10.1 Anatomy

The abdominal aorta is the extension of the thoracic aorta, running into the retroperitoneal space through an aortic hiatus, near to the inferior vena cava and in front of the spine. The abdominal aorta ends at the aortic bifurcation, where it divides into two common iliac arteries, right and left (Fig. 10.1, Table 10.1). No relevant anatomic variants are described.

Table 10.1 Abdominal aorta anatomy

<table>
<thead>
<tr>
<th>Tract</th>
<th>Arteries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supra-renal tract (yellow)</td>
<td>Celiac artery (1)</td>
</tr>
<tr>
<td></td>
<td>Superior mesenteric artery (2)</td>
</tr>
<tr>
<td></td>
<td>Lumbar arteries</td>
</tr>
<tr>
<td>Juxta-renal tract (green)</td>
<td>Right renal arteries (3)</td>
</tr>
<tr>
<td></td>
<td>Left renal arteries (4)</td>
</tr>
<tr>
<td></td>
<td>Lumbar arteries</td>
</tr>
<tr>
<td>Infra-renal tract (red)</td>
<td>Inferior mesenteric artery</td>
</tr>
<tr>
<td></td>
<td>Lumbar arteries</td>
</tr>
</tbody>
</table>

Fig. 10.1 Abdominal aorta anatomy
10.2 CTA Technique

Patient Preparation

Patients should be placed in a supine position on the CT scanner, with the arms behind the head (to reduce beam hardening artifacts).

Image Acquisition

Peripheral venous access should be made in one arm, preferably in the elbow, and must be not less than 20 G. No metal objects should be visible within the field of view.

1) Topogram acquisition must be on the coronal plane, from the diaphragmatic dome to the proximal portion of the thigh.

2) The region of interest (ROI) must be placed on the infra-renal abdominal aorta, avoiding intimal calcifications as much as possible (if using bolus tracking), which could alter the diagram of density variation and thus affect the examination.

3) Image acquisition in the caudocranial direction.

Fundamental points for an optimal angiographic study of the abdominal aorta are:

- High contrast media delivery rate (at least 4mL/sec);
- High iodine concentration contrast media (350-400 mgI/mL);
- Fast image acquisition time.

Image acquisition should start right after the threshold value is achieved (120-180 HU); distal vascular segments cannot be opacified by early acquisition. On the other hand, a delayed phase can cause venous and soft tissue contamination.

In older-generation scanners (8-16 detectors), the contrast injection length should be equivalent to the image acquisition time (Tables 10.2-10.3)

10.3 MRA Technique

This section will examine steady-state free precession sequences (SSFP), Gradient-echo T1 3D sequences (GRE), and time-resolved sequences.

Patient Preparation

Patients should be placed in a supine position on the CT scanner, with the arms behind the head; peripheral venous access should be made in one arm, preferably in the elbow, and must be not less than 20 G. No metal objects should be visible within the field of view. Phased array coils for the abdomen and pelvis are necessary.
Steady-State Free Precession sequences (SSFP) are non-contrast bright blood sequences (2D or 3D) (Table 10.4) used in MR imaging in patients with a contraindication or intolerance to paramagnetic contrast media. SSFP uses a low repetition time (RT) and a high flip angle and is used in vascular imaging and for MR enterography. Arterial and venous systems have the same intensity in SSFP imaging; several applications are used to distinguish one from the other.

- Acquisition of a localizer;
- FOV placed on the axial or coronal sequence;
- FAT and venous saturation.

All sequences are acquired in exhaled breath.

The main limitation is the difficulty in distinguishing between veins and arteries and the strong sensitivity to magnetic susceptible artifacts.

GRE T1 3D are sequences that combine high spatial resolution (high matrix values), low slice thickness (1 mm) and short acquisition times (Fig. 10.2, Table 10.5). As for other bodily applications, it is also necessary for aortic imaging to acquire a pre-contrastographic mask for digital subtraction imaging:

- Localizer acquisition;
- Pre-contrastographic mask acquisition (GRE) on the coronal plane (Fig. 10.2a);
- Real-time contrast media visualization with multiple low-resolution coronal images used as a visual trigger to synchronize image acquisition for optimal timing (Fig. 10.2b-d, Table 10.6);
- Post-processing application with digital subtraction imaging (Fig. 10.2).

