Fig 12 the presence of an hyperattenuation on the thrombus, outside luminal calcifications and, as such, in the aortic wall (arrow on Fig 12). This may evolve into frank rupture or contained rupture.

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**Fig. 13:** AAA calcification discontinuity may suggest either rupture or instability. Note the interruption of the aortic calcifications (arrow) though which a thrombosed contained rupture has happened.

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Conclusion

Computed tomography is a method of choice in the evaluation of AAA rupture, allowing not only the detection of ruptured aneurysms, but also situations of contained rupture and at risk of imminent rupture.
References