All sequences are acquired in exhaled breath.

Time-resolved imaging is based on the examination of a vascular segment (in this case the abdominal aorta) repeated several times in single time lapse, with real-time visualization of the contrast media (Table 10.7).

Table 10.4 Technical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR (msec)</td>
<td>4</td>
</tr>
<tr>
<td>TE (msec)</td>
<td>2</td>
</tr>
<tr>
<td>FoV (mm)</td>
<td>315 × 315</td>
</tr>
<tr>
<td>Slice width (mm)</td>
<td>3</td>
</tr>
<tr>
<td>Matrix</td>
<td>256 × 256</td>
</tr>
<tr>
<td>Acquisition time (sec)</td>
<td>20</td>
</tr>
</tbody>
</table>

GRE T1 3D

Time-Resolved Sequences

Fig. 10.2 a GRE T1 non-contrast mask. b-d Real-time visualization of contrast media (arrow). e GRE T1 post-contrastographic sequence with digital mask subtraction
Localizer acquisition; Pre-contrastographic mask acquisition on the coronal plane; Concurrent contrast media administration and imaging acquisition (Table 10.7); Post-processing application with digital subtraction imaging (eventually with MIP reconstruction).

10.4 Abdominal Aortic Aneurysm

The abdominal aorta is considered aneurysmatic if the transverse diameter is > 3-3.5 cm; its prevalence in the population aged > 50 years is between 1 and 4% (gradually increasing with age).

Clinical Picture and Diagnosis

The pre-contrastographic phase can provide additional information, which is necessary for adequate pre-surgical planning, such as thrombus calcification or the crescent sign (a hyperdense crescent image in the aneurysmal sac, which is predictive of an upcoming rupture).

With a standard examination technique, the flow turbulence in the aneurysmal sac can produce irregular opacification of the vascular lumen (Fig. 10.3); this problem can be resolved by applying a small delay in the acquisition threshold or positioning the ROI directly in the aneurysmatic sac.

Imaging and Reporting

Abdominal aortic aneurysms can be classified as (Fig. 10.4):
1) Supra-renal: evaluating whether the dilatation involves the aortic thoracic tract;
2) Juxta-renal: the aneurysm originates at the same level as the renal arteries; it is necessary to evaluate potential renal involvement, by analyzing vascular segments and parenchymal perfusion (pay attention to the supernumerary arteries);
3) Infra-renal: these are the most common aneurysms, which originate > 1cm below the renal artery.

Localization

Table 10.5 Technical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR (msec)</td>
<td>3</td>
</tr>
<tr>
<td>TE (msec)</td>
<td>1</td>
</tr>
<tr>
<td>FoV (mm)</td>
<td>450 × 450</td>
</tr>
<tr>
<td>Slice width (mm)</td>
<td>1.5</td>
</tr>
<tr>
<td>Matrix</td>
<td>450 × 270</td>
</tr>
<tr>
<td>Acquisition time (sec)</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 10.6 Contrast media

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM concentration</td>
<td>0.5 M</td>
</tr>
<tr>
<td>CM volume (mL)</td>
<td>15 (0.2 mL/kg)</td>
</tr>
<tr>
<td>Saline flush volume (mL)</td>
<td>20</td>
</tr>
<tr>
<td>Delivery rate (mL/s)</td>
<td>1.5-2</td>
</tr>
</tbody>
</table>

Table 10.7 Technical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR (msec)</td>
<td>2-5</td>
</tr>
<tr>
<td>TE (msec)</td>
<td>1-2</td>
</tr>
<tr>
<td>Flip angle</td>
<td>20-50</td>
</tr>
</tbody>
</table>
The diameters necessary for adequate pre-surgical planning are:

1) *Distance between dilated aorta and renal arteries:*
   a. Longitudinal and transverse diameters;
   b. Point out the presence of supernumerary renal arteries to avoid polar infarct due to the endoprosthesis (Fig. 10.5);
   c. Vascular wall characterization, reporting evidence of thrombus or ulcerations.

2) *Aneurysmal sac:*
   a. Longitudinal, anteroposterior and transverse diameters (Fig. 10.6);
   b. Vascular wall characterization, demonstrating evidence of thrombi or ulcerations;
   c. Residual lumen dimensions;

---

**Fig. 10.3** Abdominal aortic aneurysm with internal blood flow turbulence

**Fig. 10.4 a,b** Infra-renal aortic aneurysm not involving iliac arteries. c MR coronal MIP of an aneurysm originating in the renal arteries; renal arteries (*white arrow*) and polar arteries (*yellow arrows*)

---

**Measurements**
d. Coaxial study of diameters, adapting measurements to the shape of the aneurysm, which is necessary to avoid serious bias in pre-surgical planning (Fig. 10.7).

3) **Distance between dilated aorta and common iliac arteries:**
   a. Longitudinal and transverse diameters;
   b. Vascular wall characterization, demonstrating evidence of thrombi or ulcerations;
   c. Iliac arteries diameters, pointing to possible morphological alterations (Fig. 10.8, Tables 10.8 and 10.9).

**Rupture of Abdominal Aneurysms**

The most common (10%) complication in subjects with true abdominal aneurysms with a diameter of > 6 cm is rupture (Figs. 10.9 and 10.10). A retroperitoneal hematoma adjacent to an abdominal aortic aneurysm is the most common imaging finding of abdominal aortic aneurysm rupture; retroperitoneal extension can be an acute or delayed finding. Computed tomography (CT) is the method of choice for the evaluation of acute aortic syndrome, because of the speed of the examination.
**Fig. 10.7**  
(a) Abdominal aorta VR.  
(b) Incorrect transverse diameter measured on axial image (DT = 37 mm).  
(c) Co-axial diameter on coronal plane (DT = 28 mm).

**Fig. 10.8** Essential diameters of the abdominal aorta. See also Tables 10.8 and 10.9.
and its widespread availability. Unenhanced CT scans make it possible to visualize periaortic blood and the extension into the perirenal space, pararenal space, or into the psoas muscles. Contained rupture of an abdominal aortic aneurysm is seen as a draped aorta sign, when the posterior wall of the aorta either is not identifiable as distinct from adjacent structures or when it closely follows the contour of adjacent vertebral bodies.

On contrast-enhanced CT images, active extravasation of contrast material is frequently demonstrated.

MR imaging is not recommended in emergencies because of the long acquisition time and the need for high-performance scanners.

Table 10.8

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transverse diameter of proximal non-aneurysmal aorta</td>
</tr>
<tr>
<td>2</td>
<td>Transverse diameter of the aneurysm</td>
</tr>
<tr>
<td>3</td>
<td>Transverse diameter of distal non-aneurysmal aorta</td>
</tr>
<tr>
<td>4</td>
<td>Transverse diameter of common iliac arteries</td>
</tr>
<tr>
<td>5</td>
<td>Transverse diameter of external iliac arteries</td>
</tr>
<tr>
<td>6</td>
<td>Transverse diameter of femoral arteries</td>
</tr>
</tbody>
</table>

Table 10.9

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Proximal non-aneurysmal aorta</td>
</tr>
<tr>
<td>B</td>
<td>Aneurysm</td>
</tr>
<tr>
<td>C</td>
<td>Distal non-aneurysmal aorta</td>
</tr>
</tbody>
</table>

**Fig. 10.9** *a* Draped aorta sign: no identifiable limit between aneurysm and psoas muscle (*white arrow*). *b* The posterior wall of the aneurysm is irregular (*yellow arrow*), with focal discontinuity on parietal calcification (sign of instability, not rupture)
Basic findings:

1) **Impending rupture signs**
   a. Crescent sign;
   b. Volumetric augmentation of the aneurysmatic sac;
   c. Discontinuity of aortic wall calcifications in abdominal aortic aneurysm is a sign of instability.

2) **Acute rupture**
   a. Retroperitoneal hematoma.

A left renal vein with a retro-aortic or circum-aortic course is the most common venous abnormality of renal vessels (8.7% retro-aortic course and 2.1% circum-aortic course); findings must be pointed out for optimal surgical planning (mainly to avoid surgical lesions) (Fig. 10.11).

An endovascular procedure is the treatment of choice for aortic abdominal aneurysm.

The most common endovascular grafts are the aorto-biiliac prosthesis; self-expanding, bifurcated grafts composed of two single units (one for the body and iliac branch, the other for the opposite iliac branch). Endoprostheses are covered grafts, with an external steel or nitinol unit and an internal graft of Dacron.

1) **Proximal connection**: covered or not covered if localized cranially or caudally to the origin of the renal arteries;
2) **Metallic body**;
3) **Secondary (or iliac) unit**;
4) **Distal connection**: localized in the common or external iliac arteries.
   An extra-unit can be added at the proximal connection if the grafts are not fully expanded, to avoid a type I endoleak.
The CT protocol involves a pre-contrastographic phase, followed by an angiographic phase and a delayed phase (120 sec); the pre-contrastographic phase is necessary to distinguish calcification from the CM, and the delayed phase serves to identify low-flow endoleak (Fig. 10.12).

MR imaging uses an angiographic protocol similar to CT (with the delayed phase); it is also possible to use time-resolved sequences to visualize contrast media flow in real time (yielding more information for endoleak classification).

In an MR study the possibility of susceptible artifacts due to the graft metallic body must be borne in mind.

For a comparison of CT and MR imaging techniques, see Fig. 10.13.

A more frequent complication after endovascular prosthesis positioning is the endoleak, defined as a blood flow external to the stent-graft and inside the aneurysmal sac (Figs. 10.14-10.16).

Endoleak classification is divided into four types; expansion of the aneurysmal sac without the presence of visible endoleak is commonly referred to as endotension or a type V endoleak.

Fig. 10.11 Retroaortic left renal vein (arrow)

Fig. 10.12 Hyperdense mass (a) is identified as calcification thanks to non-contrast phase (b)
**Fig. 10.13 a-c** CT imaging. **d-f** MR imaging. **g** Abdominal aorta VR

**Fig. 10.14 a** Endoleak type I: blood flow into the aneurysmal sac due to incomplete seal or ineffective seal at the end of the graft. **b** Endoleak type II: blood flow into the aneurysmal sac due to opposing blood flow from collateral vessels. **c** Endoleak type III: blood flow into the aneurysmal sac due to inadequate or ineffective sealing of overlapping graft joints or rupture of the graft fabric. **d** Endoleak type IV: blood flow into the aneurysmal sac due to the porosity of the graft fabric, causing blood to pass from the graft and into the aneurysmal sac.
Fig. 10.15 a,d Non-contrast MR and CT acquisition. b,e Arterial phase MR and CT acquisition. c,f Delayed-phase MR and CT acquisition. The yellow arrow points to an endoleak, probably type II due to the hypertrophic lumbar arteries.

Fig. 10.16 Time-resolved sequences make it possible to visualize CM leakage into the aneurysm in real time.
Aneurysmal sac dimensions are an indirect index of graft validity, and are essential for follow-up planning or possible repeat surgery (Fig. 10.17).

Other complications are endoprosthesis rupture, graft migration, aneurysmal sac infection, and retroperitoneal bleeding (Figs. 10.18 and 10.19).

Surgical prosthesis (or bypass) is the treatment of choice for aneurysms > 5 cm and for aortic rupture (Fig. 10.20); the surgical procedure consists of opening the aneurysmal sac with internal positioning of a surgical device (generally Dacron) and terminal anastomosis of the aorta and iliac arteries.

**Fig. 10.17** a Patient with endovascular graft. b After 6 months of follow-up, the aneurysm is slightly enlarged

**Fig. 10.18** Inadequate sealing of overlapping graft joints. VR (a) and MIP (b)
The study protocol consists of an angiographic phase possibly preceded by a non-contrast phase (Dacron is slightly hyperdense in CT imaging).

1) Evaluate the patency and integrity of the surgical device, pointing out occlusion or severe stenosis (Fig. 10.21); rupture is quite rare (generally iatrogenic);

2) Device morphology and positioning: surgical devices can be deformed, for example, by pre-anastomotic aneurysms (Fig. 10.22);

3) Pre- or post-anastomotic dilatation (Fig. 10.23);

4) Device infection (Fig. 10.24).

**Fig. 10.19** a Aneurysm infection with left-side psoas involvement (*arrows*). b After 2 months of follow-up, enlargement of the aneurysm is evident, with an infected fistula on the skin surface.

**Fig. 10.20** a Aorto-aortic bypass: *arrows* point to the two anastomoses. b Surrounding calcification (*arrow*) is part of the aneurysmal wall, which closes over the aortic device. c MR of an aorto-aortic bypass: *arrows* point to the two anastomoses.
Fig. 10.21 Aortobifemoral by-pass with left iliac branch occlusion; MIP (a) and VR (b)

Fig. 10.22 Aortic by-pass distortion (a) with right iliac branch occlusion (b) (arrows), probably due to inadequate pre-surgical planning or to an alteration of the pre-anastomotic aorta (for example an aneurysm)
Aortitis and Inflammatory Aneurysm

Aortitis and inflammatory aneurysm (or mycotic aneurysm) are uncommon conditions (0.7-1%) defined as an infectious break in the wall of an artery with the formation of a blind, saccular outpouching that is contiguous with the arterial lumen (Figs. 10.25-10.27).

*Staphylococcus* and *Streptococcus* species are the most common causes; infectious arteritis causes destruction of the arterial wall with a subsequent contained rupture.

**Clinical Picture and Diagnosis**

**Fig. 10.23** Pre-anastomotic aneurysm. *a* Yellow arrow, points to the proximal anastomosis. *b* Left renal artery runs into the aneurysmal thrombus

**Fig. 10.24** a, b Infected aorto-aortic bypass; the aneurysmal wall (*white arrow*) is thickened and hyperdense. A large infected collection is also present (*yellow arrow*)
Fig. 10.25 Infected aneurysm with perivascular inflammatory tissue.

Fig. 10.26 a b Infected aortitis with surrounding inflammatory tissue; c,d arrows point to maximum stenosis.
and formation of a pseudoaneurysm. An infected aneurysm can rapidly develop or enlarge pathologically, the wall of an infected aneurysm consisting of compressed perivascular tissue, hematoma, and fibroinflammatory tissue.

**Imaging and Reporting**

Either in MR and CT imaging a portal phase is necessary to demonstrate perivascular tissue enhancement. Retroperitoneal tissue edema is slightly hypodense in CT imaging and slightly hyperintense in T2 FS sequences.

Is necessary to pay attention to the involvement of perivascular structures such as ureter and the duodenum.

**Treatment**

- Surgery;
- Stenting;
- Pharmacological therapy.

### 10.6 Retroperitoneal Fibrosis

**Clinical Picture and Diagnosis**

Retroperitoneal fibrosis is characterized by a proliferation of fibrous tissue around the aorta. Retroperitoneal fibrosis is typically localized in the distal abdominal (infrarenal) aorta and the common iliac arteries; involvement of the pelvis is uncommon. About two-thirds of cases are idiopathic; otherwise it can be a manifestation of a systemic disease, caused by different drugs (such as beta blockers or antibiotics) and radiation therapy. There is a 3:1 male-to-female ratio among those affected by the disease. Perirenal involvement and significant compression on the ureters may be secondary to the extension of retroperitoneal fibrosis.

**Imaging and Reporting**

The area affected by active inflammation demonstrates high T2 signal intensity and early contrast enhancement, and areas of fibrosis show low T2 signal intensity and delayed contrast enhancement. The main differential diagnosis is with lymphoma (Fig. 10.28).

**Treatment**

Double J catheter to treat stasis nephropathy.
10.7 Penetrating Ulcer

A penetrating atherosclerotic ulcer is defined as an atherosclerotic lesion with ulceration that penetrates the internal elastic lamina; this penetration facilitates hematoma formation within the medium of the aortic wall (Fig. 10.29).

- CT: the ROI should be positioned in the true lumen, to avoid intramural hematoma.
  A pre-contrastographic phase can help to distinguish between hematoma and true vascular lumen;
- Point out the localization and extent of vascular lesions;
- Indicate the involvement of splanchnic vessels.

Surgical or pharmacological treatment.

Clinical Picture and Diagnosis

Imaging and Reporting

Treatment

Fig. 10.28 Fibrous peri-aortic tissue extends over the retroperitoneum, (a) surrounding the iliac arteries and ureters, with consequent stasis nephropathy, treated with double “j” catheters (arrows) (b,c)
10.8 Dissection

In the majority of cases this is an extension of thoracic dissection (see Chapter 7); primary involvement of the abdominal aorta is quite rare (Fig. 10.30).

- CT: The ROI should be positioned in the true lumen, to avoid a delay in the acquisition phase (a false lumen opacifies more slowly);
- It is necessary to point to splanchnic vessel origin, mentioning whether it from a false or true lumen; the main abdominal complications are due to ischemic events.

Post-dissectional ischemia of abdominal organs is classified using two different pathogenetic mechanisms (Fig. 10.31):

- In *static obstruction* the dissection involves the abdominal vessel (*red*: true lumen, *black*: false lumen); concurrent formation of an atherosclerotic thrombus in the false lumen exacerbates vascular stenosis (Fig. 10.31 c,d);
- In *dynamic obstruction* the dissection does not involve the abdominal vessel but the intimal flap is pushed by internal false lumen pressure and covers the vascular ostium (Fig. 10.31 a,b);
- In *mixed obstruction* the dissection involves the abdominal vessel and the intimal flap covers the ostium (Figs. 10.31 d,e and 10.32).

**Fig. 10.30 a,b** Abdominal aortic dissection with good evidence of the intimal tear.

**c** T2 weighted imaging of the same dissection; displaced intimal wall is slightly hyperintense.

**d-g** VR, MIP and axial images
Dynamic and static obstruction can lead to severe ischemic complications. Celiac obstruction can cause splenic or intestinal infarction.

Surgical or pharmacological treatment.

**Fig. 10.31** a,b Dynamic ischemia. c,d Static ischemia. e,f Mixed mechanism

**Fig. 10.32** Aortic dissection with renal ischemia due to a mixed mechanism. Right renal artery (a, arrow) is involved in the intimal dissection; on the inferior wall of the vessel there is a small thrombus (b, yellow arrow)
### 10.9 Aortoenteric Fistula

**Clinical Picture and Diagnosis**

This is defined as a communication between the aortic and intestinal (in the majority of cases duodenal) lumen, and is classified in primary (if atherosclerotic) or secondary (if iatrogenic) (Fig. 10.33). Symptoms include abdominal pain, hematemesis, and melena.

**Imaging and Reporting**

Simply filling the duodenum with water can facilitate duodenal wall analysis. The pre-contrastographic phase can help to individualize air bubbles in the aortic lumen. A CT scan with the use of intravenous contrast media may show contrast material extravasation from the aorta into the involved portion of the bowel, if a patent fistula is present.

**Treatment**

Surgical treatment.

---

### 10.10 Leriche Syndrome

**Clinical Picture and Diagnosis**

Complete obliteration of the aortic bifurcation (generally due to atherosclerotic disease) is called Leriche syndrome (Figs. 10.34 and 10.35). This term describes a complex of clinical symptoms (e.g., claudication, decreased femoral pulses) attributed to obstruction of the infrarenal aorta. A large network of parietal and visceral vessels may be recruited to bypass any segment of the aortoiliac arterial system by means of the formation of collateral channels.

**Imaging and Reporting**

Aortic occlusion can be classified as *juxtarenal*, or within 5 mm of the lower renal arterial origin; *infrarenal*, or cephalic at the origin of the inferior mesenteric artery; and *inframesenteric*, or caudal at the origin of the inferior mesenteric artery. It is also necessary to point out the concomitant occlusive disease affecting the visceral arteries.

**Treatment**

Surgical treatment.
Fig. 10.34  a Coronal VR.  b Infrarenal Leriche syndrome; iliac arteries are reperfused by the epigastric and lumbar vessels.

Fig. 10.35  a Right common iliac artery occlusion.  b Juxtarenal Leriche syndrome with distal reperfusion.  c,d Juxtarenal Leriche syndrome treated with axillofemoral bypass and femoro-femoral crossover.